Bonneagar Iompair Éireann
Transport Infrastructure Ireland

comhairle chontae na mí
meath county council

Cavan
Comhairle Contae an Chabháin
Cavan County Council

N3 Virginia Bypass

Statement of Intent

March 2022

BARRY
TRANSPORTATION

An Roinn Iompair
Department of Transport

Tionscadal Éireann
Project Ireland
2040

Document Control Sheet

Client:	Cavan County Council
Project Title:	N3 Virginia Bypass
Document Title:	Statement of Intent
File Name:	19408-BT-06-ZZ-RP-C_0001_SOI

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Document Revision				**Document Verification**			
Issue Date *(DD/MM/YY)*	**Revision Code**	**Suitability Code**	**Author** *(Initials)*	**Checker** *(Initials)*	***Reviewer*** As Per PMP *(Initials)*	**Approver** *As Per PMP (Initials)*	**Peer Review** *(Initials or N/A)*
16/12/2021	P01	S3	CJO	DOH	DOH	TC	N/A
30/03/2022	P02	S3	CJO	DOH	DOH	TC	N/A
30/03/2022	C01	S3	CJO	DOH	DOH	TC	N/A

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Glossary of Terms

Some of the terms explained hereunder have more precise, technical explanations in the relevant technical documents (referred to where applicable). The definitions included here are valid in the context of this report.

Term	Acronym (where applicable)	Definition
Common Appraisal Framework	CAF	A common framework for appraising transport investments in accordance with the Public Spending Code.
Form C		A geotechnical data form for structures summarising all geotechnical information relevant to the specified structure. The form follows the requirements detailed in Appendix F of the TII Publication (Standards) DN-STR-03001 *Technical Acceptance of Road Structures on Motorways and Other National Roads*.
Geotechnical Design Report	GDR	A report setting out the assumptions, data, methods of calculation, and results of the verification of safety and serviceability as required by the NSAI Publication (Standard) IS EN 1997-1:2005/A1:2013 + NA:2015 *Eurocode 7: Geotechnical design – Part 1: General rules (including Irish National Annex 2015)*. The report follows the requirements detailed in Appendix E of the TII Publication (Standards) DN-ERW-03083 *Managing Geotechnical Risk*.
Geotechnical Risk		A risk to the project, or the Road Authority's asset(s), created by the site ground conditions, construction, and/or operational activities. Geotechnical risks are identified and managed as per the requirements of the TII Publication (Standards) DN-ERW-03083 *Managing Geotechnical Risk*.
Geotechnical Team Leader	GTL	A chartered geotechnical engineer, with experience appropriate to the project being undertaken, who is employed by the Designer as Lead Professional to oversee and act as a focal point for the planning, procurement, interpretation, design, and implementation of the geotechnical aspects of the project.
Ground Investigation Report	GIR	A report presenting all available geotechnical information and an evaluation of that information as required by the NSAI Publication (Standard) IS EN 1997-1:2005/A1:2013 + NA:2015 *Eurocode 7: Geotechnical design – Part 1: General rules (including Irish National Annex 2015)*. The report follows the requirements detailed in Appendix D of the TII Publication (Standards) DN-ERW-03083 *Managing Geotechnical Risk*.
Preliminary Sources Study Report	PSSR	A report including the geotechnical risks, implications, and feasibility of all the project options being considered. The report is required for all projects which involve works covered by the TII Publication (Standards) DN-ERW-03083 *Managing Geotechnical Risk*, and follows the requirements detailed in Appendix C of that document.
Project Liaison Officer	PLO	The individual appointed to liaise with land and property owners, the public, and the Local Authority as per the requirements of the TII Publication (Guidelines) PE-PMG-02041 *Project Management Guidelines*.
Project Management Guidelines	PMG	A set of guidelines which provide a framework for a phased approach to the management of the development and delivery of National Road and Public Transport Capital Projects. These guidelines are applicable to all projects funded through TII and/or where TII is the Sanctioning Authority, unless otherwise instructed by

		TII. The guidelines are set out in the TII Publication (Guidelines) PE-PMG-02041 *Project Management Guidelines*.
Road Authority	RA	For the purpose of this Technical Document, the Road Authority shall be as defined under the Roads Act, or an alternative entity appointed by the Road Authority, as per the requirements of the TII Publication (Standards) DN-ERW-03083 *Managing Geotechnical Risk*.
Site Investigation	SI	Site Investigation or Ground Investigation Works.
Specification for Works	SPW	The Specification for Works (SPW) is a collective group of Standards documents under the Construction and Commissioning activity within the TII Publications system
Statement of Intent	SOI	A report identifying the known and/or suspected geotechnical risks and stating the scope, purpose, and estimated programme and cost of the initial geotechnical assessments. The report follows the requirements detailed in Appendix B of the TII Publication (Standards) DN-ERW-03083 *Managing Geotechnical Risk*.
Study Area		The area considered for the appraisal of all road-based and/or rail-based options of the project. The boundary of this area is indicative, and the project team may undertake studies/surveys beyond these boundaries.

Departments & Stakeholders

Departments & Stakeholders	**Acronym (where applicable)**
Barry Transportation	BT
Cavan County Council	CCC
Department of Transport	DT
National Transport Authority	NTA
Transport Infrastructure Ireland	TII

SECTION 1: SCHEME

1.1 Background

Virginia town and its environs experiences a level of both local and through traffic using the N3 that is contributing to congestion within the town centre, compounded by the relatively large number of Heavy Goods Vehicles (HGVs) passing through the town and making deliveries within the town. This has contributed to poor safety and environment for non-motorised, in particular vulnerable road users (VRU). The poor VRU safety and environment has been deteriorating within Virginia town centre and its environs, with shorter and intra-town trips that are more conducive to walking and cycling being discouraged and displaced with the prevailing traffic condition. In addition, several sections of the N3 in and around Virginia has been identified as High Collision Locations, with 4 fatal collisions and 10 serious injury collisions noted in the period 2012 – 2016.

In September 2019, Cavan County Council, in association with Meath County Council and Transport Infrastructure Ireland (TII) has commissioned Barry Transportation to develop a scheme to address the safety, congestion and environmental concerns that exist as a result of the high volume of traffic travelling along the N3 through Virginia town and the settlement of Maghera and Whitegate. The project is named the 'N3 Virginia Bypass' scheme, hereafter also referred to as the 'Project' or the 'Scheme' in the report.

The Phase 1 Project Brief concluded that the development of the N3 Virginia Bypass scheme is consistent with National, Regional and Local Policies and it will:

- Enhance Regional Accessibility and enhance connectivity and improve the resilience of the transportation of people, goods and services;
- Reduce traffic through Virginia town and the settlements of Maghera and Whitegate to enable improvement of the public realm environment and to facilitate improvements for walking and cycling that will provide a safer and healthier environment conducive to active travel;
- Improve journey time reliability for all travel modes, including road based public transport, within and through Virginia town, and the settlements of Maghera and Whitegate; and
- Support sustainable and equitable mobility to encourage modal shift to help meet Irelands Climate Change goals.

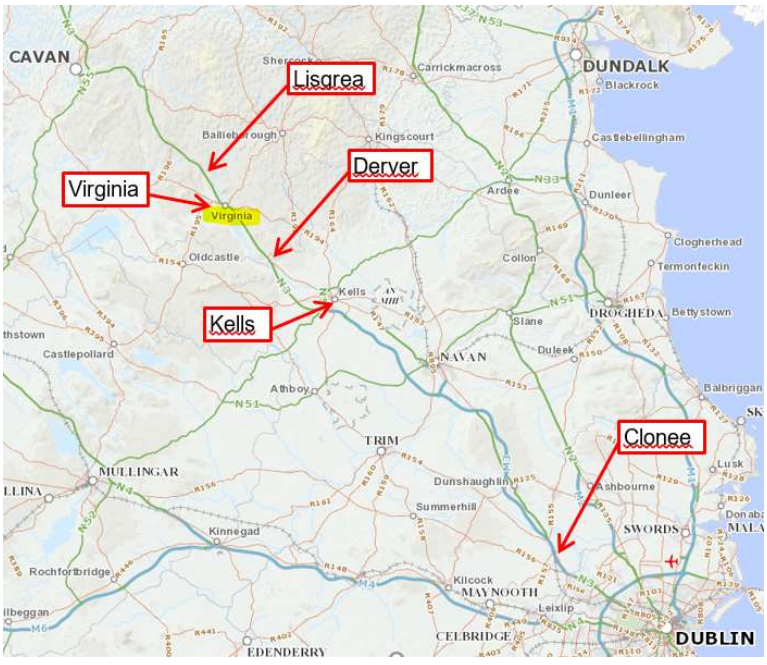

Figure 1: Location of Virginia along the M3/N3 Dublin to Cavan Route

The need for a bypass of Virginia was initially identified by Cavan County Council in the 1980's and was included as an indicative alignment in the Cavan County Development Plan of 1996. A bypass of Virginia was formally acknowledged nationally by its inclusion in the National Road Needs Study (1998) by the National Road Authority (NRA). Over the past twenty plus years, the following three Virginia Bypass schemes were proposed, each reaching various stages of development prior to suspension:

- Virginia Bypass (2003);
- Virginia Bypass as a 2+1 scheme (2004 - 2007); and
- N3 Edenburt to Cavan (2+2 scheme) (2008 - 2012).

1.1.1 Phase 1 Concept and Feasibility

In September 2019, Cavan County Council appointed Barry Transportation as Technical Advisors to provide the Engineering, Environmental, Economic and Appraisal services required to successfully deliver the Scheme through the planning and design phases; in accordance with the TII Project Management Guidelines Phases 1 to 4 inclusive.

The Phase 1 Project Brief concluded that the development of the N3 Virginia Bypass scheme is consistent with National, Regional and Local Policies and it will:

- Improve regional connectivity across the North-West Region encouraging economic development of the region.
- Improve connectivity and linkages for local trips within the town enhancing the development of Urban Expansion Areas.
- Address traffic congestion issues in Virginia town, associated with through traffic flow, and free up capacity on the existing road.

In December 2019, Cavan County Council prepared and issued the Phase 1 Gate Review Statement to Transport Infrastructure Ireland (TII) and sought their approval to proceed to Phase 2, Options Selection. On 20th December 2019 the TII confirmed approval to proceed to Phase 2 of the N3 Virginia Bypass Scheme.

1.1.2 Phase 2 Option Selection

The Option Selection process for the proposed Scheme is being undertaken in accordance with TII's Project Management Guidelines, in combination with TII'S Project Appraisal Guideline, and applicable regulations and guidance. The Option Selection Process examines the alternatives/options against defined criteria and sub-criteria, and the scheme objectives through a systematic three Stage appraisal approach. The three stages of the Option Selection Process are as follows;

- **Stage 1:** Preliminary Options Assessment;
- **Stage 2:** Project Appraisal Matrix; and
- **Stage 3:** Selection of a Preferred Option.

The purpose of the Option Selection Process is to identify the optimum solution having regard to the overall benefits and impacts based on the six criteria (see Section 1.1.4) to be considered for road transport projects.

1.1.3 Preliminary Options Assessment

The Stage 1 Preliminary Options Assessment was completed in October 2020. Within the Study Area, initial constraints were identified, and the planning and design work commenced with the identification of initial potential options. Ten options and nineteen links were assessed under the following three criteria to shortlist the number of options to be brought forward to Stage 2;

- Engineering;
- Environment; and

- Economy.

1.1.4 Project Appraisal Matrix

Stage 2 of the Option Selection process commenced in November 2020. A shortlist comprising five main options and five option variants were assessed under the following six criteria to identify the Emerging Preferred Option;

- Economy;
- Environment;
- Safety;
- Accessibility & Social Inclusion;
- Integration; and
- Physical Activity.

Following the completion of the Multi Criteria Analysis, Option C Variant 2 (Cv2) was identified as the Emerging Preferred Option. A non-statutory public consultation (Public Consultation 3) was undertaken between 19th August to 13th September on the Emerging Preferred Option Corridor as part of Stage 2.

1.1.5 Selection of a Preferred Option

Following the completion of the Stage 2 Project Appraisal Matrix, Option C Variant 2 (Cv2) was confirmed as the Preferred Option having regard to the overall benefits and impacts based on the six criteria to be considered for road transport projects.

Following the identification of the Preferred Option, a Project Appraisal Balance Sheet (PABS) was undertaken to assess and summarise the benefits and impacts of this option.

The 'Preferred Option' corridor has been identified in accordance with the TII's *Project Management Guidelines*.

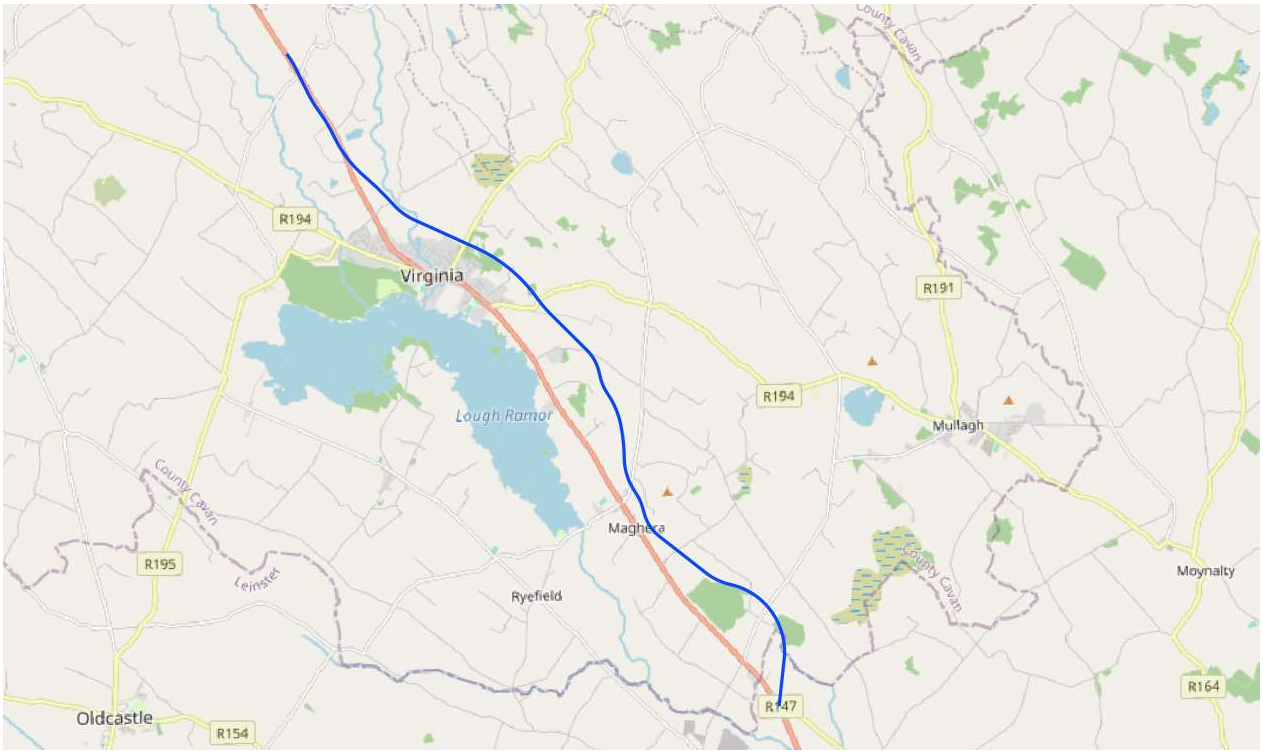

Figure 2: Preferred Option – Option C Variant 2 (Cv2) corridor

Corridor Option Cv2 is approximately 14.445km in length and commences at the N3/R147 roundabout at Derver. From Derver, the road runs approximately parallel to the existing N3, east of Virginia town and Lough Ramor, through main agricultural and forestry land, where it ties into the existing N3 just north of Lisgrea Cross via a new proposed roundabout.

There are 5 no. junctions proposed along the route, summarised below:

- Ch. 0+000m - link to the existing N3 dual carriageway north of Kells
- Ch. 6+500m – access to the south of Virginia town
- Ch. 10+025m – Virginia town / R178 (Bailieborough Road),
- Ch. 12+000m – access to the north side of Virginia town / R194 (Ballyjamesduff Road)
- Ch. 14+445m - link to the existing N3 just north of Lisgrea Cross via a roundabout

The proposed route intersects several local and regional roads and a number or rivers and streams which will require bridges or culverts. The route will also be required to include for accommodation overbridges/underpasses to service severed lands etc however details of these structures are to be developed during Phase 3 of TIIs Project Management Guidelines - Design and Environmental Evaluation

1.2 Purpose of Report

The Statement of Intent provides a framework to record the process for the management of geotechnical deign risks associated with the Scheme. The purpose of the document is to ensure that the geotechnical design risks are identified at an early stage and managed through the project life cycle.

1.3 Report Context

TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk* requires five geotechnical documents be prepared during the scheme development. These are as follows;

- Statement of Intent (SOI), including Preliminary Geotechnical Risk Register;
- Preliminary Sources Study Report (PSSR), including Geotechnical Risk Register;
- Ground Investigation Report (GIR), including Geotechnical Risk Register;
- Geotechnical Design Report (GDR), including Geotechnical Risk Register; and
- Geotechnical Feedback Report (GFR).

1.4 Overview of Information

The SOI identifies known or suspected geotechnical risks and states the scope, purpose, and estimated programme impact and cost of the initial geotechnical assessments. The SOI also includes the Preliminary Geotechnical Risk Register.

1.5 Procedure / Methodology / Sources of Information

This SOI has been prepared in accordance with the guidance set out in TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk*.

The sources of information are listed in Section 3.

SECTION 2: OBJECTIVES

The SOI provides a framework to record the process for the management of geotechnical design risks associated with the scheme. The purpose of this document is to ensure that the geotechnical design risks are identified at an early stage and managed through the project life cycle.

This document and all subsequent geotechnical documents are produced in accordance with guidance set out in TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk*, which states that a fundamental requirement of the Geotechnical Risk Management process is the production of thorough and rigorously prepared reports. The five geotechnical documents required to be prepared during the Scheme development are as follows;

- SOI, including Preliminary Geotechnical Risk Register;
- PSSR, including Geotechnical Risk Register;
- GIR, including Geotechnical Risk Register;
- GDR, including Geotechnical Risk Register; and
- GFR.

SECTION 3: EXISTING INFORMATION

The following sections provide a summary of the existing information identified to date.

3.1 N3 Virginia Bypass [2000-2003]

This proposed scheme recommended two types of carriageway cross section. The majority of the carriageway (8.5km) was Wide Single Carriageway with the remainder (0.7km) Standard Single Carriageway. The proposed scheme commenced approximately 1km south of Maghera Crossroads, bypassing Maghera Crossroads and Virginia town before tying back into the existing N3 in the townland of Cornaslieve, approximately 2km north of Virginia town. A proposed R194 link connected the existing R194 Ballyjamesduff Road to the proposed bypass providing a necessary link for vehicles wishing to gain access to the R178 Bailieborough Road and the proposed bypass without the need to travel through Virginia town.

Several reports were commissioned by CCC over the following years, including route selection and a preliminary design, before the scheme was ultimately suspended prior to lodgement of the Statutory Process documentation in 2003.

3.1.1 Constraints Report [Document No: 157/505-001-001/Rp001RevF]

This report was prepared for CCC by MCOS in 2000. The following sections of this report contain information of geotechnical interest;

- Chapter 4: Identified Constraints, including Section 4.3: Rivers and Streams; Section 4.4: Geology and Hydrogeology; Section 4.7: Protected Areas; and Section 4.9: Land Use and Agricultural Potential; and
- Appendix E: Geology and Hydrogeology.

3.1.2 Route Selection Report [Document No: MCOS/157-505/Rp009]

This report was prepared for CCC by MCOS in 2000. The following sections of this report contain information of geotechnical interest;

- Volume 1, including;
  - Chapter 6: Ground Conditions.

3.1.3 Environmental Impact Report [Document No: 157-505-001-Rp004]

This report was prepared for CCC by MCOS in 2003. The following sections of this report contain information of geotechnical interest;

- Chapter 7: Aquatic Environment, including Figures 7.0 to 7.3; and
- Chapter 8: Soil, Geology, and Hydrogeology, including Figures 8.1 to 8.2;

3.1.4 Preliminary Design Report [Document No: 157505Rp023]

This report was prepared for CCC by MCOS in March 2003. The following sections of this report contain information of geotechnical interest;

- Book 1, including; and
  - Chapter 6: Ground Conditions;
  - Chapter 8: Drainage and Receiving Waters;
- Book 3, including;
  - Drawings 505-001-SI-0000 to 505-001-SI-0010.

3.2 N3 Virginia Bypass Two Plus 1 Scheme [2004-2008]

This scheme followed on from the suspended N3 Virginia Bypass. In July 2004, CCC requested RPS-MCOS to re-examine the Virginia Bypass to develop it as a 2 plus 1 scheme, or Type 3 Dual Carriageway. Draft reports were prepared before the scheme was suspended again.

3.2.1 Supplementary Preliminary Report [Document No: MDT0245Rp0001WPR]

This report was prepared for CCC by RPS-MCOS in 2005 to re-develop the N3 Virginia Bypass as a 2 plus 1 route. The following sections of this report contain information of geotechnical interest;

- Chapter 3: Assessment of Amended Accommodation Works at Murmod, including Section 3.2.4: Geotechnical Implications.

3.2.2 Environmental Impact Report [Document No: MDT0245Rp2003]

In November 2006, an Environmental Impact Report (Document No: MDT0245Rp2003) for the proposed N3 Virginia Bypass 2 Plus 1 Scheme was prepared by M.C. O'Sullivan & Co. Ltd (MCOS) Consulting Engineers on behalf of Cavan County Council and the National roads Authority (NRA).

There was no content within the report of substantial geotechnical interest.

3.2.3 Preliminary Design Report [Document No: MDT0245Rp0003WPR]

This report was prepared for CCC by RPS-MCOS in 2008. The following sections of this report contain information of geotechnical interest;

- Chapter 6: Ground Conditions; and
- Chapter 8: Drainage and Receiving Waters.

3.3 N3 Edenburt to Cavan Bypass [2008-2012]

In 2008 the National Roads Authority requested Cavan Country Council to reassess the N3 Virginia Bypass as part of a larger strategic project. The proposed project was to develop a scheme on the N3 from the Cavan/Meath border to Cavan Town i.e., the Edenburt to Cavan Bypass Scheme. The scheme was suspended prior to completion of the Route Selection process in November 2012.

3.3.1 Constraints Report [Document No: MH-0305-R-02-0016]

In December 2009, a Constraints Study was prepared by the National Road Design Office (Meath County Council) on behalf of Cavan County Council and the National roads Authority (NRA).

The following information included in the report is of geotechnical interest:

- Section 5 – Landscape Constraints
- Section 6 – Hydrogeology & Water Quality Constraints
- Section 7 – Geology Constraints
- Section 8 – Groundwater Constraints

3.4 N3 Virginia Bypass

In September 2019, Cavan County Council, in association with Meath County Council and Transport Infrastructure Ireland (TII) has commissioned Barry Transportation to develop a scheme to address the safety, congestion and environmental concerns that exist as a result of the high volume of traffic travelling along the N3 through Virginia town and the settlement of Maghera and Whitegate.

3.4.1 Constraints Report

N3 Virginia Bypass Constraints Study was undertaken as part of Phase 2 Option Selection. The constraints study presents the various anthropogenic and environmental constraints that are within the Study Area of the proposed project and a potential 15km (minimum Zone of Influence (ZoL), TII Publications (Technical) PE-PMG-02041 (Jan 2019) *Project Management Guidelines*.

The following information included in the report is of geotechnical interest:

- Section 7 – Land, Geology and Soils
- Section 8 – Hydrogeology
- Section 9 – Water

3.4.2 Soils & Geology Assessment

A soils and geology assessment was undertaken during Phase 2 Appraisal and is included in the Options Selection Report of which this PSSR forms part. A metric weighting assessment was undertaken for the numerous corridor options under the following headings:

- Solid Geology
- Soft Soils
- Geomorphology
- Karst
- Economic Geology
- Contaminated Land
- Geological Heritage

SECTION 4: GEOTECHNICAL RISK

4.1 Complexity of the Project

Depending on the complexity of the proposed geotechnical works and the geotechnical risk implications, the project shall be assigned a Geotechnical Classification based on the Geotechnical Categories defined in the NSAI Publication (Standard) IS EN 1997-1:2005/A1:2013 + NA:2015 *Eurocode 7: Geotechnical design – Part 1: General rules (including Irish National Annex 2015)*.

The three Geotechnical Categories are defined below;

- **Geotechnical Category 1** applies only to small and relatively simple structures;
  - For which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations; and
  - With negligible risk;
- **Geotechnical Category 2** applies to conventional types of structures and foundations with no exceptional risks, or difficult ground or loading conditions; and
- **Geotechnical Category 3** applies to structures, or parts of structures, which fall outside the limits of Geotechnical Categories 1 & 2.

The Geotechnical Classification for the project will be assigned by the Geotechnical Team Leader (GTL) and is subject to acceptance by the Road Authority (RA), irrespective of the procurement method or design/construction responsibility, as part of Phase 2 Option Selection. Subject to the agreement of the RA a different Geotechnical Classification may be assigned to individual parts of the project.

The Structures Categories, as defined in the TII Publication (Standards) DN-STR-03001 (April 2019) *Technical Acceptance of Road Structures on Motorways and Other National Roads*, are independent to the Geotechnical Categories and do not necessarily correspond.

The Structures Categories are defined below;

- **Structure Category 0** applies to simple structures, where all aspects of design, assessment, and execution are in accordance with the current TII Publications (Standards) and the Specification for Works (SPW), and the structures contain no Departures, provided they also conform to one of the following;
  - Single span supported structures with a span of less than 5.0m;
  - Buried concrete boxes or buried rigid pipes greater than 2.0m clear, but less than 3.0m span/diameter, and having more than 1.0m cover; or
  - Environmental barriers less than 2.0m in height;
- **Structure Category 1** applies to simple structures, other than those in Category 0, which can be analysed by the equations of statics and where all aspects of design, assessment, and execution are in accordance with the current TII Publications (Standards) and the Specification for Works (SPW), and the structures contain no Departures, provided they also conform to one of the following;
  - Single span simply supported structures with spans greater than 5.0m, but less than 10.0m, and having a skew less than 25˚;
  - Buried concrete box type structures with spans greater than 3.0m, but less than 7.0m, and having more than 1.0m cover;
  - Corrugated steel buried structures less than 5.0m in span;
  - Retaining walls with a retained height of less than 5.0m;
  - Portal sign gantries with a span of less than 20.0m;
  - Cantilever sign gantries with an arm span of less than 9.0m;
  - Environmental barriers 2.0m and greater in height;

  - High masts; or
  - Telecom masts.

- **Structure Category 2** applies to intermediate structures which have redundant features and may contain Departures from, or aspects not covered by, the current TII Publications (Standards); and
- **Structure Category 3** applies to complex structures which require sophisticated analysis of highly redundant features, where consequences of failure would be severe, and with any one of the following;

  - High redundancy;
  - Unconventional design aspects;
  - Any span exceeding 50.0m and/or having a skew greater than 45˚;
  - Bridges with cable stays and suspension systems;
  - Post-tensioned concrete structures;
  - Difficult foundation problems, including foundation elements for embankments constructed on rigid foundation elements;
  - Tunnels;
  - Structures with M&E installation, i.e. movable bridges; and
  - Retaining structures, including strengthened earthworks, greater than 10.0m in height.

4.2 Geotechnical Risk Management

Geotechnical documents as outlined below will be submitted in accordance with the TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk* for the following Phases:

- Phase 2 *Option Selection*;

  - SOI, including Preliminary Geotechnical Risk Register;
  - PSSR, including Geotechnical Risk Register;

- Phase 3 *Design and Environmental Evaluation*; and

  - GIR, including Geotechnical Risk Register;
  - GDR, including Geotechnical Risk Register;

- Phase 6 *Construction and Implementation*;

  - Detailed Design GIR, including Geotechnical Risk Register;
  - Detailed Design GDR, including Geotechnical Risk Register;
  - GFR.

No geotechnical documents are required for Phase 0 *Scope and Pre-Approval*, Phase 1 *Concept and Feasibility*, Phase 4 *Statutory Process*, Phase 5 *Enabling and Procurement*, or Phase 7 *Closeout and Review*.

Due to the reasonable size and nature of the Scheme individual GDRs may be prepared for specific structures and/or earthworks sections and submitted to the RA for approval.

It is envisaged that Structural Category 0 and Category 1 structures and Geotechnical Classification Category 1 structures will not necessitate the production of individual detailed GDRs. The geotechnical risks of these structures may be assessed using a Form C, Earthworks Summary Form, or Geotechnical Notes Form, subject to the discretion of the GTL. Risks associated with these structures shall be incorporated in the Geotechnical Risk Register.

All Structural Category 2 and Category 3 structures and Geotechnical Classification Category 2 and Category 3 structures will necessitate the production of GDRs.

Geotechnical Certification of Phase 0 to Phase 4 geotechnical documents is not required as per TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk*. Therefore, no independent checking is proposed for the geotechnical documents submitted from Phase 1 to Phase 4.

The persons / bodies in Table 1 below are proposed to complete the geotechnical documents required from Phases 1 to 4.

Table 1: Persons / Bodies proposed to complete Geotechnical Documents (Phases 1 to 4)

Person / Body	Name	Contact Details
Geotechnical Team Leader (GTL)	Deirdre O'Hara	**Address:** Barry Transportation, Unit 14C, N5 Business Park, Moneen Road, Castlebar, Co. Mayo **Email:** dohara@jbbarry.ie **Telephone:** +353 87 983 9964

Earthworks will be designed and constructed in accordance with the TII Publication (Standards) CC-SPW-00600 *Specification for Works Series 600 – Earthworks (including Erratum No. 1, dated June 2013)*.

Piling and embedded retaining walls will be designed and constructed in accordance with the TII Publication (Standards) CC-SPW-01600 *Specification for Works Series 1600 – Piling and Embedded Retaining Walls (including Erratum No. 1, dated March 2011)*.

All geotechnical works will be designed and constructed in accordance with NSAI Publication (Standard) IS EN 1997-1:2005/A1:2013 + NA:2015 *Eurocode 7: Geotechnical design – Part 1: General rules (including Irish National Annex 2015)* and NSAI Publication (Standard) IS EN 1997-2:2007/AC:2010 *Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing*.

4.3 Preliminary Geotechnical Risk Register

A Preliminary Geotechnical Risk Register has been created as an independent document (19408-BT-06-ZZ-DO-C_0001). This register is included in Appendix 1 of this document.

The Geotechnical Risk Register is a live document that will be taken forward into the construction phase and further developed by the Designer and the Contractor. The risk register will be updated as the project progresses and will be issued with the PSSR, the GIR, and the GDR.

A high-level summary of the ground hazards and geotechnical risks is included in the Geotechnical Risk Register.

The locations of specific hazards and suspected hazards will be identified in the PSSR and the GIR. Specific control measures to mitigate risks will be accounted for in the GDR.

Risks related to soft ground are the most common geotechnical risks in this type of project. A detailed risk assessment for soft ground is included in the Geotechnical Risk Register.

SECTION 5: PROPOSED STUDIES & INVESTIGATIONS

The overall objective of Site Investigation (SI) works is to characterise the ground conditions sufficiently to allow safe and economic preliminary designs to be developed and to reduce, as far as is reasonably possible, the occurrence and impact of unforeseen conditions.

It is proposed that the SI works required for the production of documents from Phase 1 to Phase 4 will be delivered in two separate stages:

- Option Selection Stage SI (completed); and
- Preferred Option Stage SI.

5.1 Option Selection Stage SI

- Start date of SI: August 2021
- Delivery date of SI factual reports: September 2021

The Option Selection Stage SI has been completed and comprised of the following SI works;

- 194 No. Macintosh Probes (MPs)
- 95 No. Peat Probes (PP) and
- 88 No. TRL Dynamic Cone Penetrometers (DCP) tests.

5.2 Preferred Option Stage SI

- Preliminary start date of SI: Q3 2022
- Preliminary delivery date of SI factual reports: Q4 2022

The following SI works detail a proposed scope for the Preferred Option Stage SI:

- Cable Percussive Boreholes with Rotary Core follow on (BH/RC);
- Rotary Core only Boreholes (RC);
- Dynamic Window Sampling (WS);
- Dynamic Probes (DPH or DPSH);
- Trial Pits in non-paved areas (TP);
- Slit trenches (ST);
- Soil Infiltration tests;
- Instrumentation and monitoring of Standpipes:
- In-situ testing;
- Laboratory testing;
- Production of factual reports; and
- Provision of temporary traffic management.

SECTION 6: SPECIALIST CONSULTATION

6.1 Archaeology

CCC will determine the need for consultation with the project archaeologist before the commencement of each stage of the SI works.

6.2 Landowner Liaison

BT, in consultation with CCC, will provide notice to landowners of the upcoming SI works in advance of the commencement date. The appointed Contractor shall then be responsible for contacting landowners in advance of all works and to arrange access as required. All contact with landowners shall be made in coordination with the Project Liaison Officer (PLO).

The Contractor shall ensure that all accesses used are stockproof at all times. Land boundaries will not be breached unless clearly instructed by the Client and with the full assurance that agreement has been given by the landowner. The Contractor shall minimise the disturbance to land and property, and all surfaces and fencing are to be restored to their original state, or as close as is reasonably practicable, upon completion of the works.

When traversing a field, the Contractor shall travel along the boundary or along access routes agreed with the landowner by the Contractor. Narrow tyres on trailers shall not be used when traversing soft or wet ground, and if required, the contractor shall use a tractor to pull equipment in order to prevent rutting. The Contractor shall utilise machinery and/or materials that may be required to access areas of soft (peat) or uneven ground in order to limit rutting and gain safe access to the exploratory locations (e.g. bog mats). All rutting must be made good immediately to the satisfaction of the Investigation Supervisor.

6.3 Environmental

The locations of all proposed SI points shall be assessed by the Environmental Team in accordance with current environmental regulations.

6.4 Existing Services

As part of the project, the utilities or service providers in the study area are being contacted by the PLO. The information on existing services will be made available to the SI Contractor.

6.5 Geological Survey Ireland (GSI)

Two known geoheritage sites are located within the Study Area. As a result, consultation with the Geological Survey Ireland is ongoing in order to obtain sufficient information and advice regarding both sites.

6.6 Forestry Plantations

There are a number of forest plantations which are intersected by the preferred option corridor and will require some site clearance to enable works associated with the scheme to be undertaken e.g. site investigations etc. The majority of these plantations are owned and managed by Coillte with the remainder owned privately. As a result, consultation with Coillte and the private landowners is on-going.

SECTION 7: PROGRAMME & COST

The SI works required for the production of documents from Phase 1 to Phase 4 will be delivered in two separate stages;

- Option Selection Stage SI (Completed);
  - Start date of SI: August 2021
  - Delivery date of SI factual reports: September 2021

The cost incurred to carry out the Option Selection Stage SI works amounted to approximately €13,600.00 including VAT.

- Preferred Option Stage SI;
  - Preliminary start date of SI: Q3 2022
  - Preliminary delivery date of SI factual reports: Q4 2022

A cost estimate for the Preferred Option Stage SI works will be included in Annex A of the PSSR once the SI design has been finalised.

Appendix 1: Preliminary Geotechnical Risk Register (19408-BT-06-ZZ-DO-C_0001)

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

comhairle chontae na mí
meath county council

Cavan
Comhairle Contae an Chabháin
Cavan County Council

N3 Virginia Bypass

Geotechnical Risk Register

March 2022

BARRY
TRANSPORTATION

An Roinn Iompair
Department of Transport

Tionscadal Éireann
Project Ireland
2040

Document Control Sheet

Client:	**Cavan County Council**
Project Title:	N3 Virginia Bypass
Document Title:	Geotechnical Risk Register (GRR)
File Name:	19408-BT-06-ZZ-DO-C_0001

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Document Revision				**Document Verification**			
Issue Date *(DD/MM/YY)*	**Revision Code**	**Suitability Code**	**Author** *(Initials)*	**Checker** *(Initials)*	***Reviewer*** As Per PMP *(Initials)*	**Approver** *As Per PMP (Initials)*	**Peer Review** *(Initials or N/A)*
Add hyperlink to Verification Email on PIM Register for each issue							
16/12/2021	P01	S03	CJO	DOH	DOH	TC	N/A
30/03/2022	P02	S03	CJO	DOH	DOH	TC	N/A

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Appendices

SECTION 1: RISK REGISTER

1.1 Introduction

Geotechnical risk management is intended to be a continuous process from project inception through to commissioning (TII Publication (Standards) DN-ERW-03083 (October 2019) Managing Geotechnical Risk).

The Geotechnical Risk Register (GRR) highlights many of the potential risks and the consequences of those risks together with risk control measures that could be taken to mitigate those risks.

For the purpose of this report, a hazard is defined as the 'thing or activity with a potential for consequences (potential to do harm)' and a hazard event is 'the undesirable event'. The 'combination of the probability of a hazard event occurring and the severity of its consequences is the degree of risk (or risk level) and this is addressed in Section 1.2.

The Geotechnical Risk Register for the scheme is presented below in Sub-section 1.4. This is a live document which will be taken forward into the construction phase and further developed by the Designer and the Contractor.

The risk register will be updated as the project progresses and will be issued with the Preliminary Sources Study Report (PSSR), Ground Investigation Report (GIR) and Geotechnical Design Report (GDR). The locations of specific hazards and suspected hazards will be identified in the PSSR and GIR. Specific control measures to mitigate risk will be accounted for in the GDR.

The extent of soft ground is a particular geotechnical hazard that may be identified as presenting significant risk to this scheme and may get carried through to construction as a 'substantial residual risk'.

1.2 Risk evaluation

This section presents the developed Geotechnical Risk Register for the Scheme, together with details of other construction related risks known at this time. A qualitative approach has been used for the assessment of these risks based on the procedures set out in TII Publication (Standards) DN-ERW-03083 Managing Geotechnical Risk (October 2019). Under this qualitative risk assessment, the degree of risk is the expected impact of damage, loss or harm from a given hazard, under particular circumstances which is expressed as:

Degree of Risk (R) = Probability (P) x Severity (S)

The scale of probability and severity is determined using Table 1 and Table 2 respectively, which together then provide the degree of risk based on Table 3.

Table 1: Scale of Probability (P)

Probability	Scale
Very High Probability (71-100%)	5
High Probability (51-70%)	4
Medium Probability (31-50%)	3
Low Probability (11-30%)	2
Very Low Probability (0-10%)	1

Table 2: Scale of Severity (S)

Severity	Scale
Very High Impact	5
High Impact	4
Medium Impact	3
Low Impact	2
Very low Impact	1

Table 3: Degree of Risk (R)

Degree of Risk	Degree of Risk or Risk Level	Recommended Response
1 to 4	Low Risk	None
5 to 10	Medium Risk	Consider attention
11 to 19	High Risk	Attention required
20 to 25	Critical Risk	Emergency action required

1.3 Summary of Ground Hazards

A high-level summary of potential ground hazards and geotechnical risk is summarised below.

Compressible Ground Stability Hazards present the following risks:

- Soft bearing conditions and need for special foundations for structures/pavement,
- Poor ground conditions and material arising from excavation unacceptable for re-use,
- Excessive settlement of structural foundations due to poor bearing conditions, and
- Damage to road pavement or track infrastructure due to poor subgrade support.

Ground Contamination Hazards present the following risks:

- Hot spots encountered during construction,
- Excessive amount of Class U2 material for disposal,
- Changes in environmental legislation,
- Site borne leachates affect neighbouring properties or hinder site works,
- Presence of hazardous soil borne gas arising from disturbed historic landfill,
- Chemical attack on buried structural elements due to soil borne contaminants, and
- Contamination hazard arising from unknown land uses.

Collapsible Ground Stability Hazards present the following risks:

- Encountering unknown voids associated with karst limestone,
- Encountering unexpected geological features, fissures, faults, solution features etc,
- Failure of earthworks (landslide) during construction,
- Failure of structural foundations (bearing capacity) during construction,
- Damage to neighbouring property due to ground movement during construction,
- Unidentified shafts and adits associated with mineral extraction, and
- Underground workings, presence of voids arising from mineral extraction.

Groundwater hazards present the following risks:

- Groundwater flow adversely affecting stability of deep excavations,
- High groundwater levels affecting stability of earthworks,
- Groundwater flow resulting in failure of temporary excavations,
- Changed groundwater level (dewatering) impacting on neighbouring property,
- In-flow of contaminated groundwater from off-site source,
- High groundwater levels impacting on foundation design, and
- Limitations on disposal of groundwater.

Below Ground Obstruction Hazards present the following risks:

- Design changes due to inadequate coverage of GI for structures,
- Unforeseen ground conditions requiring additional land take for treatment,
- Design conflict with known buried services,
- Delay due to long lead times for permanent diversion of services,
- Uncharted buried services causing delays during construction,
- Obstructions to construction due to existing foundations, and
- Unexploded ordnance.

Environmental/Land Use Constraint Hazards present the following risks:

- Endangered animal species (badgers, bats, frogs etc.),
- Design conflict with Protected Tree Species,
- Invasive plant species (Japanese Knotweed, Giant Hogweed etc.),
- Flooding of works due to influence of river and canal,
- Adverse weather conditions during earthworks season,
- Material rendered unacceptable through poor site management,
- Access to land denied by landowner,
- Design conflict with known overhead services,
- Restrictions to ground investigation due to Archaeological features,
- Delay to programme due to heritage approval following archaeological finds, and
- Design conflict with Listed Structures.

1.4 Geotechnical Risk Register

The GRR is presented as a table and is included in Appendix A. The table can be categorised into different elements of the design as follows:

- Earthworks GRR: risk items E1 to E50
- Bridge GRR: risk items B1 to B20
- Retaining walls GRR: risk items RW1 to R20
- Culverts GRR: C1 to C18

Appendix A: Geotechnical Risk Register Table (19415-BT-06-ZZ-RG-C_0001_Geotechnical Risk Register)

Geotechnical Risk Register (GRR)

N3 Virginia Bypass

Author	CJO
Approver	DOH
Revision	P02
Date	30/03/2022

Unique Risk ID.	Category	Hazard Description	Route Section	Probability x Severity = Degree of Risk			Design Measures to Manage the Risk	Probability x Severity = Degree of Risk		
				Probability	Severity	Risk		Probability	Severity	Risk
E1	[E] Earthworks	Compressible Ground (Existing): Damage to pavement due to insufficient subgrade support from existing sub-grade.	All	3	3	9	Identify areas of compressible soils. Design/implement mitigation measures such as dig and replace. Induce settlement prior to surfacing through use of surcharge loading.	1	3	3
E2	[E] Earthworks	Compressible Ground (Existing): Damage to embankment/new pavement due to excessive settlement over alluvium, or thick layers of soft material.	All	3	3	9	Identify areas of compressible soils. Design/implement mitigation measures such as dig and replace. Induce settlement prior to surfacing through use of surcharge loading.	1	3	3
E3	[E] Earthworks	Compressible Ground (Existing): Damage to embankment/new pavement due to differential settlement where it crosses drainage ditches, existing tracks, made ground or thick topsoil.	All	3	3	9	Identify areas of soft ground (ditch crossings). Identify areas of loose made ground. Identify areas of thick topsoil. Design/implement special measures (provide SED drawings). Induce settlement prior to surfacing through use of surcharge loading.	1	2	2
E4	[E] Earthworks	Compressible Ground (Existing): Damage to embankment/new pavement due to long term secondary consolidation of organic alluvium or thick topsoil.	All	3	3	9	Identify areas of compressible soils. Design/implement special measures/monitoring. Induce settlement prior to surfacing through use of surcharge loading.	1	3	3
E5	[E] Earthworks	Compressible Ground (Existing): Damage to proposed bridge abutment due to lateral loading induced by new approach embankments.	All	2	4	8	Identify areas of compressible soils. Design/implement special measures. Liaise with Bridge Designer.	1	3	3
E6	[E] Earthworks	Compressible Ground (Existing): Damage to existing structures due to settlement of adjacent embankment.	All	3	4	12	Assess impact on adjacent structures. Undertake preconstruction condition assessment of potentially impacted structures. Design solutions and specify construction monitoring.	1	3	3
E7	[E] Earthworks	Compressible Ground (Existing): Damage to existing services caused by settlement of new embankment.	All	3	3	9	Locate services and divert where appropriate. Transmit foundation loads to competent strata beneath services. Protect services from plant/ crane loads.	1	2	2
E8	[E] Earthworks	Compressible Ground (New Fill): Damage to pavement due to insufficient subgrade support from imported fill.	All	3	3	9	Specify type of fill and level of compaction. Specify site testing of subgrade support.	1	3	3
E9	[E] Earthworks	Compressible Ground (New Fill): Damage to pavement due to settlement within imported fill.	All	2	3	6	Specify type of fill and level of compaction.	1	3	3

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				Probability	Severity	Risk		Probability	Severity	Risk
E10	[E] Earthworks	Compressible Ground (New Fill): Damage to pavement due to differential settlements between bridge abutments and new approach embankment.	All	4	3	12	Implement sufficient ground investigation. Specify type of structural fill behind structure. Specify mitigation measures/monitoring requirement.	1	2	2
E11	[E] Earthworks	Groundwater (High water table): Erosion of toe of embankment due to flooding and groundwater seepage.	All	2	3	6	Provide SED drawing for protection of toe in affected areas.	1	2	2
E12	[E] Earthworks	Groundwater (High water table): Unable to traffic soft ground or compact embankment foundation.	All	4	2	8	Provide SED drawing for starter layer where necessary.	1	2	2
E13	[E] Earthworks	Groundwater (High water table): Damage to pavement due to softening of formation (loss of subgrade support CBR)	All	3	3	9	Provide sufficient drainage to prevent inundation of sub- base.	1	2	2
E14	[E] Earthworks	Groundwater (High water table): Loss of efficacy of drainage system due to groundwater inundation/ siltation.	All	3	3	9	Maintain pavement alignment above water table. Provide sufficient capacity to drains/protect drains.	1	2	2
E15	[E] Earthworks	Groundwater (High water table): Potential limitations on disposal of groundwater during construction/ post construction.	All	2	2	4	Maintain road alignment above water table. Provide sufficient capacity to drains/ protect drains.	1	2	2
E16	[E] Earthworks	Groundwater (High water table): Erosion of excavated face due to erosion	All	2	3	6	Implement sufficient ground investigations Specific inspection of excavated slopes Provide SED drawings for slope drainage	1	2	2
E17	[E] Earthworks	Groundwater (High water table): High moisture content renders arisings unacceptable for re-use as bulk fill	All	3	2	6	Specify acceptability criteria for the earthworks materials Make allowance for unacceptable material in Earthworks Schedule Install pre-earthworks drainage and subgrade drainage before excavation of material	1	2	2
E18	[E] Earthworks	Groundwater (High water table): High moisture content renders Landscape Fill/ Unsuitable Fill difficult to handle.	All	3	2	6	Specify acceptability criteria for landscape fill. Zone landscape areas to receive all site arisings. Install pre-earthworks drainage and subgrade drainage before excavation of material.	1	1	1
E19	[E] Earthworks	Groundwater (Changed water table): Reduced groundwater level adversely affecting land drainage / habitat (peat bog)	All	2	3	6	Implement sufficient ground investigation. Specify mitigation measures where necessary. Implement monitoring as required.	1	2	2
E20	[E] Earthworks	Groundwater (Changed water table): Changed groundwater level impacting on new structures.	All	2	4	8	Implement sufficient ground investigation. Specify mitigation measures where necessary. Include groundwater standpipe and piezometer installations and implement monitoring as required.	1	3	3

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				Probability	Severity	Risk		Probability	Severity	Risk
E21	[E] Earthworks	Groundwater (Changed water table): Changed groundwater level impacting on neighbouring property.	All	2	4	8	Implement sufficient ground investigation. Specify mitigation measures where necessary. Include groundwater standpipe and piezometer installations and implement monitoring as required.	1	2	2
E22	[E] Earthworks	Below Ground Obstructions (Natural): Cobbles/boulders/buried obstructions render site arisings impractical to compact.	All	2	2	4	Implement sufficient ground investigation. Implement monitoring and screening if material re-use required.	1	2	2
E23	[E] Earthworks	Below Ground Obstructions (Natural): Cobbles/boulders/bedrock/buried obstructions delay excavation for cuttings/ foundations/retaining.	All	3	2	6	Implement sufficient ground investigation	1	1	1
E24	[E] Earthworks	Below Ground Obstructions (Natural): Impractical to construct cutting without blasting due to hard bedrock being encountered	All	3	4	12	Implement sufficient ground investigation Investigate rock strength and fracturing properties Specify special measures. Monitor site works	2	3	6
E25	[E] Earthworks	Below Ground Obstructions (Services): Proximity to services restricts ability to construct foundations without damaging services (cables/pipelines).	All	2	3	6	Locate Services and relocate where necessary. Specify special measures where necessary (e.g. dedicated spotters) Monitor site works.	1	2	2
E26	[E] Earthworks	Below Ground Obstructions (Services): Design conflict with known services or uncharted services.	All	3	3	9	Early engagement with utility owners. Locate Services and relocate where necessary. Specify special measures where necessary (e.g. dedicated spotters) Monitor site works.	1	3	3
E27	[E] Earthworks	Below Ground Obstructions (Services): Delay due to long lead times on permanent diversion of services	All	3	3	9	Locate services and relocate where necessary	1	2	2
E28	[E] Earthworks	Below Ground Obstructions (Various): Breakout required of existing foundations, basement structures or storage tanks	All	3	3	9	Implement sufficient ground investigations Investigate buried structures. Specify special measures	2	2	4
E29	[E] Earthworks	Below Ground Obstructions: Unexploded ordnance (UXO)	All	2	5	10	Undertake a desktop review historic records. Agree site protocol for UXO.	1	4	4
E30	[E] Earthworks	Ground Contamination (Soil): Potential for unlicensed landfill or animal burial sites to delay earthworks.	All	3	3	9	Implement sufficient ground investigation to screen for potential contaminants. Agree site protocol for investigation/reporting. Specify special measures which may include waste classification testing.	1	2	2

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				Probability	Severity	Risk		Probability	Severity	Risk
E31	[E] Earthworks	Ground Contamination (Soil): Material from unknown land use potentially hazardous to health.	All	3	3	9	Implement sufficient ground investigation to screen for potential contaminants. Agree site protocol for investigation/reporting. Specify special measures which may include waste classification testing.	1	2	2
E32	[E] Earthworks	Ground Contamination (Groundwater): Damage to structures including buried structures arising from chemical agents.	All	2	4	8	Implement sufficient ground investigation. Liaise with Structural Designer to determine appropriate concrete exposure class. Specify protective measures as appropriate.	1	3	3
E33	[E] Earthworks	Ground Contamination (Groundwater): Polluted water harmful to human health and the environment.	All	3	4	12	Implement sufficient ground investigation to understand and quantify the nature of any contamination present. Implement controls to limit/intercept contamination transport. Specify special measures relevant to the nature of the contaminants. Agree site protocol for investigation/monitoring.	1	4	4
E34	[E] Earthworks	Ground Contamination (Groundwater): Site borne leachate requiring disposal/limitations on groundwater discharges.	All	3	3	9	Implement sufficient ground investigation. Implement adequate site drainage. Specify special measures relevant to the nature of the contaminants. Agree site protocol for investigation/monitoring.	1	3	3
E35	[E] Earthworks	Ground Contamination (Groundwater): Site borne leachate polluting neighbouring property.	All	2	4	8	Implement sufficient ground investigation to understand and quantify the nature of any contamination present. Implement controls to limit/intercept contamination transport. Specify special measures relevant to the nature of the contaminants. Agree site protocol for investigation/monitoring.	1	3	3
E36	[E] Earthworks	Ground Contamination (Groundwater): Inflow of contaminated water from off-site source.	All	3	3	9	Implement sufficient ground investigation to understand and quantify the nature of any contamination present. Implement controls to limit/intercept contamination transport. Specify special measures relevant to the nature of the contaminants. Agree site protocol for investigation/monitoring.	1	2	2
E37	[E] Earthworks	Ground Contamination (Groundwater): Hazardous gas arising from contaminated land/organic alluvium.	All	2	3	6	Implement sufficient ground investigation. Specify special measures relevant to the nature of the contaminants (e.g. gas monitoring installations). Agree site protocol for investigation/monitoring.	1	2	2
E38	[E] Earthworks	Unforeseen ground conditions due to Insufficient ground investigation data points in specific areas.	All	3	3	9	Request supplementary ground investigation is undertaken. Undertake a sensitivity assessment of the current design to more worst credible conditions.	1	2	2

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				Probability	Severity	Risk		Probability	Severity	Risk
E39	[E] Earthworks	Failure of rock cut slopes Due to structural conditions of rock mass (planar failures, wedge failures, toppling failures).	All	2	4	8	All rock cuts to be inspected by the ER or DSR following excavations Requirement for further scaling works, dentition works, or drainage works will be confirmed by the ER or DSR. Where possible, at detailed design stage of rock cuts an assessment of the structural conditions of the rock shall be made. At construction stage an assessment of the potential for rock structural failures (planar, wedge and toppling failure) shall be made after the rock mass is exposed. An experienced geotechnical engineer or engineering geologist shall record the dip orientation / direction of the exposed rock mass.	1	3	3
E40	[E] Earthworks	Excessive settlement of embankments Where topsoil is below embankments, especially where topsoil is over 0.5m in depth	All	3	3	9	All topsoil below embankments of less than 3m in height is to be removed. Topsoil shall be removed where topsoil depth is of more than 0.5m and is below embankments of over 3m in height. The GIR to identify the areas with topsoil over 0.5m in height along scheme corridor. Locations to be identified in Earthwork Plan & Profile. Requirement to be added to appendix to series 600 specification.	1	3	3
E41	[E] Earthworks	Encountering unexpected geological features, fissures, faults, solution features etc.	All	2	3	6	Investigate geomorphological features. Implement sufficient ground investigations. Specific mitigation measures.	1	2	2
E42	[E] Earthworks	Collapsible Ground (Landslip) Instability of new embankment slopes (Internal stability).	All	2	4	8	Specify appropriate design slope angles. Specify suitable fill material. Bench new fill into existing ground	1	3	3
E43	[E] Earthworks	Collapsible Ground (Landslip) Failure of new embankment due to weak formation (Global Stability)	All	2	4	8	Specify appropriate design slope angles. Specify suitable fill material. Control filling rate for affected embankment	1	3	3
E44	[E] Earthworks	Collapsible Ground (Landslip) Failure of new embankment due to artesian pressure/high water table (Global Stability)	All	2	4	8	Specify appropriate design slope angles. Specify suitable fill material. Control filling rate for affected embankment	1	3	3
E45	[E] Earthworks	Collapsible Ground (Landslip) Damage to cutting due to local instability of loose material in slope or temporary works excavation	All	3	3	9	Specify appropriate design slope angles. Inspect exposed faces Recompact / replace / support during excavation.	1	2	2
E46	[E] Earthworks	Collapsible Ground (Landslip) Failure of rock cutting due to weak zones / fissures (Global Stability)	All	2	4	8	Select appropriate slope angles Inspect exposed faces Recompact / replace / support during excavation	1	2	2

Geotechnical Risk Register (GRR)

N3 Virginia Bypass

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Approver	DOH
Revision	P02
Date	30/03/2022

Unique Risk ID.	Category	Hazard Description	Route Section	Probability x Severity = Degree of Risk			Design Measures to Manage the Risk	Probability x Severity = Degree of Risk		
				Probability	Severity	Risk		Probability	Severity	Risk
E47	[E] Earthworks	Collapsible Ground (Landslip) Damage to neighbouring property due to ground movement during construction	All	2	5	10	Select appropriate slope angles Inspect exposed faces Agree contingency measures	1	4	4
E48	[E] Earthworks	Failure of structure or earthworks. Due to use of geotechnical design parameters in detailed design without verification of the validity leading to an unsafe design	All	2	4	8	The use of characteristic parameters is subject to a location and geotechnical design case assessment of the validity in each GDR	1	3	3
E49	[E] Earthworks	Collapsible Ground (Karst) Encountering unexpected geological features, fissures, faults, solution features etc.	All	1	4	4	Investigate geomorphological features. Implement sufficient ground investigation. Specify mitigation measures.	1	3	3
E50	[E] Earthworks	Land Use Constraint Hazard (Geoheritage Site) Implications of scheme to Bruse Hill	All	4	3	12	Consultation with GSI Design scheme with sensitivity to the Geoheritage site Specify procedures during development/construction to raise awareness of the geoheritage site's significance	3	2	6
B1	[B] Bridge	Collapsible Ground: Encountering uncollapsed voids associated with karst	All	1	4	4	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures	1	3	3
B2	[B] Bridge	Collapsible Ground Induced collapse of solution feature due to construction activities or change in ground water regime	All	2	4	8	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	4	4
B3	[B] Bridge	Collapsible Ground: Encountering unexpected geological features, fissures, faults, solution features etc.	All	2	3	6	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations.	1	3	3
B4	[B] Bridge	Compressible ground: Damage to bridge caused by settlement/subsidence of foundation.	All	3	4	12	Implement sufficient ground investigation. Identify stratum able to support structural loads and design foundations to limit settlement to acceptable levels (<25mm).	1	4	4
B5	[B] Bridge	Compressible ground: Damage to bridge caused by settlement of adjacent wing wall foundation.	All	3	4	12	Implement sufficient ground investigation. Wing walls to be founded in same stratum or same foundation.	1	3	3
B6	[B] Bridge	Compressible ground: Damage to pavement caused by differential settlement / subsidence between bridge abutment and approach embankment.	All	3	3	9	Implement sufficient ground investigation. Reduce embankment load carried by soft strata. Ensure adequate transition zones within bridge approaches.	1	2	2

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				Probability	Severity	Risk		Probability	Severity	Risk
B7	[B] Bridge	Compressible ground: Damage to service crossings due to differential settlement at bridge abutment.	All	3	4	12	Investigate location of services and divert where appropriate. Transmit foundation loads to competent strata beneath the services.	1	3	3
B8	[B] Bridge	Compressible ground: Lateral loading on bridge foundation piles due to compression beneath approach embankment.	All	3	4	12	Where pile foundations are proposed, design to resist lateral loading. Reduce embankment load carried by soft strata at bridge wing walls. Control upfill rate for affected embankment.	1	4	4
B9	[B] Bridge	Compressible ground: Negative skin friction on bridge foundation piles due to compression beneath approach embankment.	All	3	4	12	Where pile foundations are proposed, design to accept negative skin friction.	1	4	4
B10	[B] Bridge	Variable ground: Damage to bridge caused by differential settlement of foundations.	All	3	4	12	Implement sufficient ground investigation. Investigate variability of founding strata. Transmit loads to competent strata.	1	4	4
B11	[B] Bridge	Soft/Loose ground: Damage to bridge due to inadequate bearing capacity of foundation.	All	3	4	12	Identify stratum able to support structural loads and design foundations to limit settlement to acceptable levels (<25mm).	1	4	4
B12	[B] Bridge	Soft/Loose ground: Damage to bridge abutment due to instability of supporting slope.	All	3	4	12	Implement sufficient ground investigation. Design factor of safety against slip failure in bank seat or found bridge at sufficient depth.	1	4	4
B13	[B] Bridge	Soft/Loose ground: Unable to construct foundations due to collapse of saturated ground.	All	3	3	9	Implement sufficient ground investigation and adopt appropriate construction techniques. May need to adopted temporary or permanent casing.	1	2	2
B14	[B] Bridge	Obstructions: Impractical to construct foundations due to obstructions.	All	3	3	9	Adopt appropriate piling techniques with facility to break obstructions.	1	2	2
B15	[B] Bridge	Existing structures: Damage to existing structure during construction.	All	3	3	9	Implement sufficient ground investigation and identify existing structure arrangements. Undertake pre-construction condition surveys.	1	3	3
B16	[B] Bridge	Proximity to services: Impractical to construct foundations without damaging services (overhead cables/pipeline).	All	3	4	12	Locate Services and relocate where necessary. Specify special measures where necessary (e.g. dedicated spotters) Monitor site works. Contractor to use best practice, appropriate plant and equipment.	1	4	4
B17	[B] Bridge	Groundwater (chemical aggressivity): Sulphates/Chloride content	All	3	3	9	Implement sufficient ground investigation. Liaise with Structural Designer to determine appropriate concrete exposure class. Specify protective measures as appropriate.	1	2	2

Geotechnical Risk Register (GRR)

N3 Virginia Bypass

Author	CJO
Approver	DOH
Revision	P02
Date	30/03/2022

Unique Risk ID.	Category	Hazard Description	Route Section	Probability x Severity = Degree of Risk			Design Measures to Manage the Risk	Probability x Severity = Degree of Risk		
				Probability	Severity	Risk		Probability	Severity	Risk
B18	[B] Bridge	Pollutants in groundwater: Environmental damage such as pollution of aquifer (piling works) and watercourses.	All	2	3	6	Implement sufficient ground investigation to understand potential pollutant pathways. Specify protective measures as appropriate.	1	2	2
B19	[B] Bridge	Unforeseen ground conditions: Due to Insufficient ground investigation data points in specific areas.	All	3	3	9	Request supplementary ground investigation is undertaken. Undertake a sensitivity assessment of the current design to more worst credible conditions.	1	2	2
B20	[B] Bridge	Failure of Structure Due to use of geotechnical design parameters in detailed design without verification of their validity leading to an unsafe design.	All	3	4	12	The use of characteristic parameters is subject to a location and geotechnical design case assessment of their validity in each GDR.	1	4	4
RW1	[RW] Retaining Walls	Collapsible Ground Encountering uncollapsed void associated with Karst.	All	1	4	4	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	3	3
RW2	[RW] Retaining Walls	Collapsible Ground Induced collapse of solution feature due to change in groundwater regime and/or construction activities.	All	2	4	8	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	4	4
RW3	[RW] Retaining Walls	Collapsible Ground: Encountering unexpected geological features, fissures, faults, solution features etc.	All	2	3	6	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations.	1	2	2
RW4	[RW] Retaining Walls	Compressible ground: Damage to retaining wall caused by settlement/subsidence of foundation.	All	3	4	12	Implement sufficient ground investigation. Identify stratum able to support structural loads and design foundations to limit settlement to acceptable levels (<25mm).	1	4	4
RW5	[RW] Retaining Walls	Compressible ground: Damage to buried services (e.g. brittle pipework) caused by displacement of wall and retained embankment.	All	3	4	12	Investigate location of services and divert where appropriate. Transmit foundation loads to competent strata beneath the services.	1	3	3
RW6	[RW] Retaining Walls	Compressible ground: Lateral loading on retaining wall foundation piles due to compression beneath retained embankment.	All	3	3	9	Where pile foundations are proposed, design to resist lateral loading. Reduce embankment load carried by soft strata at bridge wing walls.	1	2	2
RW7	[RW] Retaining Walls	Compressible ground: Negative skin friction on foundation piles due to compression beneath adjacent embankment.	All	3	4	12	Where pile foundations are proposed, design to accept negative skin friction.	1	3	3
RW8	[RW] Retaining Walls	Variable ground: Damage to retaining walls caused by differential settlement of foundations.	All	3	4	12	Implement sufficient ground investigation. Investigate variability of founding strata. Transmit loads to competent strata.	1	4	4

Geotechnical Risk Register (GRR)

N3 Virginia Bypass

Author	CJO
Approver	DOH
Revision	P02
Date	30/03/2022

Unique Risk ID.	Category	Hazard Description	Route Section	Probability x Severity = Degree of Risk			Design Measures to Manage the Risk	Probability x Severity = Degree of Risk		
				Probability	Severity	Risk		Probability	Severity	Risk
RW9	[RW] Retaining Walls	Soft/loose ground: Damage to retaining wall due to bearing failure of foundation.	All	3	4	12	Identify stratum able to support structural loads and design foundations with factor of safety against shear failure of supporting soil.	1	4	4
RW10	[RW] Retaining Walls	Soft/loose ground: Damage to retaining wall due to instability of supporting slope.	All	3	4	12	Design factor of safety against slip failure. Ensure the retaining walls are founded at sufficient depth.	1	4	4
RW11	[RW] Retaining Walls	Soft/loose ground: Unable to construct foundations due to collapse of weak or saturated ground.	All	3	3	9	Investigate slopes for evidence of instability. Control and inspect temporary works excavations.	1	3	3
RW12	[RW] Retaining Walls	Soft/loose ground: Collapse of wall due to instability of retained slope.	All	3	4	12	Investigate slopes for evidence of instability. Ensure adequate design of slopes and inspect founding layer.	1	4	4
RW13	[RW] Retaining Walls	Obstructions: Impractical to construct foundations due to obstructions.	All	3	3	9	Undertake adequate geotechnical investigation to ensure any obstructions are identified in advance and implement appropriate design mitigation.	1	2	2
RW14	[RW] Retaining Walls	Existing Structures: Damage to existing structures during construction.	All	3	3	9	Implement sufficient ground investigation and identify existing structure arrangements. Undertake pre-construction condition surveys.	1	2	2
RW15	[RW] Retaining Walls	Proximity to services: Impractical to construct foundations without damaging services (overhead cables/pipeline).	All	3	3	9	Locate Services and relocate where necessary. Specify special measures where necessary (e.g. dedicated spotters) Monitor site works. Contractor to use best practice, appropriate plant and equipment.	1	3	3
RW16	[RW] Retaining Walls	Groundwater (chemical aggressivity): Sulphates/Chloride content	All	3	3	9	Implement sufficient ground investigation. Liaise with Structural Designer to determine appropriate concrete exposure class. Specify protective measures as appropriate.	1	3	3
RW17	[RW] Retaining Walls	Pollutants in groundwater: Environmental damage such as pollution of aquifer (piling/ground works) and watercourses.	All	3	4	12	Implement sufficient ground investigation to understand potential pollutant pathways. Specify protective measures as appropriate.	1	3	3
RW18	[RW] Retaining Walls	Contaminated Ground: Damage to retaining wall elements arising from exposure to contaminants.	All	2	3	6	Implement sufficient ground investigation. Liaise with Structural Designer to determine appropriate concrete exposure class. Specify protective measures as appropriate.	1	2	2
RW19	[RW] Retaining Walls	Unforeseen ground conditions: Due to Insufficient ground investigation data points in specific areas.	All	3	3	9	Request supplementary ground investigation is undertaken. Undertake a sensitivity assessment of the current design to more worst credible conditions.	1	2	2

Geotechnical Risk Register (GRR)

N3 Virginia Bypass

Author	CJO
Approver	DOH
Revision	P02
Date	30/03/2022

Unique Risk ID.	Category	Hazard Description	Route Section	Probability x Severity = Degree of Risk			Design Measures to Manage the Risk	Probability x Severity = Degree of Risk		
				Probability	Severity	Risk		Probability	Severity	Risk
RW20	[RW] Retaining Walls	Failure of Structure Due to use of geotechnical design parameters in detailed design without verification of their validity leading to an unsafe design.	All	3	4	12	The use of characteristic parameters is subject to a location and geotechnical design case assessment of their validity in each GDR.	1	4	4
C1	[C] Culverts	Collapsible Ground Encountering uncollapsed void associated with Karst.	All	1	4	4	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	4	4
C2	[C] Culverts	Collapsible Ground Induced collapse of solution feature due to change in groundwater regime and/or construction activities.	All	1	4	4	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	4	4
C3	[C] Culverts	Collapsible Ground Encountering unexpected geological features, fissures, faults, solution features etc.	All	2	3	6	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	2	2
C4	[C] Culverts	Compressible ground Damage to culvert / pipes caused by settlement / subsidence of embankment.	All	3	3	9	Select structure that can accommodate predicted level of settlement. Identify stratum able to support structural loads and design culvert foundations to limit settlement to acceptable levels. Install road drainage when predicted settlement is substantially complete.	1	3	3
C5	[C] Culverts	Compressible ground Loss of capacity to culvert / pipes due to settlement.	All	2	4	8	Oversize culvert / pipes to allow redundant capacity. Install road drainage when predicted settlement is substantially complete.	1	4	4
C6	[C] Culverts	Compressible ground Damage to carriageway where fines washed into culvert / pipe joints from embankment fill.	All	2	4	8	Concrete slab to maintain water- tightness of culvert joints.	1	4	4
C7	[C] Culverts	Compressible ground Loss of profile to culvert/ pipes due to settlement.	All	3	4	12	Accept 'dead water' and possible siltation within culvert / pipes. Install road drainage when predicted settlement is substantially complete. Consider remedial jacking of culvert.	1	4	4
C8	[C] Culverts	Variable ground Damage to culvert caused by differential settlement of foundations.	All	3	4	12	Investigate variability of founding strata. Construct foundation slab to regulate differential movement.	1	4	4
C9	[C] Culverts	Variable ground Damage to carriageway due to differential settlement across structure.	All	3	3	9	Ground treatment to provide transition zone. Construct carriageway when predicted settlements are substantially completed.	1	2	2

Geotechnical Risk Register (GRR)

N3 Virginia Bypass

Author	CJO
Approver	DOH
Revision	P02
Date	30/03/2022

Unique Risk ID.	Category	Hazard Description	Route Section	Probability x Severity = Degree of Risk			Design Measures to Manage the Risk	Probability x Severity = Degree of Risk		
				Probability	Severity	Risk		Probability	Severity	Risk
C10	[C] Culverts	Soft/loose ground Damage to culvert and wing walls due to instability of supporting slope.	All	3	3	9	Adequate ground investigation and design for overall stability.	1	3	3
C11	[C] Culverts	Soft/loose ground Unable to construct culvert due to collapse of weak or saturated ground.	All	3	3	9	Investigate slopes for evidence of instability. Control and inspect temporary works excavations.	1	2	2
C12	[C] Culverts	Obstructions - Impractical to construct culvert due to obstructions.	All	2	4	8	Investigate ground conditions (include inspection of plans).	1	3	3
C13	[C] Culverts	Proximity to services Impractical to construct foundations without damaging services (overhead cables / pipeline).	All	3	3	9	Investigate services / contractor to use best practice, appropriate plant and equipment.	1	2	2
C14	[C] Culverts	Sulphate in groundwater Sulphate attack to buried concrete.	All	2	3	6	Investigate groundwater chemistry and protect concrete as necessary.	1	3	3
C15	[C] Culverts	Pollutants in groundwater Egress of pollutants along pipe surround.	All	2	3	6	Assess ground conditions / Consult with Environment Agency / adopt appropriate techniques. See also H&S Risk Assessment.	1	3	3
C16	[C] Culverts	Contaminated ground Damage to buried concrete and pipes arising from exposure to contaminants.	All	2	4	8	Specify appropriate materials for foundations and pipework etc. See also H&S Risk Assessment.	1	3	3
C17	[C] Culverts	Unforeseen ground conditions Due to Insufficient ground investigation data points in specific areas.	All	2	4	8	Additional ground investigation to be requested.	1	3	3
C18	[C] Culverts	Failure of Structure Due to use of geotechnical design parameters in detailed design without verification of their validity leading to an unsafe design.	All	2	4	8	The use of characteristic parameters is subject to a location and geotechnical design case assessment of their validity in each GDR.	1	3	3

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

comhairle chontae na mí
meath county council

Cavan
Comhairle Contae an Chabháin
Cavan County Council

N3 Virginia Bypass

Preliminary Sources Study Report (PSSR)

May 2022

BARRY
TRANSPORTATION

An Roinn Iompair
Department of Transport

Tionscadal Éireann
Project Ireland
2040

Document Control Sheet

Client:	Cavan County Council
Project Title:	N3 Virginia Bypass
Document Title:	Preliminary Sources Study Report (PSSR)
File Name:	19408-BT-06-ZZ-RP-C_0002_PSSR

Table of Contents *(incl. Y/N)*	**List of Tables** *(incl. Y/N)*	**List of Figures** *(incl. Y/N)*	**Pages of Text** *(No.)*	**Appendices** *(No.)*
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Document Revision				**Document Verification**			
Issue Date *(DD/MM/YY)*	**Revision Code**	**Suitability Code**	**Author** *(Initials)*	**Checker** *(Initials)*	***Reviewer*** As Per PMP *(Initials)*	**Approver** *As Per PMP (Initials)*	**Peer Review** *(Initials or N/A)*
29/04/2022	P01	S3	CJO	DOH	DOH	TC	N/A
11/05/2022	P02	S3	CJO	DOH	DOH	TC	N/A
11/05/2022	C01	A2	CJO	DOH	DOH	TC	N/A

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Appendices

Glossary of Terms

Some of the terms explained hereunder have more precise, technical explanations in the relevant technical documents (referred to where applicable). The definitions included here are valid in the context of this report.

Term	Acronym (where applicable)	Definition
Common Appraisal Framework	CAF	A common framework for appraising transport investments in accordance with the Public Spending Code.
Crag and tail		A steep resistant rock mass (crag), with sloping softer sediments (tail) protected from glacial erosion or deposited as glacial debris on the crag's 'downstream' side.
Drumlin		A streamlined mound of glacial drift, rounded or elongated in the direction of the original flow of ice.
Formation		A formal term for a sequence of related rock types differing significantly from adjacent sequencies
Form C		A geotechnical data form for structures summarising all geotechnical information relevant to the specified structure. The form follows the requirements detailed in Appendix F of the TII Publication (Standards) DN-STR-03001 (April 2019) *Technical Acceptance of Road Structures on Motorways and Other National Roads*.
Geotechnical Design Report	GDR	A report setting out the assumptions, data, methods of calculation, and results of the verification of safety and serviceability as required by the NSAI Publication (Standard) IS EN 1997-1:2005/A1:2013 + NA:2015 *Eurocode 7: Geotechnical design – Part 1: General rules (including Irish National Annex 2015)*. The report follows the requirements detailed in Appendix E of the TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk*.
Geotechnical Risk		A risk to the project, or the Road Authority's asset(s), created by the site ground conditions, construction, and/or operational activities. Geotechnical risks are identified and managed as per the requirements of the TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk*.
Greywacke		Impure sandstones. They are aggregates of sharply angular fragments of every size between sand and fine gravel. Often in a matrix of mud. Sometimes there is so much mud that the sand particles float in the mud (wacke). The grains often been derived from a wide variety of parent rocks and were deposited rapidly by turbidity currents.
Ground Investigation Report	GIR	A report presenting all available geotechnical information and an evaluation of that information as required by the NSAI Publication (Standard) IS EN 1997-1:2005/A1:2013 + NA:2015 *Eurocode 7: Geotechnical design – Part 1: General rules (including Irish National Annex 2015)*. The report follows the requirements detailed in Appendix D of the TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk*.
Hummock		A small hill or knoll in the landscape, which may be formed by many different processes.
Igneous		A rock or mineral that solidified from molten or partially molten material i.e. from a magma.

National Indicative Fluvial Mapping	NIFM	"Predictive" flood maps outside of CFRAM areas showing area predicted to be inundated during a theoretical or "design flood" event.
Option Selection Stage SI		The Option Selection Stage SI (soft ground probing) was undertaken in August 2021 by Causeway Geotech Ltd and comprised 194 No. Mackintosh Probes (MP), 95 No. Peat Probes (PP) and 88 No. Dynamic Probe Penetrometer (DCP). The purpose of this preliminary SI was to establish the extent and depth of soft soils (Peat and Alluvium) as identified by GSI mapping of Quaternary Sediments along 10 No. short listed route options within the N3 Study Area
Preferred Option	PO	The current proposed design alignment which has been presented for stakeholder consultation. This alignment is based on the recommendations outlined in the Option Selection Report – Stage 2.
Preferred Option Corridor	PO Corridor	The PO corridor is a nominal 300m wide corridor along the PO however it is locally widened at the southern and northern tie-ins of the scheme and at the Burrencarragh Link Road. The PO Corridor is indicative, and the project team may undertake some studies/surveys beyond the PO Corridor.
Preliminary Sources Study Report	PSSR	A report including the geotechnical risks, implications, and feasibility of all the project options being considered. The report is required for all projects which involve works covered by the TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk*, and follows the requirements detailed in Appendix C of that document.
Project Liaison Officer	PLO	The individual appointed to liaise with land and property owners, the public, and the Local Authority as per the requirements of the TII Publication (Guidelines) PE-PMG-02041 (December 2020) *Project Management Guidelines*.
Project Management Guidelines	PMG	A set of guidelines which provide a framework for a phased approach to the management of the development and delivery of National Road and Public Transport Capital Projects. These guidelines are applicable to all projects funded through TII and/or where TII is the Sanctioning Authority, unless otherwise instructed by TII. The guidelines are set out in the TII Publication (Guidelines) PE-PMG-02041 (December 2020) *Project Management Guidelines*.
Road Authority	RA	For the purpose of this Technical Document, the Road Authority shall be as defined under the Roads Act, or an alternative entity appointed by the Road Authority, as per the requirements of the TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk*.
Site Investigation	SI	Site Investigation or Ground Investigation Works.
Site Investigation - 2022		A more detailed site investigation focussing on the preferred option only. Investigation techniques to comprise deep and shallow site investigations coupled with sampling and on in-situ and lab testing.
Statement of Intent	SOI	A report identifying the known and/or suspected geotechnical risks and stating the scope, purpose, and estimated programme and cost of the initial geotechnical assessments. The report follows the requirements detailed in Appendix B of the TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk*.
Study Area		The area considered for the appraisal of all road-based and/or rail-based options of the project. The boundary of this area is indicative, and the project team may undertake studies/surveys beyond these boundaries.

Subgrade		Subgrade is the top level of natural ground upon which a road or structure is constructed i.e. underside of road or structure construction materials
Sub-formation		Sub-formation shall be the top surface of earthworks at the underside of capping.

Departments & Stakeholders

Departments & Stakeholders	Acronym (where applicable)
Barry Transportation	BT
Cavan County Council	CCC
Meath County Council	MCC
Department of Transport	DT
National Transport Authority	NTA
Transport Infrastructure Ireland	TII

SECTION 1: INTRODUCTION

1.1 Background

Virginia town and its environs experiences a level of both local and through traffic using the N3 that is contributing to congestion within the town centre, compounded by the relatively large number of Heavy Goods Vehicles (HGVs) passing through the town and making deliveries within the town. This has contributed to poor safety and environment for non-motorised, in particular vulnerable road users (VRU). The poor VRU safety and environment has been deteriorating within Virginia town centre and its environs, with shorter and intra-town trips that are more conducive to walking and cycling being discouraged and displaced with the prevailing traffic condition. In addition, several sections of the N3 in and around Virginia has been identified as High Collision Locations, with 4 fatal collisions and 10 serious injury collisions noted in the period 2012 – 2016.

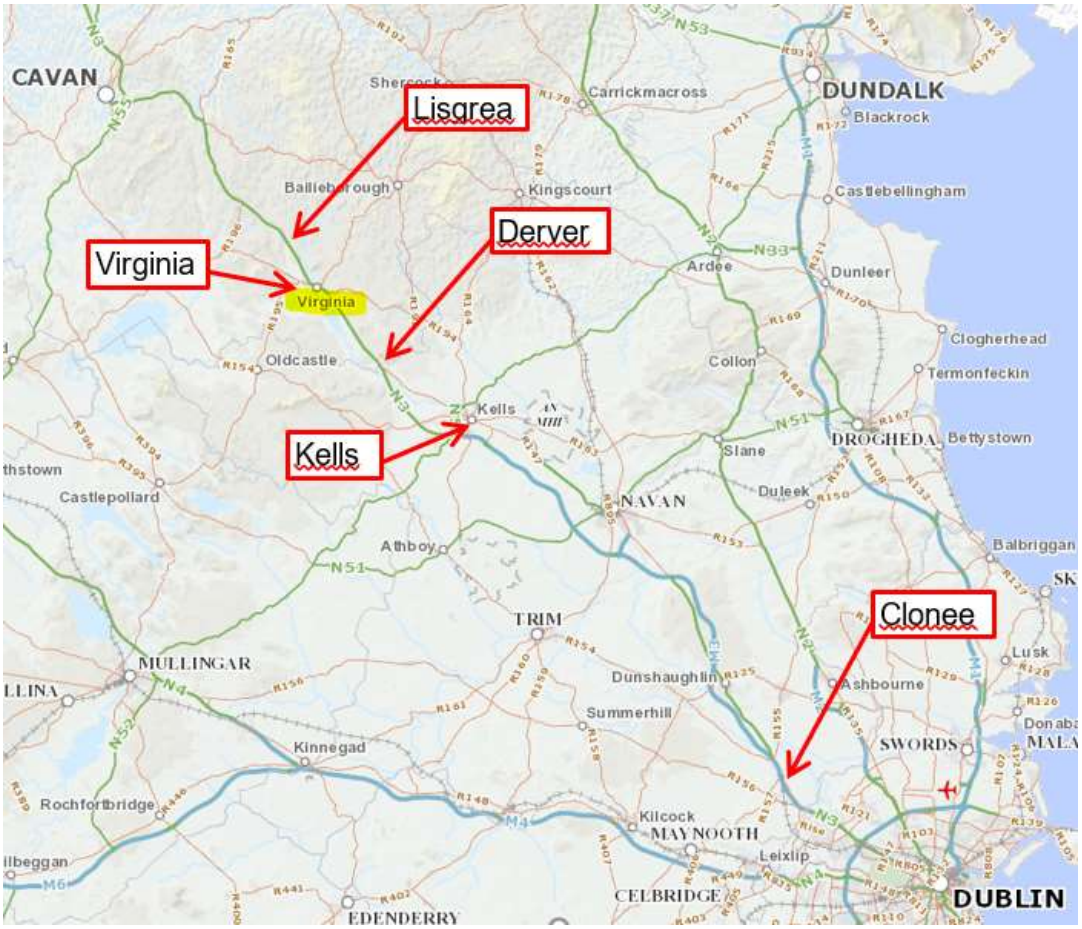

Figure 1: Location of Virginia along the M3/N3 Dublin to Cavan Route

In September 2019, Cavan County Council appointed JB Barry Transportation Ltd, trading as Barry Transportation, as Technical Advisors to provide the Engineering, Environmental, Economic and Appraisal services required to develop a scheme to address the safety, congestion and environmental concerns that exist as a result of the high volume of traffic travelling along the N3 through Virginia town and the settlements of Maghera and Whitegate, and to successfully deliver the Scheme through the Planning and Design Phases 1 to 4 inclusive in accordance with the TII Project Management Guidelines. The project is named the 'N3 Virginia Bypass' scheme, hereafter also referred to as the 'Project' or the 'Scheme' in this report.

The need for a bypass of Virginia was initially identified by Cavan County Council in the 1980's and was included as an indicative alignment in the Cavan County Development Plan of 1996. A bypass of Virginia was formally acknowledged nationally by its inclusion in the National Road Needs Study (1998) by the National Road Authority (NRA). The formal development of a scheme was initiated by the NRA and Cavan County Council in 2000 and over the past twenty plus years, the following three Virginia Bypass schemes were proposed, each reaching various stages of development prior to suspension:

- Virginia Bypass (2003);
- Virginia Bypass as a 2+1 scheme (2004 - 2007); and
- N3 Edenburt to Cavan (2+2 scheme) (2008 - 2012).

Each of the above schemes will be discussed in more detail in Section 2.

1.2 Phase 1 Concept and Feasibility

In September 2019, Cavan County Council appointed Barry Transportation as Technical Advisors to provide the Engineering, Environmental, Economic and Appraisal services required to successfully deliver the Scheme through the planning and design phases; in accordance with the TII Project Management Guidelines Phases 1 to 4 inclusive. The Phase 1 Project Brief concluded that the development of the N3 Virginia Bypass scheme is consistent with National, Regional and Local Policies and it will:

- Enhance Regional Accessibility and enhance connectivity and improve the resilience of the transportation of people, goods and services;
- Reduce traffic through Virginia town and the settlements of Maghera and Whitegate to enable improvement of the public realm environment and to facilitate improvements for walking and cycling that will provide a safer and healthier environment conducive to active travel;
- Improve journey time reliability for all travel modes, including road based public transport, within and through Virginia town, and the settlements of Maghera and Whitegate; and
- Support sustainable and equitable mobility to encourage modal shift to help meet Irelands Climate Change goals.

In December 2019, Cavan County Council prepared and issued the Phase 1 Gate Review Statement to Transport Infrastructure Ireland (TII) and sought their approval to proceed to Phase 2, Options Selection. On 20th December 2019 the TII confirmed approval to proceed to Phase 2 of the N3 Virginia Bypass scheme.

1.3 Phase 2 Option Selection

The Phase 2 Option Selection process essentially comprises the identification of a Study Area, the identification of constraints within that Study Area, consideration and assessment of various alternatives/options such that an Emerging Preferred Option can be identified, and ultimately a Preferred Option selected before the project progresses to its subsequent design and planning phases.

Phase 2 Option Selection utilised the following process:

- Stage 1 Preliminary Options Assessment.
- Stage 2 Project Appraisal Matrix.
- Stage 3 Preferred Option.

The next three sections, Section 1.3.1, Section 1.3.2 & Section 1.3.3 broadly summarises each of the above-mentioned stages. However, for a more detail please refer to Section 8, 9 and 10 of the Option Selection Report.

The Study Area which was developed for the N3 Virginia Bypass (illustrated in Figure 2 below) commences near the end of the Type 2 dual carriageway at Woodpole/Jonesborough, Co. Meath, approximately 9km northwest of Kells and extends north of Virginia town to just north of Billis Bridge.

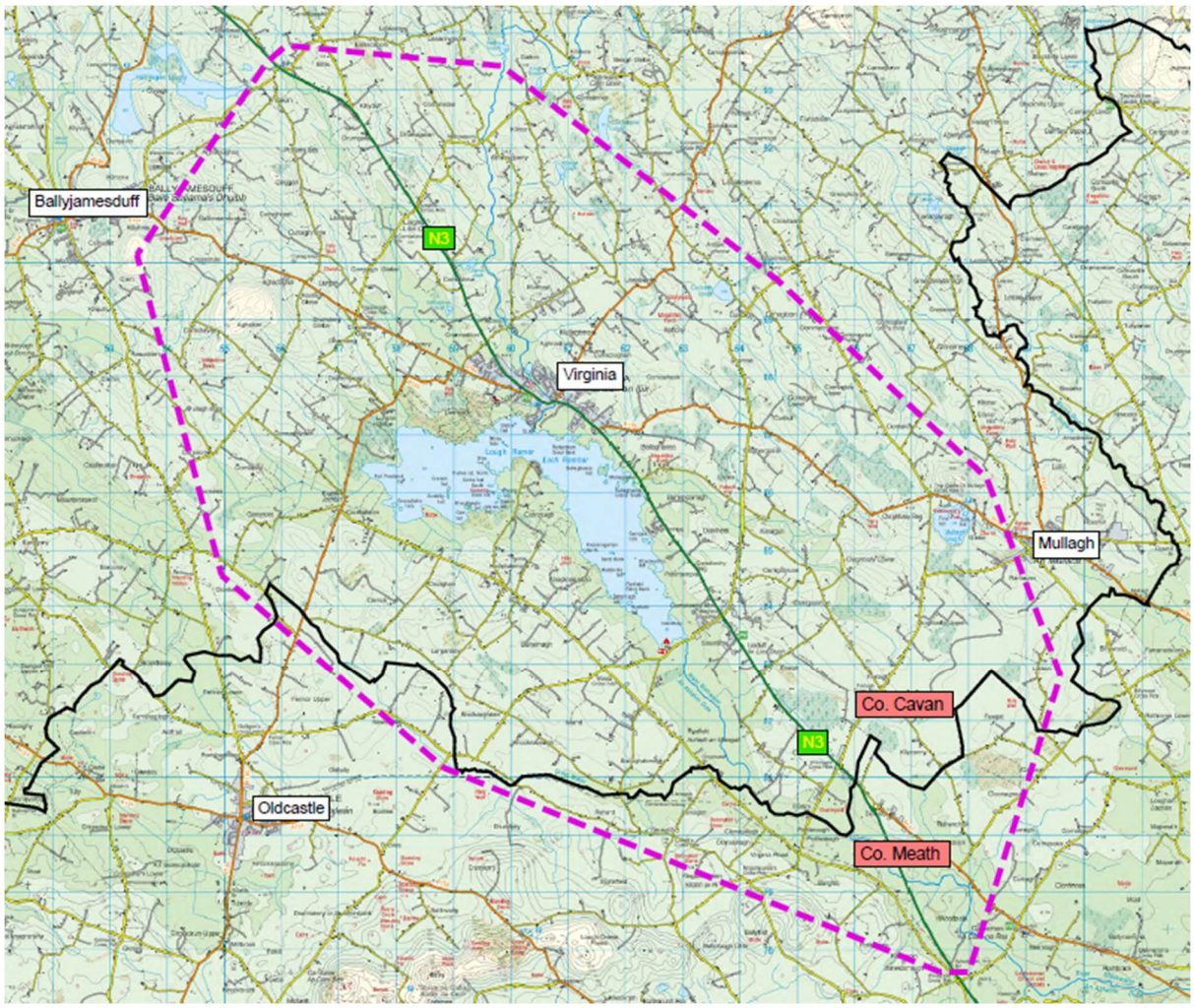

Figure 2: N3 Virginia Bypass - Study Area

1.3.1 Stage 1 - Preliminary Options Assessment

At the outset of option development, basic plan designs were developed by navigating between constraints as much as reasonably practicable to develop preliminary options which were feasible and within the Study Area.

In total, 29 preliminary options and links were developed for the Stage 1 Preliminary Assessment (see Figure 3 below). These options were comparatively assessed within a matrix to determine the proposed options for Stage 2.

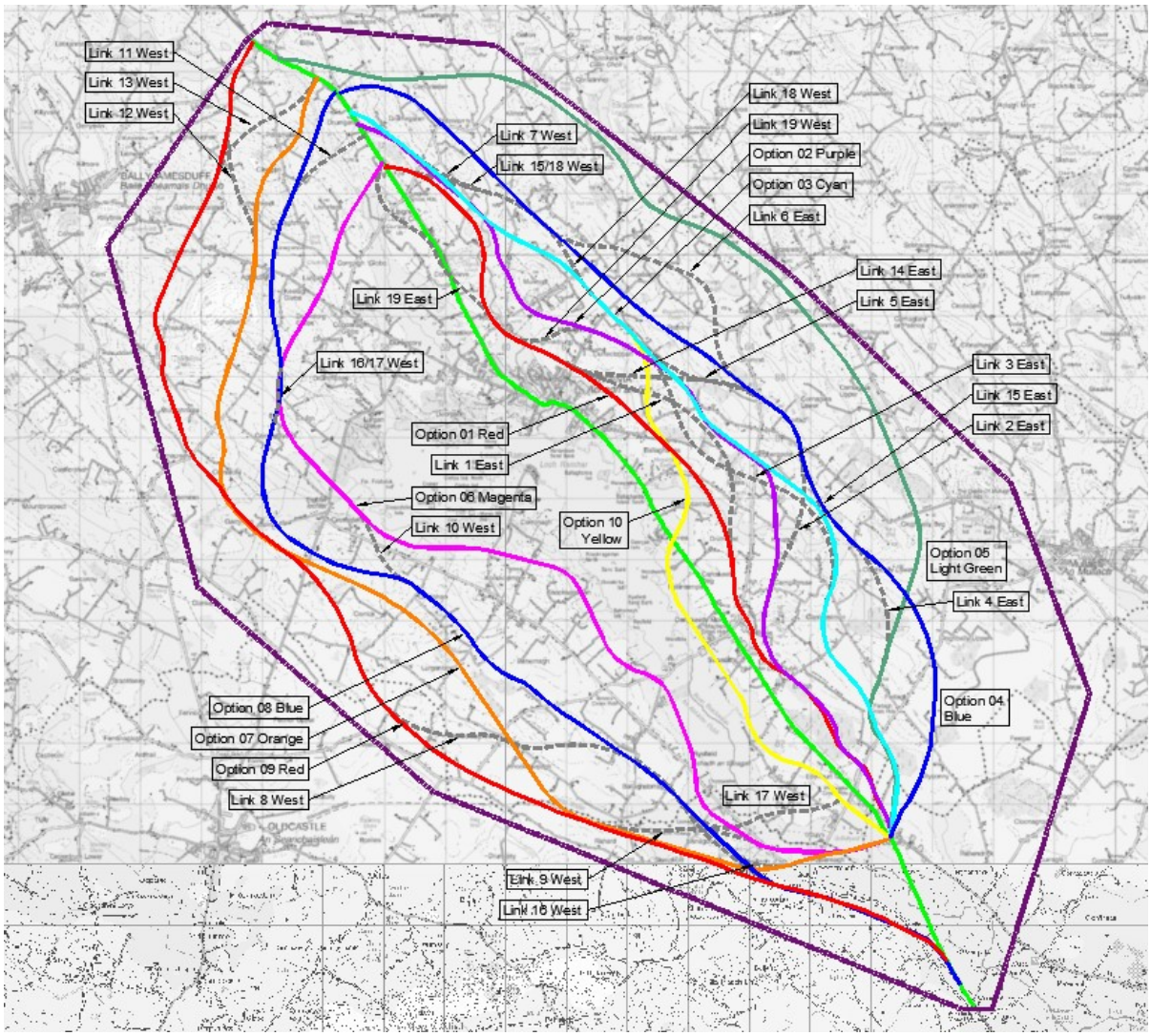

Figure 3: Stage 1 Options & Links

Each Option was assessed against the Stage 1 Preliminary Options Assessment criteria: Engineering, Environment and Economy.

1.3.2 Stage 2 - Project Appraisal Matrix

Following completion of Stage 1, a shortlist of ten options (five main options and five option variants) were identified for the project to be taken forward to the Stage 2 process (see Figure 4 below). All shortlisted options were identified as being feasible and having greater benefit / lower impact that the options eliminated at the end of stage 1.

The shortlist of ten options variants were assessed under the following six criteria to identify the Emerging Preferred Option;

- Economy;
- Environment;
- Safety;
- Accessibility & Social Inclusion;
- Integration; and
- Physical Activity.

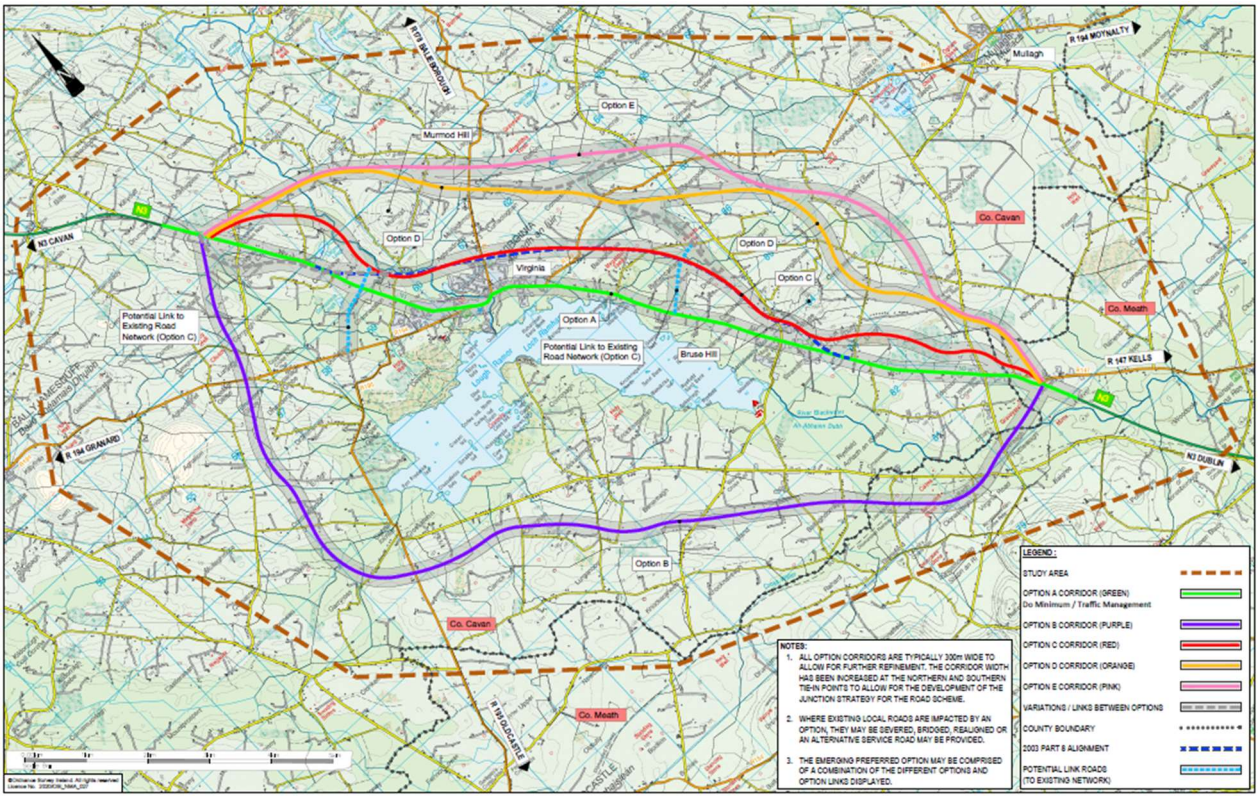

Figure 4: Stage 2 Options and Variations

Following the completion of the Stage 2 appraisal process and Project Appraisal Matrix, Option C Variant (Cv2) was identified as the Emerging Preferred Option (EPO) corridor having regard to the overall benefits and impacts based on the six criteria to be considered for road transport projects. This option is a combination of the Options D, C and A as presented at Public Consultation 2, with some localised corridor widening, as the best overall performing option.

Figure 5 below shows a layout plan of the EPO (Option Cv2) as presented to the Public at Public Consultation 3 from 19th August 2021.

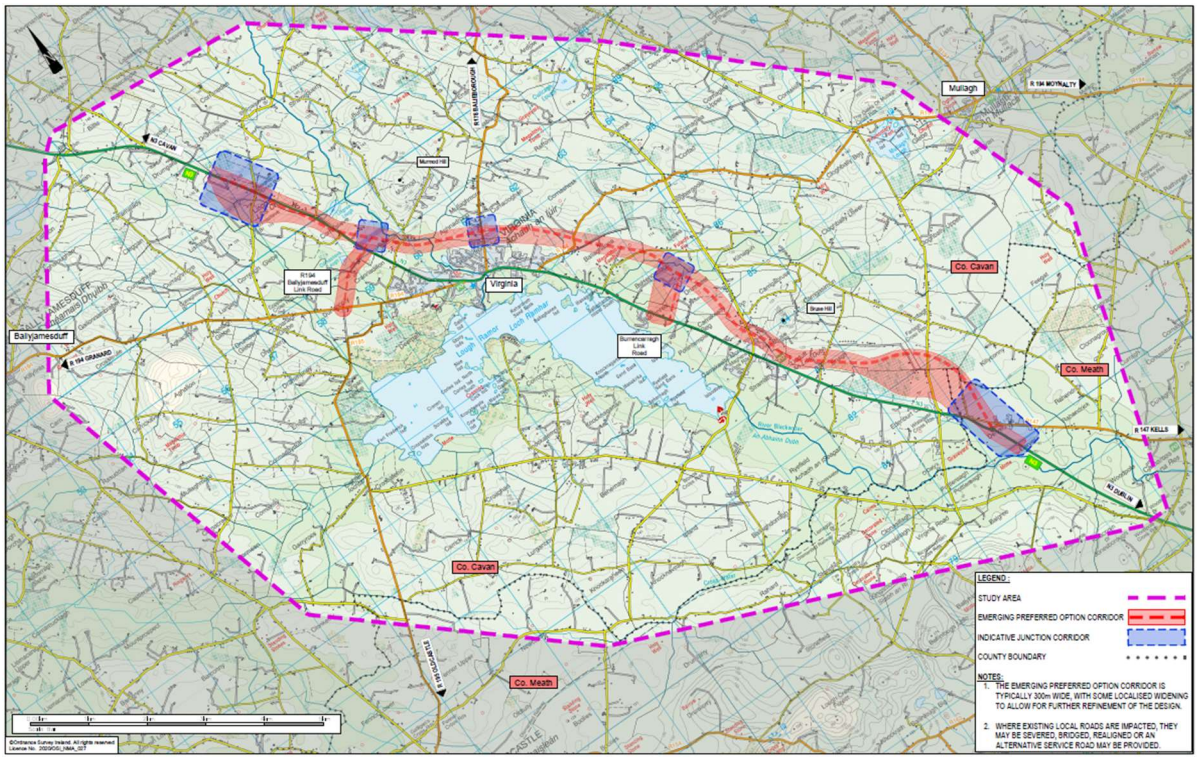

Figure 5: Preferred Option (Option CV2) Corridor

1.3.3 Stage 3 - Preferred Option

Following the completion of the Stage 2 Project Appraisal Matrix, Option C Variant 2 (Cv2) was confirmed as the Preferred Option having regard to the overall benefits and impacts based on the six criteria to be considered for road transport projects.

Following the confirmation of the Preferred Option, a Project Appraisal Balance Sheet (PABS) was undertaken to assess and summarise the benefits and impacts of this option. The 'Preferred Option' corridor has been identified in accordance with the TII's *Project Management Guidelines*.

1.4 Preferred Option

Following Phase 2 Option Selection, it has been assessed that the Preferred Option (Option Cv2) is the optimum solution to meet the Project Specific Need and the Scheme Objectives, as outlined in Section 2 and Section 1.5 respectively of the Options Selection Report (Ref: 19408-BT-GN-XX-RP-Z_2001_Option Selection Report) which this PSSR forms part of.

It is recommended that the Preferred Option Corridor, Option Cv2, including the R194 Ballyjamesduff Link Road and the Burrencarragh Link Road and active travel provision along the mainline and link roads that will facilitate safe, efficient travel by active modes both as a primary mode and as a supporting mode to access public transport, at a local level and will provide a direct link into Virginia and Maghera, be adopted as the Preferred Option, and be taken forward to form the basis of TII PMG Phase 3 (Design and Environmental Evaluation).

A more detailed description of PO Corridor Cv2 is given is Section 4.1 of this report.

1.5 Project Objectives

The objective of the N3 Virginia Bypass is to develop a scheme to address the safety, congestion and environmental concerns that exist as a result of the high volume of traffic travelling along the N3 through Virginia town and the settlement of Maghera and Whitegate.

For a more detailed description of the scheme's objectives, please refer to Section 1.5 of the Option Selection Report (Ref: 19408-BT-GN-XX-RP-Z_2001_Option Selection Report).

1.6 Purpose of Report

The Preliminary Sources Study Report (PSSR) is a desktop study which documents the geotechnical and other investigation implications for the PO. For the purposes of the desk top study, a nominal 300m wide corridor with localised widened sections at the southern and northern tie-ins and at the Burrencarragh Link Road are assessed. The corridor is hereafter referred to as the Preferred Option (PO) Corridor. Additional sites outside of the PO Corridor where impacts on setting might occur were also considered.

1.7 Report Context

TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk* requires five geotechnical documents be prepared during the scheme development. These are as follows;

- Statement of Intent (SOI), including Preliminary Geotechnical Risk Register;
- **Preliminary Sources Study Report (PSSR), including Geotechnical Risk Register;**
- Ground Investigation Report (GIR), including Geotechnical Risk Register;
- Geotechnical Design Report (GDR), including Geotechnical Risk Register; and
- Geotechnical Feedback Report (GFR).

1.8 Overview of Information

The PSSR addresses the geological, geotechnical, geomorphological, hydrogeological, and geo-environmental aspects of the project site as well as the historical development of the area. Potential contamination risks are also highlighted for further investigation during the Site Investigation (SI) phase.

The PSSR provides a preliminary engineering assessment of the project area and informs of the likely hazards to construction. It identifies risks and consequences to the project, based on the information gathered to date, which is documented in the Geotechnical Risk Register as the means to track and manage those risks.

1.9 Procedure / Methodology / Sources of Information

This PSSR has been prepared in accordance with the guidance set out in TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk*.

The sources of information are listed in Section 2. All drawings produced are listed in Section 8 and are included in Appendix 2.

SECTION 2: SOURCES OF INFORMATION & DESK STUDY

The following three Virginia Bypass schemes were previously proposed, each reaching various stages of development prior to suspension:

- Virginia Bypass (2003);
- Virginia Bypass as a 2+1 scheme (2004 - 2007); and
- N3 Edenburt to Cavan (2+2 scheme) (2008 - 2012).

The details of all sources of geotechnical, historical, and other general information relevant to the PO Corridor and the wider Study Area are summarised in the following sections.

2.1 N3 Virginia Bypass (2003)

This proposed scheme recommended two types of carriageway cross section. The majority of the carriageway (8.5km) was Wide Single Carriageway with the remainder (0.7km) Standard Single Carriageway.

The proposed scheme commenced approximately 1km south of Maghera Crossroads, bypassing Maghera and Virginia town before tying back into the existing N3 in the townland of Cornaslieve, approximately 2km north of Virginia town. A proposed R194 link connected the existing R194 Ballyjamesduff Road to the proposed bypass providing a necessary link for vehicles wishing to gain access to the R178 Bailieborough Road and the proposed bypass without the need to travel through Virginia town. The proposed route for the Virginia Bypass (2003) runs approximately along the same alignment as the current PO between Ch. 4+000 to 12+800m including the proposed link road to R194 at Ch. 12+000m (see Figure 6 below).

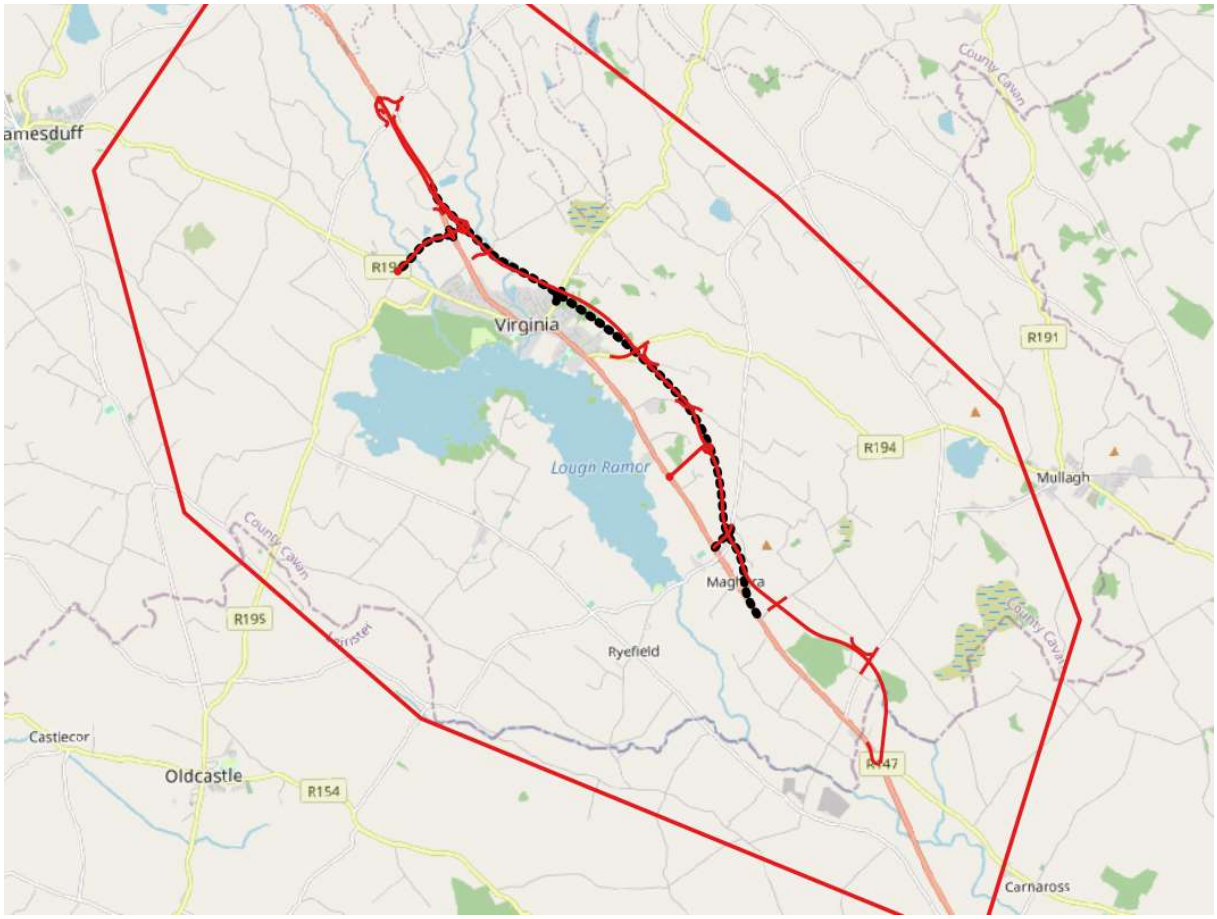

Figure 6: Preferred Option (Red) vs Previous Planned Route (Dashed Black)

This scheme was suspended prior to lodgement of the Statutory Process documentation in 2003. A Supplementary Report was prepared by RPS Consulting Engineers in July 2005 and stated that the Virginia Bypass was considered to be somewhere between single carriageway and dual carriageway in terms of capacity, cost and safety. The Supplementary Report concluded that the N3 Virginia Bypass scheme was suitable for a 2 + 1 (Type 3 Dual Carriageway) scheme and that the section of the existing N3 between Maghera and the Meath/Cavan County Boundary could be retrofitted to a 2 + 1 scheme. Cavan County Council has been protecting the route corridor from development since October 2003.

2.1.1 Constraints Study

In December 2000, a Constraints Study (Document No: 157/505-001-001/Rp001RevF) was undertaken by project consultants M.C. O'Sullivan & Co. Ltd to review the physical, procedural, and legal constraints that exist affecting the design and choice of route for the scheme.

The following information included in the report is of geotechnical interest:

- Chapter 4: Identified Constraints, including Section 4.3: Rivers and Streams; Section 4.4: Geology and Hydrogeology; Section 4.7: Protected Areas; and Section 4.9: Land Use and Agricultural Potential; and
- Appendix E: Geology and Hydrogeology.

2.1.2 Route Selection Report

This report (Document No: MCOS/157-505/Rp009) was prepared for CCC by MCOS in 2000. The following sections of this report contain information of geotechnical interest;

- Volume 1, including;
  - Chapter 6: Ground Conditions.

2.1.3 Preliminary Ground Investigation Phase 1

The Geotechnical Unit of Westmeath County Council were commissioned by Cavan County Council to perform a Preliminary Ground Investigation (Phase 1) along the corridor of the proposed routes as part of the proposed N3 Virginia Bypass. The work involved the completion of 96 Probes and 25 Trial Pits to investigate the presence of soft ground. This factual information was not available for use on the project during the planning and design phase.

2.1.4 Preliminary Ground Investigation Phase 2

In March 2003, a Factual Report on Ground Investigation (Final Report No. K2191) was prepared by Geotech Specialists Ltd on behalf on Cavan County Council and project consultants M.C. O'Sullivan & Co. Ltd as part of the proposed N3 Virginia Bypass Ground Investigation (Phase 2) Contract. The preliminary ground investigation was carried out during May – August 2009. As part of this ground investigation, exploratory holes were undertaken along the proposed route and are shown in the Historic Site Investigation Location Plan drawing included in Appendix 2 (Ref No. 19408-BT-06-ZZ-DR-C_0105).

This investigation comprised of the following:

- 26 No. RC to max depth 20.0m
- 38 No. Trial Pits to max depth 7.3m
- 32 No. Dynamic Probes (Heavy probe and Mackintosh probe) to max depth 4.3m
- 12 No. Slit Trenches to max depth of 1.5m and max length 7.5m
- 6No. standpipes

The Factual Report summarises ground conditions encountered as follows:

"In general, the strata encountered comprised glacial granular and cohesive deposits overlying bedrock at depths typically less than 5.0m

The bedrock core typically comprised strong to very strong greywacke and siltstone and occasionally weak to moderately weak sandstone and mudstone".

The results of the above exploratory holes have been provided to Barry Transportation and subsequently reviewed providing information on the ground profile along the PO.

2.1.5 Environmental Impact Statement

This report (Document No: 157505Rp023) was prepared for CCC by MCOS in 2003. The following sections of this report contain information of geotechnical interest;

- Book 1, including; and
  - Chapter 6: Ground Conditions;
  - Chapter 8: Drainage and Receiving Waters;
- Book 3, including;
  - Drawings 505-001-SI-0000 to 505-001-SI-0010.

2.1.6 Preliminary Design Report

In March 2003, a Preliminary Design report (Document No: 157505Rp023) was prepared by M.C. O'Sullivan & Co. Ltd (MCOS) Consulting Engineers on behalf of Cavan County Council and the National roads Authority (NRA).

The following information included in the report is of geotechnical interest:

- Book 1, including; and
  - Chapter 6: Ground Conditions;
  - Chapter 8: Drainage and Receiving Waters;
- Book 3, including;
  - Drawings 505-001-SI-0000 to 505-001-SI-0010.

In conclusion, the report states that the results of the Ground Investigation (Phase 2) indicate that the ground conditions along the proposed route do not constitute any major difficulties for road construction.

2.2 Virginia Bypass as a 2 + 1 scheme (2004 – 2008)

This scheme followed on from the suspended N3 Virginia Bypass. In July 2004, CCC requested RPS-MCOS to re-examine the Virginia Bypass to develop it as a 2 plus 1 scheme, or Type 3 Dual Carriageway. Draft reports were prepared before the scheme was suspended again.

2.2.1 Supplemental Preliminary Report (July 2005)

Additional works were carried out on the proposed N3 Virginia Bypass by M.C. O'Sullivan & Co. Ltd (MCOS) Consulting Engineers on behalf of Cavan County Council and the National roads Authority (NRA). The main works included an assessment of the introduction of a 2 + 1 road scheme for the project following the introduction of the road type on a pilot basis in 2004.

There was limited geotechnical content contained within the report (Document No: MDT0245Rp0001WPR):

- Chapter 3: Assessment of Amended Accommodation Works at Murmod, including Section 3.2.4: Geotechnical Implications.

2.2.2 Preliminary Design Report

In February 2008, a Preliminary Design Report titled "N3 Virginia Bypass – 2 Plus 1 Scheme" (Document No: MDT0245Rp0003WPR) was prepared by M.C. O'Sullivan & Co. Ltd (MCOS) Consulting Engineers on behalf of Cavan County Council and the National roads Authority (NRA).

The following information included in the report is of geotechnical interest:

- Chapter 6: Ground Conditions; and
- Chapter 8: Drainage and Receiving Waters.

In conclusion, the report states that the results of the Ground Investigation (Phase 2) indicate that the ground conditions along the proposed route do not constitute any major difficulties for road construction however areas of soft ground (up to 2m of peat) are present at certain sections along the route. The report indicates that the excavation of rock in proposed cuttings is assessed as easy to hard ripping with potential for re-use meeting Class 6 testing requirements.

2.2.3 Environmental Impact Report

In November 2006, an Environmental Impact Report (Document No: MDT0245Rp2003) for the proposed N3 Virginia Bypass 2 Plus 1 Scheme was prepared by M.C. O'Sullivan & Co. Ltd (MCOS) Consulting Engineers on behalf of Cavan County Council and the National roads Authority (NRA).

There was no content within the report of substantial geotechnical interest.

2.3 N3 Edenburt to Cavan Bypass Scheme (2008 - 2012)

In 2008 the National Roads Authority requested Cavan Country Council to reassess the N3 Virginia Bypass as part of a larger strategic project. The proposed project was to develop a scheme on the N3 from the Cavan/Meath border to Cavan Town i.e., the Edenburt to Cavan Bypass Scheme.

A Project Brief was prepared by Cavan County Council and the Meath National Roads Design Office. This report was submitted to the NRA (TII) in 2009 and concluded that there was a need for this scheme.

A Constraints Study for this scheme was completed in September 2009. The purpose of the Constraints Study was to identify any features or issues that could affect the design, delay the progress or influence the cost of the N3 Edenburt to Cavan Bypass Scheme and to accumulate relevant background information in this regard. The scheme was suspended prior to completion of the Route Selection process in November 2012.

Following the closure of the Meath NRDO, Cavan County Council obtained agreement from the NRA (TII) in March 2014 for Donegal NRDO to carry out a review of the Route Selection process to date. A Route Selection Status Report was produced in July 2014 outlining the works necessary to complete the Route Selection Process. This report concluded that the Route Selection Process was only 40 – 50 % complete.

2.3.1 Constraints Study

In December 2009, a Constraints Study (Document No.: MH-0305-R-02-0016) was prepared by the National Road Design Office (Meath County Council) on behalf of Cavan County Council and the National roads Authority (NRA).

The following information included in the report is of geotechnical interest:

- Section 5 – Landscape Constraints
- Section 6 – Hydrogeology & Water Quality Constraints
- Section 7 – Geology Constraints
- Section 8 – Groundwater Constraints

2.4 N3 Virginia Bypass

In September 2019, Cavan County Council, in association with Meath County Council and Transport Infrastructure Ireland (TII) has commissioned Barry Transportation to develop a scheme to address the safety, congestion and environmental concerns that exist as a result of the high volume of traffic travelling along the N3 through Virginia town and the settlement of Maghera and Whitegate.

2.4.1 Constraints Study

N3 Virginia Bypass Constraints Study was undertaken as part of Phase 2 Option Selection. The constraints study presents the various anthropogenic and environmental constraints that are within the Study Area of the proposed project and a potential 15km (minimum Zone of Influence (ZoL), TII Publications (Technical) PE-PMG-02041 (December 2020) *Project Management Guidelines*. In summary, the scope for the N3 Virginia Bypass is to investigate options that would improve road safety and congestion in Virginia town centre and its approach roads.

The following information included in the report is of geotechnical interest:

- Section 7 – Land, Geology and Soils
- Section 8 – Hydrogeology
- Section 9 – Water

2.4.2 Soils & Geology Assessment

A soils and geology assessment was undertaken during Phase 2 Appraisal and is included in the Options Selection Report of which this PSSR forms part. A metric weighting assessment was undertaken for the numerous corridor options under the following headings:

1. Solid Geology
2. Soft Soils
3. Geomorphology
4. Karst
5. Economic Geology
6. Contaminated Land
7. Geological Heritage

2.5 Published Resources

2.5.1 GIS Map Viewers

Published online databases from the following organisations were reviewed using GIS map viewers in the preparation of this PSSR;

- Geological Survey of Ireland (GSI) [https://www.gsi.ie/en-ie/data-and-maps/Pages/default.aspx];
- Environmental Protection Agency (EPA) [https://gis.epa.ie/SeeMaps];
- National Parks & Wildlife Service (NPWS) [https://www.npws.ie/maps-and-data]; and
- Office of Public Works (OPW) [https://www.floodinfo.ie/].

Table 1 below summarises the data layers reviewed using these GIS map viewers. It should be noted that, while these databases are regularly updated to the best ability of the relevant organisation, they are not comprehensive (unless otherwise stated), and no guarantee is given to their accuracy. These resources were accessed in June to December 2021 and have been used to identify potential geotechnical risks for further investigation. Geotechnical risks not identified may still be encountered on site and will be added to the Geotechnical Risk Register as necessary.

Table 1: GIS Map Viewer Data Layers

Organisation	Database	Description	Link
ASI	Archaeology	*The Historic Environment Viewer is a new on-line digital service provided by the Department of Culture, Heritage and the Gaeltacht. It has been developed to enhance the user's experience by facilitating access to the databases of the National Monuments Service Sites and Monuments Record (SMR) and the National Inventory of Architectural Heritage (NIAH) in a seamless one-stop point of access for both built heritage data resources.*	https://maps.archaeology.ie/historicenvironment
GSI	Bedrock	**Bedrock 100k:** *Bedrock geology map of Ireland at 1:100,000 scale.*	https://www.gsi.ie/en-ie/data-and-maps/Pages/Bedrock.aspx#
	Geohazards	**Landslides Susceptibility Mapping:** *Systematic mapping of Ireland identifying areas predisposed to landslides and classifying susceptibility from low to high;* **Karst Features:** *Database of all known karst features in Ireland, including boreholes, caves, dry valleys, enclosed depressions, estavelles, springs, superficial solution features, swallow holes, and turloughs.*	https://www.gsi.ie/en-ie/data-and-maps/Pages/Geohazards.aspx#
	Geological Heritage	**Geological Heritage Sites Audited:** *Database of all audited geological heritage sites;* **Geological Heritage Sites Unaudited:** *Database of all unaudited geological heritage sites, including buffer zones around features.*	https://www.gsi.ie/en-ie/data-and-maps/Pages/Geoheritage.aspx
	Geotechnical	**External Geotechnical Boreholes and Site Investigations:** *Borehole logs and site investigation data submitted to the National Geotechnical Borehole Database.*	https://www.gsi.ie/en-ie/data-and-maps/Pages/Geotechnical.aspx
	Groundwater	**Groundwater Flood Data:** *Mapping of historic groundwater flood events and potential groundwater flood areas;* **Groundwater Resources (Aquifers):** *Mapping of bedrock aquifers, including classification of resource potential;* **Groundwater Vulnerability:** *Mapping identifying areas susceptible to groundwater contamination;* **Groundwater Wells and Springs:** *Database of all boreholes, dug wells, springs, and ground site investigations.*	https://www.gsi.ie/en-ie/data-and-maps/Pages/Groundwater.aspx
	Minerals	**Mineral Localities:** *Database of mineral localities compiled from 6" geological maps, field investigations, exploration reports, and other sources;* **Quarry Directory:** *Comprehensive database of active quarries containing information such as quarry products, location, and contact details;*	https://www.gsi.ie/en-ie/data-and-maps/Pages/Minerals.aspx

Organisation	Database	Description	Link
		Aggregate Potential Mapping: *Mapping showing the potential for crushed rock, and sand and gravel aggregates, including an inventory of active and historical pits and quarries.*	
	Quaternary	**Quaternary Geomorphology:** *Mapping of Irish glacial geomorphological features at 1:50,000 scale;* **Quaternary Sediments:** *Mapping of all sediments within 1m of the surface, including those which were laid down during the Quaternary, bedrock at or close to the surface, and Made Ground.*	https://www.gsi.ie/en-ie/data-and-maps/Pages/Quaternary.aspx
EPA	Industrial Emissions (IE) Facilities	*Point dataset of IE licensed facilities in Ireland, including those licensed, applied, surrendered, and other. The EPA is the competent authority for granting and enforcing these licenses for specified industrial and agricultural activities, as listed in the First Schedule of the Environmental Protection Agency Act 1992 as amended.*	https://gis.epa.ie/geonetwork/srv/eng/catalog.search#/metadata/7905844c-a43d-4dd4-b262-c95c7aa0e9c7
	Integrated Pollution Control (IPC) Facilities	*Point dataset of IPC licensed facilities in Ireland, including those licensed, applied, surrendered, and other. The EPA is the competent authority for granting and enforcing these licenses for specified industrial and agricultural activities, as listed in the First Schedule of the Environmental Protection Agency Act 1992 as amended.*	https://gis.epa.ie/geonetwork/srv/eng/catalog.search#/metadata/70e60147-0f3f-4ce5-9831-6787d016f439
	Integrated Pollution Prevention Control (IPPC) Facilities	*Point dataset of IPPC licensed facilities in Ireland, including those licensed, applied, surrendered, and other. The EPA is the competent authority for granting and enforcing these licenses for specified industrial and agricultural activities, as listed in the First Schedule of the Environmental Protection Agency Act 1992 as amended.*	https://gis.epa.ie/geonetwork/srv/eng/catalog.search#/metadata/7459f32a-afa0-470f-aae9-7eae49419740
	Licensed Waste Facilities	*Point dataset of waste licensed facilities in Ireland, including licensed, applied, surrendered, and other. The EPA is the competent authority for granting and enforcing these licenses. Facilities include landfills, transfer stations, hazardous waste disposal, and other significant waste disposal and recovery activities.*	https://gis.epa.ie/geonetwork/srv/eng/catalog.search#/metadata/00750a6a-e2f4-451d-b41c-0f067a40c94c
NPWS	Protected Sites	*Mapping of protected sites, including Special Protection Areas (SPAs), Special Areas of Conservation (SACs), Natural Heritage Areas (NHAs), and proposed National Heritage Areas (pNHAs).*	https://dahg.maps.arcgis.com/apps/webappviewer/index.html?id=8f7060450de3485fa1c1085536d477ba
OPW	Flood Maps	**Past Flood Events:** *Mapping of historic flood events, including single and recurring events.* **National Indicative Fluvial Mapping:** *"Predictive" flood maps outside of CFRAM*	https://www.floodinfo.ie/map/floodmaps/

Organisation	Database	Description	Link
		areas showing area predicted to be inundated during a theoretical or "design flood" event.	

2.5.2 Academic Literature

The following academic journals were reviewed as part of the preparation of this PSSR;

- Mathew Parkes, Robert Meehan, Vincent Gallagher & Sarah Gately, 2013. The Geological Heritage of Cavan "An Audit of County Geological Sites in Cavan".
- McConnell, B., Philcox M.E., Geraghty, M., Morris, J., Cox W., Wright, G.R. and Meehan, R.T., 2001. *Geology of Meath. A geological description to accompany the Bedrock Geology 1:100,000 Map Series, Sheet 13, Meath.* Geological Survey Ireland, Dublin.

2.5.3 Other Historical Site Investigation Reports

A review of the GSI online map viewer referenced in Section 2.5.1 identified other historic site investigation reports undertaken within the Study Area comprising unrelated projects.

The relevant reports are listed in Table 2 below:

Table 2: Summary of Historic SI Reports from within Study Area

Report ID	Report Title	Link	PDF Reference
1540	North Eastern Pipeline 3 Phase 2 (Dunleer to Virginia) Virginia Spur & Bailieborough Spur	https://secure.decc.gov.ie/goldmine/docpage.html?id1=63170061&id2=63361229&id3=63178453	63178453
1290	Virginia Milk Products	https://secure.decc.gov.ie/goldmine/docpage.html?id1=63168913&id2=63371156&id3=63176343	63176343

2.6 Consultation with Public & Statutory Bodies and Agencies

2.6.1 Geological Survey of Ireland

The GSI was consulted directly for further information relating to the Geological Heritage sites. Drawings of the proposed Route Options and subsequent Preferred Option were issued to the agency with an invitation to reply with comments and preferences leading to several correspondences between BT and GSI. This is discussed in more detail is Section 4.2.4 and Section 6.6.4 of this report.

SECTION 3: FIELD STUDIES

3.1 Previous Site Investigation

3.1.1 N3 Virginia Bypass (2003) - Preliminary Ground Investigation (Phase 1)

The Geotechnical Unit of Westmeath County Council were commissioned by Cavan County Council to perform a Preliminary Ground Investigation (Phase 1) along the corridor of the proposed routes as part of the proposed N3 Virginia Bypass. The work involved the completion of 96 Probes and 25 Trial Pits to investigate the presence of soft ground. This factual information was not available for use on the project during the planning and design phase.

3.1.2 N3 Virginia Bypass (2003) - Preliminary Ground Investigation (Phase 2)

As mentioned in Section 2.4, a Factual Report on Ground Investigation (Final Report No. K2191) was prepared by Geotech Specialists Ltd on behalf on Cavan County Council and project consultants M.C. O'Sullivan & Co. Ltd as part of the proposed N3 Virginia Bypass 2003 Ground Investigation (Phase 2) Contract. The preliminary ground investigation was carried out during May – August 2003. The investigation was undertaken approximately along the current PO between Ch. 4+000 to 12+800m (including the R194 Link Road at Ch. 12+000). The results were reviewed as part of this report providing an excellent source of data.

This investigation comprised of the following:

- 26 No. RC to max depth 20.0m
- 38 No. Trial Pits to max depth 7.3m
- 32 No. Dynamic Probes (Heavy probe and Mackintosh probe) to max depth 4.3m
- 12 No. Slit Trenches to max depth of 1.5m and max length 7.5m
- 6 No. Standpipes for ground water monitoring

3.1.3 Other Non-related Site Investigations in the Study Area

A site investigation was undertaken in 1991 as part of Bord Gais' North Eastern Pipeline 3 Phase 2 – Dunleer to Virginia (Virginia Spur & Bailieborough Spur). This report is available on the GSI website and was reviewed as part of this report.

A site investigation was also undertaken by Irish Geotechnical Services Ltd for Virginia Milk Products (now known as Glanbia Ingredients Virginia Ltd) in May 1991 comprising for 4 No. cable percussive boreholes. This report was also reviewed as part of this report.

3.2 Option Selection Stage SI

The Option Selection Stage SI (soft ground probing) was undertaken in August 2021 by Causeway Geotech Ltd and comprised 194 No. Mackintosh Probes (MP), 95 No. Peat Probes (PP) and 88 No. Dynamic Probe Penetrometer (DCP). The purpose of this SI was to establish the extent and depth of soft soils (Peat and Alluvium) as identified by GSI mapping of Quaternary Sediments along 10 No. short listed route options within the N3 Study Area (see Figure 4 above).

In general, the SI results were broadly consistent with the GSI Quaternary Sediments 1:50,000 mapping series however the extent of soft soils encountered was approximately 25% less than that indicated by the GSI. For a more detailed analysis of the Option Selection Stage SI, please refer to the Soils and Geology Assessment included in the Option Selection Report. The location of the soft ground probing (and depth of soft ground encountered) along the PO is shown on the Option Selection Stage SI drawing (Ref: 19408-BT-06-ZZ-DR-C_0116) included in Appendix 2 of this report.

SECTION 4: SITE DESCRIPTION

4.1 General

The preferred option (Option Cv2) is 14.445km in length and commences at the N3/R147 roundabout at Derver. From Derver, the road runs approximately parallel to the existing N3, east of Virginia town and Lough Ramor, passing through the townland areas of Derver, Fartagh, Enagh, Lisduff, Bruse, Carrakeelty Beg, Carrigbruse, Drumheel, Burrencarragh, Lislea, Ballaghnea, Cornashesk, Curragloghan, Aghnadrung, Rahardrum, Virginia, Cornaslieve and Lisgrea where it ties into the existing N3 via a new roundabout.

There are 5 no. potential junctions proposed along the route, summarised below:

- Ch. 0+000m - link to the existing N3 dual carriageway north of Kells
- Ch. 6+500m – access to the south of Virginia town
- Ch. 10+025m – Virginia town / R178 (Bailieborough Road),
- Ch. 12+000m – access to the north side of Virginia town / R194 (Ballyjamesduff Road)
- Ch. 14+445m - link to the existing N3 in the vicinity of Lisgrea Cross

The proposed route intersects several local and regional roads which will require either overbridges or underbridges depending on whether the route is in cut of fill. Such roads include L3021 (Ch. 1+750), L7106 (Ch. 3+500m), L7102 (Ch. 4+900m), L7107 (Ch. 7+225m), R194 (Ch. 8+400m) and L7031 (Ch. 11+375m).

There are a number or rivers and streams which are intersected which will require bridges or culverts. The route will also be required to include for accommodation overbridges/underpasses to service severed lands etc however details of these structures is not known at the time of writing this report.

The scheme's mainline will be located predominantly on a green field site comprising agricultural land and forestry.

4.2 Geology

Section 2 provides details of the sources of information used in preparation this section which includes a range of geological maps, academic literature and historical site investigation reports.

4.2.1 Bedrock Geology

Based on the GSI database mapping "Bedrock Geology 100k", the PO Corridor is located over 3 main bedrock formations, including:

- Clontail Formation – PO Ch. 0+000 to 2+850m
- Castlerahan Formation – PO Ch. 2+850 to 12+870m
- Shercock Formation – PO Ch. 12+870 to 14+445m

See Bedrock Geology drawing (Ref: 19408-BT-06-ZZ-DR-C_0102) included in Appendix 2.

The Clontail Formation is described as grey to green-grey, medium to thickly bedded, coarse and very fine-grained greywackes, with dark grey, thinly bedded, poorly graded, quartzose fine sandstone to siltstone units. The Castlerahan Formation is described as dark grey to black, usually massive quartzo-greywacke. The Shercock Formation is described as grey to green-grey, fine to coarse grained, medium to thick bedded turbidities that are rich in white mica and contain significant felsic igneous material.

A review of the rotary core (RC) borehole logs from the N3 Virginia Bypass 2003 SI were reviewed to determine depth to bedrock and description of bedrock between Ch. 4+000 to 12+500m, see table below. For comparison purposes, the depth to bedrock as inferred on the GSI's Groundwater Vulnerability mapping and can also be seen in the table below:

Table 3: Depth to Bedrock

2003 N3 Virginia Bypass SI - BH ID	PO Chainage (m)	Termination depth (m)	Bedrock Type (Driller's Log Description)	Depth to Bedrock (m)	Depth to Bedrock as inferred from Groundwater Vulnerability Mapping (m)
VBH28	4+900	10.1	Strong to very strong grey fine to medium grained GREYWACKE	3.6	5-10
VBH27	4+940	10.1	Strong dark grey SILTSTONE	2.8	>10
VBH26	4+975	12.1	Strong grey fine grained GREYWACKE	2.5	>10
VBH24	5+375	10	Strong grey fine grained GREYWACKE	2	>10
VBH23	5+910	15	Bedrock Not Encountered	Bedrock Not Encountered	>15
VBH22	6+490	11	Strong and very strong grey thickly interbedded coarse grained SANDSTONE / SITLSOTNE	4.2	1 - 3
VBH21	6+770	12	Moderately weak orange brown fine and medium grained SANDSTONE	6.5	Straddles 1-3 / 3-5
VBH20	6+950	14.6	Non intact SILTSTONE. At 8.35m bgl, moderately strong to strong purple to brown fine-grained SILTSTONE	5	1 - 3
VBH19	7+150	14.5	Recovered core is predominantly non-intact SILTSTONE. At 12m bgl, very strong grey green SILTSTONE	5	1 - 3
VBH18	7+720	11.8	Very strong grey widely interbedded SILTSTONE / SANDSTONE	1.6	1 - 3
VBH17	7+880	10	Moderately weak to moderately strong grey to green fine-grained SILSTONE	5.4	1 - 3
VBH16	8+050	9.5	Very strong dark green grey SILSTONE	5	1 - 3
VBH15	8+400	10.25	Very strong grey massive SILSTONE	4.55	1 - 3
VBH14	8+400	10	Very strong dark grey medium grained SILSTONE	5	1 - 3
VBH13	8+410	9.6	Strong to very strong dark grey medium to coarse grained GREYWACKE	3.8	1 - 3
VBH12	8+800	8	Recovered core in non-intact comprising dark brown very weak to weak LITHORELIC with weak to moderately strong purple, grey SILSTONE	7.5	5-10
VBH11	8+950	12	Strong dark grey fine to medium-grained SILSTONE	6	5-10
VBH10	10+400	20	Recovered core is predominantly non-intact (gravel and cobbles) of very	17.4	3 - 5

2003 N3 Virginia Bypass SI - BH ID	PO Chainage (m)	Termination depth (m)	Bedrock Type (Driller's Log Description)	Depth to Bedrock (m)	Depth to Bedrock as inferred from Groundwater Vulnerability Mapping (m)
			strong pale grey fine grained META-SILSTONE		
VBH9	10+500	20	Moderately weak and moderately strong orange brown medium grained SANDSTONE	17.85	3 - 5
VBH8	10+850	14	Recovered core is non-intact of weak and mod weak orange brown MUDSTONE	5	1 - 3
VBH6	10+900	12.1	Moderately strong to strong grey fine to medium grained SANDSTONE	4.1	1 - 3
VBH5	10+950	12.3	Moderately strong and strong (where intact) orange brown fine and medium grained sandstone	2	1 - 3
VBH4	11+500	5.2	Very strong grey strongly cemented SILTSTONE	0.9	<1
VBH3	11+800	19.5	Strong pale greenish grey coarse grained SANDSTONE / Very strong grey SILTSTONE (greywacke)	3.9	1 - 3
VBH2	12+250	10.1	Strong to very strong grey brown fine to medium-grained GRYEWACKE	0.7	<1
VBH1	12+300	8	Strong light occasional dark grey fine to medium-grained GREYWACKE	0.35	<1

For the remainder of the scheme, based on the GSI Groundwater Vulnerability Mapping, depth to bedrock between Ch. 0+000 to 1+500 is expected to be approximately 3-5m transitioning to 5-10m between Ch. 1+500 to 4+000m. At the northern end, depth to bedrock between Ch. 12+500 to Ch. 14+100m is expected to be between 5-10m becoming deeper (>10m bgl) from Ch. 14+100 to the end of the scheme.

4.2.2 Quaternary Geology

Based on the GSI mapping, the overburden material within the PO Corridor comprises predominately Till derived from Lower Palaezonic sandstones and shales with large areas of "cut over raised peat". Minor areas of Alluvium, bedrock outcrop or subcrop and gravels derived from Lower Palaezonic sandstones and shales are also present. A Quaternary Geology plan overlaying the PO Corridor is included in Appendix 2 (Ref: 19408-BT-06-ZZ-DR-C_103 Quaternary Geology) for reference.

The exploratory holes undertaken as part of the N3 Virginia Bypass 2003 SI, comprising rotary core boreholes, trial pits and dynamic probes were utilised to establish the likely overburden type beneath the PO (limited to Ch. 4+000 to Ch. 12+800m due to extent of 2003 SI). Based on 2003 SI, it is likely that the overburden material comprises predominantly cohesive and glacial tills with large areas of peat and some areas of made ground. Peat was encountered in the following exploratory holes at the locations outlined below:

- Ch. 6+500 to 6+800m – Peat encountered in VBH22 and VBH21 to 1.0m bgl (Not identified on the GSI mapping database).
- Ch. 7+700 to 8+300m – Peat encountered in VBH16, VBH18 and VTP19 between to 1.6m bgl
- Ch. 9+200 to 10+200 – Peat encountered in VTP15, VTP10, VTP11 and VPR11 to VPR18 to 2.4m bgl.

- R194 Link Road – Peat encountered in VTP41 to 1.9m bgl and soft ground proven in VPR 1, 2, 3, 4, 5 6, 38 & 39 between 0.3 to 1.5m bgl

Made ground, which was not shown on the GSI mapping, was encountered in the following exploratory holes at locations outlined below:

- Ch. 4+560m – Made Ground was encountered in VTP33 to 1.5m bgl comprising cobbles and boulders with varies lithologies and fragments of timber, tarmac and bricks (driller's log)
- Ch. 9+990m – Made Ground was encountered in VTP11 to 0.55m bgl over peat to 1.4m bgl (Not identified on the GSI mapping database).

The Option Selection Stage SI (soft ground probing) undertaken along the PO confirmed the presence of peat/soft soils. The max depth of soft ground encountered was 3.0m located at Ch. 9+800m. The depth of soft ground encountered during the soft ground probing along the PO Corridor are shown on the Option Selection Stage SI drawing (Ref: 19408-BT-06-ZZ-DR-C_0116) included in Appendix 2.

In summary, based on the GSI Quaternary Sediment mapping database and results from both the N3 Virginia Bypass 2003 SI and Options Selection Stage SI (soft ground probing), it is likely that the PO is underlain by peat and alluvium for 5.0km and 1.5km respectively to varying depths.

4.2.3 Karst

Although karst can develop on evaporate rocks such as gypsum and siliceous rocks such as quartzite, the vast majority of karst landforms are found on carbonate rocks, such as limestones.

There are no known karst features within the Study Area. The Clontail and Castlerahan Formation comprises Greywacke rock type whilst the Shercock Formations comprises Sandstone rock type and are not susceptible to karstification.

Using the GSI mapping database, the closest recording of karst features closest to the PO Corridor are as follows:

- Two karst features comprising spring (holy well) and superficial solution feature are located 4km south of Derver roundabout near Carnacross (Stackallan Member – Micrite)
- Multiple karst features comprising enclosed depressions, springs, superficial solution features and caves are located 13km south-east of Derver Roundabout near Dromone (Derravaragh Cherts – Limestone)
- Multiple karst features comprising boreholes and enclosed depressions are located 19km east of the PO near Kingscourt (Milverton Group – Limestone)

4.2.4 Geological Heritage

The geological heritage database held by the GSI was reviewed in preparation of this PSSR. From this, it can be seen that two audited geological heritage sites, Bruse Hill and the Blackwater Valley, are present within the Study Area. The PO will intersect the outer western limits of Bruse Hill potentially impacting on the 'crag' section of the western side of Bruse Hill. The Blackwater Valley is located to the west of the existing N3 between Derver Roundabout and Lough Ramor and will not be affected by the PO. An overlay of the PO Corridor and geological heritage mapping is provided in Appendix 2 for reference (Ref: 19408-BT-06-ZZ-DR-C_0104 Geological Heritage).

Bruse Hill is described by the Cavan – County Geological Site Report as "an excellent example of a crag and tail ridge". Based on the report, the crag comprises quartz-greywacke of the Castlerahan Formation. The crag-and-tail feature itself is Qauternary in age, having been formed at the base of the ice sheet moving northeast to southwest during the maximum period of the last Ice Age. Bruse Hill's tail feature extends for approximately 3 kilometres, and the crag reaches a height of 196m O.D. at its summit.

Crags are formed when a glacier or ice sheet passes over an area that contains particularly resistant mass of rock (in this case, the rock summit if Bruse Hill itself). The force of the glacier erodes the surrounding softer material, leaving the rocky block protruding from the surrounding terrain. The crag then serves as a partial shelter to softer material in the wake of the glacier, which remains as a gradual fan or ridge forming a tapered ramp (called the tail) up the leeward side of the crag. This is seen on the south-eastwards side of the crag itself, tailing into Enagh and Fartagh townlands.

Following consultation, the GSI have requested that any development should try to enhance the significance and general awareness of the geological site through provision of signage/view points/tourist information boards etc at the development site.

4.3 Hydrology

The key hydrology constraints are shown in the Hydrological Features drawing (Ref: 19408-BT-06-ZZ-DR-C_0106) included in Appendix 2

4.3.1 Rivers

There are a number of rivers and streams which are intersected by the PO however the main rivers include the Lislea River (EPA Ref Name: Lislea 07) at Ch. 6+825m and the Blackwater River (EPA Ref Name: Blackwater Kells) at Ch. 10+900m out falling to Lough Ramor. The Nadreegeel Lough Stream is the largest stream in the area and is intersected by a proposed link road at Ch. 12+000m (linking the PO to the existing N3).

Blackwater (Kells)

The Blackwater (Kells) is the largest watercourse in the area. It is a tributary of the River Boyne. The river rises near Bailieborough to the north east of Virginia. It flows through a number of small lakes before passing under the existing N3 in Virginia town and flowing into Lough Ramor west of Virginia town. The river then outflows from the southern end of Lough Ramor. At this point the river becomes part of the River Boyne and River Blackwater SAC and SPA. It flows in a south easterly direction, passing under the existing N3, flowing towards Carnaross, Kells and onwards to Navan, where it meets the Boyne River. The river reach is approximately 68km. The OPW Hydronet Rainfall and Flood Estimation Application estimates a catchment area for the entire river of 712.605km^2.

The PO Corridor will traverse the flood plain at Murmod. It will therefore be necessary to consider the impact of the road earthworks on the existing flow regime.

Lislea 07

The Lislea watercourse is one of the larger streams in the area. It is a tributary of Lough Ramor. It consists of two main branches together with some smaller contributory streams. Numerous other small watercourses discharge into the river. The main branches of the watercourse rise in the townlands of Crossbane and Lisnabantry. The stream reach is approximately 17.5km. The watercourse ranges in elevation from approximately 145mOD to 80mOD where it enters Lough Ramor. The OPW Hydronet Rainfall and Flood Estimation Application estimates a catchment area of 29.437km^2.

The PO Corridor will traverse the flood plain in the townlands of Burrencurragh, Drumheel and Lislea (approximately between mainline Ch. 6+200 to 7+200m). It will therefore be necessary to consider the impact of the road earthworks on the existing flow regime.

Nadreegeel Lough Stream

The Nadreegeel Lough Stream watercourse is one of the larger watercourses in the area and is a tributary of Lough Ramor. Numerous other small watercourses discharge into the stream. It rises in the townland of Tirlahode Lower. The stream reach is approximately 16.0km. The elevation of the stream ranges from approximately 175mOD to 85mOD. It flows from north to south in a rural environment, passing beneath the

existing N3, the R194 Virginia to Ballyjamesduff road and numerous local roads until it reaches the Lough Ramor. The OPW Hydronet Rainfall and Flood Estimation Application estimates a catchment area of 46.328km^2.

The proposed Ballyjamesduff Link Road will traverse the flood plain at Dunancory and Crannadillon. It will therefore be necessary to consider the impact of the road earthworks on the existing flow regime.

4.3.2 Integrated Constructed Wetlands

There are no known constructed wetlands within or adjacent to the footprint of the PO Corridor.

4.3.3 Flooding

The Interactive National Indicative Fluvial Mapping (NIFM) indicates that the following listed locations are prone to flooding in both the 100 year and 1000 year flood events.

- The PO Corridor between Ch. 6+200 to 7+200 in the townland areas of Lislea, Drumheel and Burrencarragh. Flooding caused by the Lislea River
- The PO Corridor between Ch. 10+800 to 11+850m in the townland areas of Virginia, Murmod and Cornaslieve. Flooding caused by the Blackwater River.
- The proposed link road between the PO and the existing N3 at Ch. 12+000 encroaches on a flood plain associated with the Nadreegeel Lough Stream.

The Catchment Flood Risk Assessment and Management (CFRAM) website (www.cfram.ie) was also consulted to identify locations where flooding is expected. There are no CFRAM identified areas within the study area. The GSI Groundwater Flooding Data Viewer was reviewed, this indicated no issue with groundwater flooding. However, the viewer did indicate surface water flooding in the region associated with the winter of 2015/2016.

The respective scheme components will need to be suitably designed to manage this. The extent of the flooding can be seen on the Hydrological Features drawing included in Appendix 2.

4.4 Hydrogeology

4.4.1 Aquifer Type & Classification

The Geological Society of Ireland has devised a system for classifying the aquifers in Ireland based on the hydrogeological characteristics, size and productivity of the groundwater resource. The three main aquifer classifications as devised by the GSI are Regionally Important, Locally Important and Poor aquifers.

The proposed scheme is underlain by a Poor Aquifer as outlined on GSI mapping and shown on the Groundwater Aquifers drawing (Ref No: 19408-BT-06-ZZ-DR-C_0107) included in Appendix 2. The Poor Aquifer is described as bedrock which is generally unproductive except for local zones.

Poor Aquifers generally provide little groundwater for water supply or for baseflow to surface water bodies, however, they are sometimes used for local supply for individual houses/farms. While the impact on the environment of locating a transport scheme on a Poor Aquifer will be significantly less than that on a Regionally Important Aquifer, it may still require consideration and mitigation against impacts during the design and construction stages.

4.4.2 Groundwater Vulnerability

The classification guidelines, as published by the GSI, are given in Table 4 which demonstrate that bedrock groundwater is most at risk in areas where the subsoils are thin or absent. The is due to the ability of potential contaminants to reach the aquifer following a low travel time and with little or no contaminant attenuation due to the thin or absent overburden. Groundwater vulnerability may increase where any future design includes the removal or reduction of protective overburden layers.

Groundwater vulnerability maps have been produced by the GSI and have five characteristics. "Extreme X - Rock at or Near Surface or Karst" and "Extreme" are those areas most at risk from contamination and mitigation measures should be put in place for their protection. Areas classified as having "High" vulnerability are less vulnerable to contamination, however, they still need a certain measure of protection. Likewise, for those classified as "moderate which have a lower risk of contamination due to natural conditions, a degree of protection is still required. "Low" vulnerability areas have natural protection in place and mitigation measures do not need to be put in place here.

Table 4: GSI Vulnerability Mapping Guidelines (adapted from DoELG, EPA and GSI, 1999)

Vulnerable Rating	Hydrogeological Conditions		
	Subsoil Permeability (Type) and Thickness		
	High Permeability (e.g. sand/gravel)	Medium Permeability (e.g. sandy subsoil)	Low Permeability (e.g. clayey subsoil, clay, peat)
Extreme (X) (Rock at or Near Surface or Karst)	0 – 1.0 m	0 – 1.0 m	0 – 1.0 m
Extreme (E)	1 - 3.0 m	1 - 3.0 m	1 - 3.0 m
High (H)	>3.0 m	3.0 – 10.0 m	3.0 – 5.0 m
Moderate (M)	N/A	>10.0 m	5.0 – 10.0m
Low (L)	N/A	N/A	10.0 m

The PO Corridor is predominantly located upon areas classified as predominantly Moderate to Extreme vulnerability, with localised sections classified as Rock at or near Surface or Karst.

The groundwater vulnerability mapping for the PO is shown in the Groundwater Vulnerability drawings (Ref No: 19408-BT-06-ZZ-DR-C_0108) and is included in Appendix 2. The drawing outlines interpreted depth to bedrock based on the ground water vulnerability mapping.

4.4.3 Wells & Springs

The Groundwater Supplies drawing (Ref No: 19408-BT-06-ZZ-DR-C_0109) is included in Appendix 2. This drawing shows the locations of public supply and commercial wells only. Locations of private wells are not known at the time of writing this report however anecdotal accounts indicate that there are many private wells for residential dwellings and farming properties, particularly in areas where a public water supply is not available.

Once the preferred route has been confirmed and the next stage is commenced, a detailed audit of all residential properties within 500m of the proposed route shall be conducted to determine the extent of domestic wells adjacent to the proposed route. Details of all domestic wells located within this corridor will need to be taken and monitoring of well water levels shall be commenced. In addition, private percolation areas encroaching on the footprint of the proposed route will also need to be identified and logged during this audit.

4.5 Topography

The landscape along the PO Corridor, which predominantly runs southeast to northwest in direction, is dominated by the presence of a rolling drumlin topography and can be described as generally flat to slightly undulating with topographical highs of 125m OD to lows of close to 90m OD. There is a broad gradual fall from east to west towards Lough Ramor.

An overlay plan of the PO Corridor and topography contours (Ref No: 19408-BT-06-ZZ-DR-C_0101) is included in Appendix 2.

4.6 Geomorphology & Landslide Susceptibility

The geomorphology along the PO is dominated by drumlins with areas of peat and hummocky sand and gravel. As mentioned in Section 4.2.4, there is also a crag and tail feature (Bruse Hill) present adjacent to the proposed route in the townland areas of Bruse and Enagh. The topography along the proposed route was created during the last ice age where deposits laid down by glaciers were subsequently re-moulded by further advances of the ice sheets and subsequent fluvial glacial action.

GSI mapping indicates that there is streamlined bedrock in the study area which is a product of glacier ice flow during the last ice age. The drumlins and eskers are trending in a north-west to south-east direction, the same general direction as the PO, and it is thought that the exposure of these geomorphological landforms along the route would enhance the proposed development with the geological character of the area. Small drainage channels and streams within this area are generally flowing west to Lough Ramor. An overlay of the PO Corridor and the geomorphology features is shown in the Topography and Geomorphology drawing (Ref No: 19408-BT-06-ZZ-DR-C_0101) is included in Appendix 2.

There are no recorded landslide events within the PO corridor (and Study Area) based on the GSI mapping. The PO is predominantly at a low risk landslide susceptibility, however there are areas of moderate to high landslide susceptibility along the PO Corridor at Bruse Hill between Ch. 4+000 to 5+000m and Murmod Hill and surrounding areas between Ch. 11+500 to 13+000m. An overlay of the PO Corridor and the Landslide Susceptibility Mapping is shown on drawing Ref No: 19408-BT-06-ZZ-DR-C_0110 which is included in Appendix 2.

4.7 Man-Made Features

The PO Corridor intersects a large number of man-made features such as commercial and agricultural holdings, residential dwellings, roads, bridges. Notwithstanding this, the below sections 4.7.1 to 4.7.5 focus only on the man-made features which are intersected by the current alignment of the proposed route.

4.7.1 Existing Utilities

Numerous buried and overhead utilities are present within the PO corridor. The relevant utility stakeholders are currently being contacted to acquire the latest asset location drawings and assess the relocation of the impacted assets.

A high pressure 150mm transmission gas main is present south of Virginia town crossing the PO at Ch. 6+750m. A distributor gas main (size unknown) is also present within the existing N3 and R147 (old N3 south of Derver Roundabout) road alignments. Slit Trenches will be arranged, in consultation with Gas Networks Ireland, to identify the exact location and depth of each gas main at location of intersection with the PO.

4.7.2 Landfills, Quarries & Pits

Refer to Section 4.9 below and drawing ref 19415-BT-06-ZZ-DR-C_0112 in Appendix 2

4.7.3 Archaeology, architectural and cultural heritage sites

Refer to Section 4.8 below and drawing ref 19415-BT-06-ZZ-DR-C_0111 in Appendix 2

4.7.4 Pavements & Roads

The proposed route currently crosses or interacts with the following list of roads. This is not exhaustive and is likely to change subject to on-going design development.

Such roads include

- L28245 (Ch. 0+000m)
- L3021 (Ch. 1+750),
- Enagh Local Road (Ch. 2+075m),
- L7106 (Ch. 3+500m),
- L7102 (Ch. 4+900m),
- L7107 (Ch. 7+225m),
- R194 (Ch. 8+400m),
- R178 (Ch. 10+025m)
- L7031 (Ch. 11+400m)
- Existing N3 (Ch12+400m & Ch. 14+000m)
- L3007 (Ch. 14+000m)
- L3012 at (Ch. 14+040m)

4.8 Historical Development of Area

Historic mapping (OSI 6 Inch 1st Edition Maps, 1937-1942) indicates that much of the land along the proposed route was pasture for agricultural use with intermittent estate buildings in the wider vicinity of the route. Local industries were dotted around the area and included several quarries, kilns, corn mills and tuck mills.

Cultural Heritage constraint databases have been reviewed in relation to the PO Corridor. Such heritage constraints include:

- Sites and Monuments Records (SMR)
- National Inventory or Architectural Heritage (NIAH)

A summary of Sites and Monuments Records (SMR) constraints within the PO Corridor are listed in Table 5 below and includes Archaeological Survey of Ireland (ASI) descriptions sourced from National Monuments Service's Historic Environmental Viewer (www.archaeology.ie)

Table 5: Sites and Monuments Record

SMRS No.	Classification	Description	Easting (ITM)	Northing (ITM)
CV039-013----	Ringfort - rath	Raised circular area (int. diam. 31.7m) enclosed by a much-denuded, low earthen bank. An earlier report (OPW 1969) suggested that the original entrance was probably at SE. At the centre of the enclosed area is a low, roughly circular platform of earth and stone (diam. c. 8.5m) which presumably represents a hut site.	662979	786571
CV039-044----	Ringfort - rath	Marked 'Fort' on OS 1836 and 1876 eds. Raised circular area (int. diam. c. 34m) enclosed by a low but well-defined bank of earth and stone which has been extensively modified and incorporated into the field boundary. Break in bank at NE may represent original entrance.	663497	785246
CV039-057----	Ringfort - rath	Marked 'Fort' on OS 1836 and 1876 eds. Situated on the SW shoulder of a drumlin hill. Not visible at ground level.	658728	790494

SMRS No.	Classification	Description	Easting (ITM)	Northing (ITM)
CV039-058----	Ringfort - rath	Marked 'Fort' on OS 1836 and 1876 eds. An earlier report (OPW 1970) described it as a raised circular area (int. dims. 32m ENE-WSW; 31.5m NNW-SSE) enclosed by a substantial earthen bank which by that time had been partly replaced by a modern stone wall. Original entrance was at SE. Site has since been levelled.	663360	786182
CV039-074----	Ringfort - unclassified	Marked 'Fort' on OS 1836 ed. and 'Site of' on 1876 ed. Situated in relatively flat pasture-land. Not visible at ground level.	660638	788265
CV039-078----	Ringfort - rath	Marked 'Fort' on OS 1836 ed. and 'Site of' on 1876 ed. Situated on a slight natural knoll in gently sloping pasture-land. Not visible at ground level.	659588	788905
CV044-012----	Mound	A roughly circular round-topped, grass-covered earthen mound (H at NW 0.2m), scarped about base of perimeter. Situated a short distance NE of a partially destroyed rath (CV044-011----).	665897	781166

A summary of the NIAH constraints within the PO Corridor is shown in the below table:

Table 6: National Inventory of Architectural Heritage (NIAH)

Reg No.	Name	Description	Easting (ITM)	Northing (ITM)
40403916	Farmhouse, Ballyjamesduff Road, Dunancory, Virginia, Co. Cavan	Detached three-bay two-storey built c.1840. Now disused.	658434	788442

There are no listed protected structures within the footprint of the PO Corridor. An overlay plan of the PO and the cultural heritage constraints listed above have been included in the Archaeological, Architectural and Cultural Heritage drawing (Ref No: 19408-BT-06-ZZ-DR-C_0111) in Appendix 2.

4.9 Geo-Environmental & Possible Contamination Issues

4.9.1 Mining Areas

There are no known areas of historic mining within the footprint of the Study Area.

4.9.2 Quarries & Pits

Review of the historic quarry dataset by GSI indicates that there are five historic quarries present within the PO Corridor. The historic quarries are summarised in table below:

Table 7: Historic Quarries and Pits

Constraint Number	Mineral Type	Description	Status
P-01	Unknown	Early to Mid-20thC: Pits	Historic
P-02	Sandy clay and angular gravel	Mid-Late 19thC: Pits	Historic

Constraint Number	Mineral Type	Description	Status
P-03	Sandy clay and gravel	Mid-Late 19thC: Pits	Historic
Q-01	Greywacke	Mid-Late 20thC: Quarries	Currently used as a Road's Depot by Cavan CoCo
Q-02	Massive, jointed grits	Mid-Late 19thC: Quarries	Historic

There are no operational quarries either within the PO Corridor or Study Area. The closest quarry to the PO is Gray's Quarries Ltd located in Carrickgorman, Bailieborough approximately 6.5km from the PO (mainline). The quarry produces all sizes aggregates, rockfill, drainage stone, Clause 804, road chippings a speciality.

For locations of all historic quarries within the PO Corridor (and beyond), the locations have been overlaid with the proposed PO and is shown in Quarries and Pits drawing (Ref No: 19408-BT-06-ZZ-DR-C_0112) included in Appendix 2.

4.9.3 Landfills & Contaminated Sites

Potentially contaminated sites include legacy landfills, waste licensed sites, and pits & quarries. This assessment is limited to sites known to the EPA and the relevant local authorities. No potential sites have been identified however that may change the results of this assessment.

4.9.4 Licensed Industrial & Agricultural Facilities

The EPA has been licensing certain large-scale industrial and agricultural activities since 1994. Under the Environmental Protection Agency Act 1992, such facilities were required to be granted an Integrated Pollution Control (IPC) license before any activities likely to release pollutants could commence.

The Act was amended in 2003 by the Protection of the Environment Act 2003, which gave effect to the Integrated Pollution Prevention Control (IPPC) Directive 2008/1/EC. The IPPC Directive was adopted in the EU in 1996 and codified in 2008. The IPPC license replaced the IPC license from July 2004, with greater aims of preventing or reducing pollution. Detailed procedures concerning the IPPC licensing process are set out in the First Schedule to the EPA Act 1992 as amended and the associated licensing regulations.

The Act was further amended in 2011 by the Environment (Miscellaneous Provisions) Act 2011, which gave effect to the Industrial Emissions Directive 2010/75/EU. The IE Directive was adopted in the EU in 2010. The IE License is separate to the IPC and IPPC licenses and applies to a wider range of activities. There have also been major changes in the way such activities will be licensed.

There are a number of facilities with IPC, IPPC, and IE licences located within the Study Area, see Table 8 below, however there are no licensed facilities located within the PO Corridor.

Table 8: Licensed Facilities with IE and IPC Licenses

Name	License Type
Dromagoland Farms Ltd	IE & IPPC
FSW Coatings Ltd	IPC & IPPC
Glanbia Ingredients (Virginia) Ltd	IE & IPPC
A.W. Ennis Limited	IE & IPPC

SECTION 5: GROUND CONDITIONS

5.1 Anticipated Geological Conditions

Based on the GSI geological maps for the area and both historic and Option Selection Stage SI, the near surface materials beneath the PO Corridor are likely to comprise:

- Cohesive and Granular Glacial Tills derived from Lower Palaezonic sandstones and shales
- Peat
- Alluvium
- Made Ground
- Bedrock at Near Surface

The Historic SI data obtained from the proposed N3 Virginia Bypass 2003 indicates that the overburden material comprises predominantly topsoil, underlain by firm to stiff clay/silt over gravels until bedrock with considerably large areas containing peat to depths of 2.4m bgl. The thickness of the overburden varies greatly across the site with less than 1m of overburden encountered at Ch. 11+500 (VBH4), 12+250 (VBH2) & 12+300 (VBH1) and a thickness of overburden greater than 17.5m at Ch. 10+400 (VBH10) and 10+500 (VBH9). Made ground was encountered at Ch. 4+560m and Ch. 9+990m. Other unidentified made ground may also be present along the PO.

Based on the GSI Groundwater Vulnerability mapping, overburden of thickness greater than 10m is indicated between Ch.5+000 to 6+000m and Ch. 14+100 to the end. Shallow rock < 3m is indicated between Ch. 4+000 to 4+400m, Ch. 6+500 to 8+750m and 10+750 to 12+750m.

The results from the Option Selection Stage SI “soft ground probing” were broadly similar with the GSI Quaternary Sediment 1:50,000 mapping series however indicated that the extent of soft soils (in plan) is approximately 25% less.

Based on the Bedrock Geology drawings (1:100,000 scale map series), the Bedrock Formation units present under the PO Corridor comprise the following:

- Clontail Formation (grey to green-grey greywacke) – PO Ch. 0+000 to 2+850m
- Castlerahan Formation (dark greywacke) – PO Ch. 2+850 to 12+870m
- Shercock Formation (fine to coarse grained turbidite) – PO Ch. 12+870 to 14+445m

See Bedrock Geology drawing (Ref: 19408-BT-06-ZZ-DR-C_0102) included in Appendix 2. Based on previous studies, rock is identified as being easy to hard ripping with potential for re-use meeting Class 6 testing requirements. Notwithstanding this, the proposed SI (Site Investigation - 2022) will need to be undertaken to confirm the findings of previous studies. The proposed SI will target the cuttings of the current PO which will allow a detailed assessment to be undertaken of each cutting and the respective material won.

5.2 Typical Geotechnical Design Parameters

Based on published academic literature and experience, the following indicative geotechnical parameters are provided for context only.

Table 9: Geotechnical Design Parameters

Parameter	Bulk Density(γ_k)	Effective cohesion (c')	Effective angle of shearing resistance (ϕ'_k)	Undrained shear strength ($C_{u,k}$)	Unconfined Compressive Strength (UCS)
Unit	**Mg/m^3**	**kPa**	**degree**	**kPa**	**MPa**
Topsoil	1.8	0	24-29	20-40	N/A
Peat	1.1	0	28-40	5-10	N/A
Alluvium	2.1	0	32-40	N/A	N/A
Cohesive Material	2.1	0	28-38	40-100	N/A
Granular Material	2.1	0	32-42	N/A	N/A
Bedrock	2.6	100kPa-3MPa	22-40	N/A	10-30

5.3 Groundwater

For preliminary design purposes, a groundwater level is conservatively assumed to be shallow (i.e. 0.5m below the existing surface). This assumption will be revised following the recorded levels of groundwater strikes in the proposed exploratory holes and the installation and monitoring of groundwater standpipes along the PO which will form part of the upcoming ground investigation works.

Ground water monitoring was undertaken during the Site Investigations as part of the N3 Virginia Bypass 2003. Findings from the installation of standpipes are summarised below:

Table 10: Groundwater Monitoring

Hole ID	PO Chainage (m)	Instrument Type	Tip Depth (m BGL)	Observation	Depth to Water (m BGL)
				Date	
VBH2	12+300	Standpipe	10.1	18/01/2003	2.15
VBH5	10+910	Standpipe	8.00	18/01/2003	0.85
VBH8	10+850	Standpipe	14.00	18/01/2003	1.28
VBH9	10+500	Standpipe	20.00	18/01/2003	2.55
VBH10	10+400	Standpipe	20.00	18/01/2003	2.68
VBH11	10+050	Standpipe	12.00	18/01/2003	11.03

As can be seen from the above table, the installation of standpipes during the 2003 SI were limited to PO Ch. 10+050 to 12+300m with only one recording of water level undertaken for each standpipe. Inquiries are currently ongoing to determine the condition of these historic standpipes to determine they can be re-used for ground water monitoring as part of the PO stage SI. Nevertheless, the proposed SI design will ensure an appropriate number of standpipes are in place throughout the length of the scheme to enable sufficient groundwater monitoring to be undertaken during and following the completion of fieldwork to obtain seasonal readings.

SECTION 6: PRELIMINARY ENGINEERING ASSESSMENT

6.1 Cuttings

Based on the early preliminary design for the proposed scheme, there will be 11 No. cuttings along the mainline. The max cutting is 14m. This is likely to change as the scheme is developed.

The typical side slope shall be 1:2 in overburden, and in rock, a steeper side slope may be utilised. In order to assess the stability of potential rock cuttings, it is important to identify the orientation of present discontinuities, their condition and the extent of weathering present during the site investigation. The rocks associated with the Carboniferous Period, such as the Palezonic bedrock around Virginia, may be susceptible to cutting instability because of the complex geological structure characteristic of these rocks (i.e. folds, faults, and variable dips). This susceptibility may be due to the presence of several layers of different rock types and faulting leading to low strength zones with weathered surfaces.

Based on GSI geological maps and historic SI data, it is expected that the overburden material won from cuttings will classify predominantly as Class 1 and Class 2 material and will be suitable for re-use in the construction of fill embankments subject to careful handling by the earthwork's specialist contractors. Notwithstanding this, material encountered which is not suitable for re-use (high moisture content, organic material) will require a specific area designated to place this material.

The expected reusability of cut material in rock is shown in the Crushed Rock Aggregate Potential drawing included in Appendix 2 (Ref No: 19415-BT-06-ZZ-DR-C_0115). Notwithstanding this, a full suite of on site and laboratory testing will be required to confirm the geotechnical parameters of the different rock types encountered.

6.2 Embankments

Based on the early preliminary design for the proposed scheme, there will be ten fill embankments along the mainline. The max fill embankment height is 11m. This is likely to change as the scheme is developed.

Approach embankments will also be required for overbridge structures which are likely to be required where the PO intersects many of the existing local and regional roads. The remainder of the proposed road construction will be constructed at "at-grade" or in cuttings. There may be other structures (i.e. accommodation structures) required within the fill embankments however this is yet to be confirmed.

The fill embankments shall be constructed with 1V:2H or 1V:3H side slopes and shall be constructed using acceptable fill material as outlined in the TII Specification for Works (SPW). Suitable construction plant and fill placement techniques shall also be undertaken in accordance with the SPW.

The Quaternary Geology drawings in Appendix 2 show the soft ground extents. The likely engineering mitigation options to embankments above soft ground are:

- avoidance of need to excavate into soft ground deposits wherever possible,
- dig-out and replacement of deposits (where <3m approximate depth) with selected engineered fills,
- use of staged construction and reinforcement of embankment bases with geosynthetic reinforcements,
- use of vertical drains, pre-loading and/or surcharging to speed up consolidation settlement, and
- founding embankments (especially at structural transitions) on piles, or, where ground characteristics allow, using ground improvement techniques.

Based on findings from the proposed Site Investigation works, a suitable mitigation measure will be chosen.

As highlighted in Section 4.3.3., NIFM mapping indicates that a section that the PO Corridor between Ch. 10+800 to 11+850m is prone to flooding caused by the Blackwater River in the townland areas of Virginia, Murmod and Cornaslieve. The NIFM also indicates that a section of the PO Corridor between Ch. 6+200

to 7+200 is prone to flooding from the Lislea River and that the proposed link road between the PO and the existing N3 at Ch. 12+000 encroaches on a flood plain associated with the Nadreegeel Lough Stream. For these sections of the PO, the design and construction of fill embankments will need to consider the flood levels for this area. The respective scheme components will need to be suitably designed to manage this. The flood extents are included in the Hydrology drawings in Appendix 2.

6.3 Subgrade/Sub-formation

Much of the route will be constructed across in-situ Cohesive Glacial Till (Boulder Clay), Granular Glacial Tills or bedrock (in the deep cut sections). For these sections, the subgrade is considered favourable however the condition subgrade material is likely to be variable, and therefore a CBR value of 2.5% should be assumed at this stage for subgrade of fill embankments, cuttings and areas at grade.

In areas where the route crosses sections of peat and alluvium material (mostly fill and at-grade sections), a subgrade CBR value of 2.5% is not likely to be achieved. As a result, engineering mitigation measures shall be required similar to Section 6.2 to achieve a CBR value of 2.5%, measures include:

- avoidance soft ground deposits wherever possible,
- dig-out and replacement of deposits (where <3m approximate depth) with selected engineered fills,
- use of staged construction and reinforcement of embankment bases with geosynthetic reinforcements,
- use of vertical drains, pre-loading and/or surcharging to speed up consolidation settlement, and
- founding embankments (especially at structural transitions) on piles, or, where ground characteristics allow
- Ground improvement (i.e. in-situ stabilisation).

Based on findings from the proposed Site Investigation works, a suitable mitigation measure will be chosen.

To protect the integrity of the subgrade, suitable drainage will need to be designed and installed. In addition, once the fill or cutting formation has been constructed, adequate capping layers will be required to protect the sub-formation. It may be possible to process rock won on site to produce the required capping material however this cannot be confirmed until the proposed site investigations have been completed. Importing of capping material may also be possible from local quarries.

6.4 Structure Foundations

The key structural and foundation elements of the proposed N3 Virginia Bypass scheme are those associated with side road crossings, river/stream crossings and accommodation underpasses/overbridges.

In addition, culverts will also be required for drainage and small streams. It is likely that other structures such as accommodation underpasses/overbridges, retaining walls and environmental noise barriers may also be required.

At these subject locations, appropriate site-specific site investigations will be undertaken in order to complete a preliminary design of appropriate foundation systems which will transfer the loadings created by the structure to the ground safely and without excessive settlement/deformation.

Some of the hazards/risks to be investigated include, but not limited to, are as follows:

- The possible presence of soft or highly compressible soils
- The presence of uncontrolled fill (made ground) which may also include contaminated material
- The assessment of strength profiles within the near surface materials
- The assessment of the bedrock in areas of deep cuttings to determine rock stability problems, rock excitability and re-usability.

6.5 Contaminated Land / Soil Chemistry

Potentially contaminated sites include legacy landfills including made ground, waste licensed sites and historic pits & quarries which may have been backfilled.

A review of the GSI database has indicated that there are no legacy landfills present along the PO. There are five historic quarries, all recorded as Mid-Late 19th Century to Mid-Late 20th Century located within the footprint of the PO Corridor which may have potential to be contaminated sites.

Made ground was 2 No. trial pits from the N3 Virginia Bypass 2003 SI at Ch. 4+560m and Ch. 9+990m. Other unidentified areas of made ground may also be present throughout the PO. These identified and unidentified areas may have the potential to be contaminated sites

In order to determine the soil chemistry, particularly in the areas mentioned above, a suite of environmental sampling and testing will be scheduled as part of the future site-specific geotechnical investigation works.

6.6 Existing Geotechnical Problems

6.6.1 Soft Ground

As stated in Section 4.2.2., it is likely that the PO is underlain by peat and alluvium for 5.0km and 1.5km respectively to varying depths. These are shown in the Quaternary Sediments included in Appendix 2. A risk assessment of soft ground and likely mitigation measures is included in the Geotechnical Risk Register in Appendix 1.

Peat classifies as a U1 material, has no potential reusability, and cannot remain in situ under an embankment or in pavement (in cuttings or sections of at-grade) without complex detail design engineering requiring site specific information. Alluvium is unlikely to be reusable due to its high moisture content but does have the potential to remain in situ, however, site-specific information is required to confirm this. Areas containing soft ground provide very poor foundations, due to typically low soil strengths, and high water and/or organic contents. They are difficult to excavate and have a greater risk of slope stability issues. Moreover, uncontrolled disturbance of upland bogs can lead to slope failure and landslides.

It is not possible to completely avoid these deposits as they are present throughout the PO Corridor, however it is recommended to avoid them where feasible. Avoiding larger deposits should be given priority at Phase 3 design and environmental evaluation as they are typically associated with designated areas and/or it is likely to be more difficult and expensive to construct the proposed development within these areas.

6.6.2 Made Ground

Although made ground is not indicated by the GSI mapping to be present along the PO, made ground was encountered in 2 No. trial pits from the N3 Virginia Bypass 2003 SI at Ch. 4+560m and Ch. 9+990m. Other unidentified areas of made ground may also be present along the PO.

Areas of Made Ground should be considered as unstable ground as the deposits could be uncompacted, and/or the materials used could be of varying engineering properties. Furthermore, excavation can be difficult and expensive as the potential for contaminated material is greater and these sources of contamination would need specialist treatment.

6.6.3 Landslide Susceptibility

Although cuttings in soft ground are largely avoided, cuttings in soft ground are potential areas of landslide susceptibility. Earthworks in these areas can typically be engineered to mitigate impacts, provided the land take for the proposed development is sufficient. From review of the GSI Quaternary Mapping and Historic SI exploratory holes, it appears that the only section of the PO cutting through areas of peat is between Ch. 13+000 to 13+800m.

As mentioned in Section 4.6, there are several areas along the PO Corridor with significant slopes that have been identified by the GSI as areas of moderately high to high landslide susceptibility along the PO Corridor at Bruse Hill between Ch. 4+000 to 5+000m and Murmod Hill and surrounding areas between Ch. 11+500 to 13+000m. These areas will require careful consideration when carrying out detailed design.

6.6.4 Geoheritage

As mentioned in Section 4.2.4, the footprint of the geological heritage site at Bruse Hill is intersected on the outer western limits by the PO. Bruse Hill is described by the GSI as an example of a 'crag and tail' ridge with the proposed road development potentially impacting on the 'crag' section of the western side of Bruse Hill.

It is important to note that not all geological heritage sites are a constraint to the scheme's development, exposure (such as in road cuttings), in consultation with the GSI, can enhance the value of the heritage site and allow a greater number of people to appreciate it.

Following consultation, the GSI have requested that:

"Any development should try to enhance the significance and general awareness of this site. Raising awareness, strengthening their significance and enhancing our scientific understanding of them can be done by allowing Geological Survey Ireland staff or representatives access to them during any development/construction type works, by providing signage/viewpoints/tourist information at the development site where possible."

6.6.5 Flooding

As highlighted in Section 4.3.3, the NIFM identifies three locations along the PO which are prone to flooding in the 100 year and 1000 year events. The proposed scheme will need to carefully consider the areas prone to flooding during it's design and construction.

It is envisaged, for the purposes of inclusion of climate change, that 1 in 1000 year projections are used to represent the 1 in 100 year flood with climate change allowance.

SECTION 7: COMPARISON OF PROJECT OPTIONS & RISKS

The geotechnical, geo-environmental, and historical factors which may influence the project are described in Sections 4, 5, and 6 above.

The three Geotechnical Categories are defined below;

- **Geotechnical Category 1** applies only to small and relatively simple structures;
  - For which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations; and
  - With negligible risk;
- **Geotechnical Category 2** applies to conventional types of structures and foundations with no exceptional risks, or difficult ground or loading conditions; and
- **Geotechnical Category 3** applies to structures, or parts of structures, which fall outside the limits of Geotechnical Categories 1 & 2.

The majority of geotechnical activities associated with the Scheme are anticipated to fall within Geotechnical Category 2, with some aspects of the works within Geotechnical Category 1. Geotechnical Category 3 works may be present in the soft ground areas south of the R178 (Bailieborough Road) and south of the L7106 (Enagh Bog) but are not envisaged at the time of writing this report. All identified geotechnical risks have been recorded in the Geotechnical Risk Register, which has been included in Appendix 1.

Drawings outlining the Study Area and Options considered in Phase 2 of the Scheme are shown in Volume 2 of the Option Selection Report. As part of the Option Selection Report an appraisal of the different Options was carried out in accordance with TII Publication (Technical) PE-PAG-02031 (October 2016) *Project Appraisal Guidelines for National Roads Unit 7.0. Multi Criteria Analysis*. This included a comparison of different geotechnical parameters in both Stage 1 and Stage 2. The Preferred Option was selected following completion of these assessments.

SECTION 8: DRAWINGS

The figures identified in Table below have been produced as part of the PSSR and are included in Appendix 2.

Table 11: List of Drawings

Figure Title	Drawing No.
Topography & Geomorphology	19408-BT-06-ZZ-DR-C_0101
Bedrock Geology	19408-BT-06-ZZ-DR-C_0102
Quaternary Geology	19408-BT-06-ZZ-DR-C_0103
Geological Heritage	19408-BT-06-ZZ-DR-C_0104
Historic SI Location Plan	19408-BT-06-ZZ-DR-C_0105
Hydrological Features	19408-BT-06-ZZ-DR-C_0106
Groundwater Aquifers	19408-BT-06-ZZ-DR-C_0107
Groundwater Vulnerability	19408-BT-06-ZZ-DR-C_0108
Groundwater Supplies	19408-BT-06-ZZ-DR-C_0109
Landslide Susceptibility	19408-BT-06-ZZ-DR-C_0110
Archaeological, Architectural and Cultural Heritage	19408-BT-06-ZZ-DR-C_0111
Quarries and Pits	19408-BT-06-ZZ-DR-C_0112
Landfill and Potential Contamination Sites	19408-BT-06-ZZ-DR-C_0113
Licensed Waste Facilities	19408-BT-06-ZZ-DR-C_0114
Crushed Rock Aggregate Potential	19408-BT-06-ZZ-DR-C_0115
Option Selection Stage Site Investigation	19408-BT-06-ZZ-DR-C_0116

Appendix 1: Geotechnical Risk Register (19408-BT-06-ZZ-RP-C_0001)

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

comhairle chontae na mí
meath county council

Cavan
Comhairle Contae an Chabháin
Cavan County Council

N3 Virginia Bypass

Geotechnical Risk Register

April 2022

BARRY
TRANSPORTATION

An Roinn Iompair
Department of Transport

Tionscadal Éireann
Project Ireland
2040

Document Control Sheet

Client:	**Cavan County Council**
Project Title:	N3 Virginia Bypass
Document Title:	Geotechnical Risk Register (GRR)
File Name:	19408-BT-06-ZZ-DO-C_0001

Table of Contents *(incl. Y/N)*	**List of Tables** *(incl. Y/N)*	**List of Figures** *(incl. Y/N)*	**Pages of Text** *(No.)*	**Appendices** *(No.)*
Y	N	N	4	1

Document Revision				**Document Verification**			
Issue Date *(DD/MM/YY)*	**Revision Code**	**Suitability Code**	**Author** *(Initials)*	**Checker** *(Initials)*	***Reviewer*** As Per PMP *(Initials)*	**Approver** *As Per PMP (Initials)*	**Peer Review** *(Initials or N/A)*
Add hyperlink to Verification Email on PIM Register for each issue							
16/12/2021	P01	S3	CJO	DOH	DOH	TC	N/A
30/03/2022	P02	S3	CJO	DOH	DOH	TC	N/A
29/04/2022	P03	S3	CJO	DOH	DOH	TC	N/A

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Appendices

SECTION 1: RISK REGISTER

1.1 Introduction

Geotechnical risk management is intended to be a continuous process from project inception through to commissioning (TII Publication (Standards) DN-ERW-03083 (October 2019) Managing Geotechnical Risk).

The Geotechnical Risk Register (GRR) highlights many of the potential risks and the consequences of those risks together with risk control measures that could be taken to mitigate those risks.

For the purpose of this report, a hazard is defined as the 'thing or activity with a potential for consequences (potential to do harm)' and a hazard event is 'the undesirable event'. The 'combination of the probability of a hazard event occurring and the severity of its consequences is the degree of risk (or risk level) and this is addressed in Section 1.2.

The Geotechnical Risk Register for the scheme is presented below in Sub-section 1.4. This is a live document which will be taken forward into the construction phase and further developed by the Designer and the Contractor.

The risk register will be updated as the project progresses and will be issued with the Preliminary Sources Study Report (PSSR), Ground Investigation Report (GIR) and Geotechnical Design Report (GDR). The locations of specific hazards and suspected hazards will be identified in the PSSR and GIR. Specific control measures to mitigate risk will be accounted for in the GDR.

The extent of soft ground is a particular geotechnical hazard that may be identified as presenting significant risk to this scheme and may get carried through to construction as a 'substantial residual risk'.

1.2 Risk evaluation

This section presents the developed Geotechnical Risk Register for the Scheme, together with details of other construction related risks known at this time. A qualitative approach has been used for the assessment of these risks based on the procedures set out in TII Publication (Standards) DN-ERW-03083 Managing Geotechnical Risk (October 2019). Under this qualitative risk assessment, the degree of risk is the expected impact of damage, loss or harm from a given hazard, under particular circumstances which is expressed as:

Degree of Risk (R) = Probability (P) x Severity (S)

The scale of probability and severity is determined using Table 1 and Table 2 respectively, which together then provide the degree of risk based on Table 3.

Table 1: Scale of Probability (P)

Probability	Scale
Very High Probability (71-100%)	5
High Probability (51-70%)	4
Medium Probability (31-50%)	3
Low Probability (11-30%)	2
Very Low Probability (0-10%)	1

Table 2: Scale of Severity (S)

Severity	Scale
Very High Impact	5
High Impact	4
Medium Impact	3
Low Impact	2
Very low Impact	1

Table 3: Degree of Risk (R)

Degree of Risk	Degree of Risk or Risk Level	Recommended Response
1 to 4	Low Risk	None
5 to 10	Medium Risk	Consider attention
11 to 19	High Risk	Attention required
20 to 25	Critical Risk	Emergency action required

1.3 Summary of Ground Hazards

A high-level summary of potential ground hazards and geotechnical risk is summarised below.

Compressible Ground Stability Hazards present the following risks:

- Soft bearing conditions and need for special foundations for structures/pavement,
- Poor ground conditions and material arising from excavation unacceptable for re-use,
- Excessive settlement of structural foundations due to poor bearing conditions, and
- Damage to road pavement or track infrastructure due to poor subgrade support.

Ground Contamination Hazards present the following risks:

- Hot spots encountered during construction,
- Excessive amount of Class U2 material for disposal,
- Changes in environmental legislation,
- Site borne leachates affect neighbouring properties or hinder site works,
- Presence of hazardous soil borne gas arising from disturbed historic landfill,
- Chemical attack on buried structural elements due to soil borne contaminants, and
- Contamination hazard arising from unknown land uses.

Collapsible Ground Stability Hazards present the following risks:

- Encountering unknown voids associated with karst limestone,
- Encountering unexpected geological features, fissures, faults, solution features etc,
- Failure of earthworks (landslide) during construction,
- Failure of structural foundations (bearing capacity) during construction,
- Damage to neighbouring property due to ground movement during construction,
- Unidentified shafts and adits associated with mineral extraction, and
- Underground workings, presence of voids arising from mineral extraction.

Groundwater hazards present the following risks:

- Groundwater flow adversely affecting stability of deep excavations,
- High groundwater levels affecting stability of earthworks,
- Groundwater flow resulting in failure of temporary excavations,
- Changed groundwater level (dewatering) impacting on neighbouring property,
- In-flow of contaminated groundwater from off-site source,
- High groundwater levels impacting on foundation design, and
- Limitations on disposal of groundwater.

Below Ground Obstruction Hazards present the following risks:

- Design changes due to inadequate coverage of GI for structures,
- Unforeseen ground conditions requiring additional land take for treatment,
- Design conflict with known buried services,
- Delay due to long lead times for permanent diversion of services,
- Uncharted buried services causing delays during construction,
- Obstructions to construction due to existing foundations, and
- Unexploded ordnance.

Environmental/Land Use Constraint Hazards present the following risks:

- Endangered animal species (badgers, bats, frogs etc.),
- Design conflict with Protected Tree Species,
- Invasive plant species (Japanese Knotweed, Giant Hogweed etc.),
- Flooding of works due to influence of river and canal,
- Adverse weather conditions during earthworks season,
- Material rendered unacceptable through poor site management,
- Access to land denied by landowner,
- Design conflict with known overhead services,
- Restrictions to ground investigation due to Archaeological features,
- Delay to programme due to heritage approval following archaeological finds, and
- Design conflict with Listed Structures.

1.4 Geotechnical Risk Register

The GRR is presented as a table and is included in Appendix A. The table can be categorised into different elements of the design as follows:

- Earthworks GRR: risk items E1 to E49
- Bridge GRR: risk items B1 to B20
- Retaining walls GRR: risk items RW1 to R20
- Culverts GRR: C1 to C18

Appendix A: Geotechnical Risk Register Table (19415-BT-06-ZZ-RG-C_0001_Geotechnical Risk Register)

Geotechnical Risk Register (GRR)

N3 Virginia Bypass

Author	CJO
Approver	DOH
Revision	P04
Date	29/04/2022

Unique Risk ID.	Category	Hazard Description	Route Section	Probability x Severity = Degree of Risk			Design Measures to Manage the Risk	Probability x Severity = Degree of Risk		
				Probability	Severity	Risk		Probability	Severity	Risk
E1	[E] Earthworks	Compressible Ground (Existing): Damage to pavement due to insufficient subgrade support from existing sub-grade.	All	3	3	9	Identify areas of compressible soils. Design/implement mitigation measures such as dig and replace. Induce settlement prior to surfacing through use of surcharge loading.	1	3	3
E2	[E] Earthworks	Compressible Ground (Existing): Damage to embankment/new pavement due to excessive settlement over alluvium, or thick layers of soft material.	All	3	3	9	Identify areas of compressible soils. Design/implement mitigation measures such as dig and replace. Induce settlement prior to surfacing through use of surcharge loading.	1	3	3
E3	[E] Earthworks	Compressible Ground (Existing): Damage to embankment/new pavement due to differential settlement where it crosses drainage ditches, existing tracks, made ground or thick topsoil.	All	3	3	9	Identify areas of soft ground (ditch crossings). Identify areas of loose made ground. Identify areas of thick topsoil. Design/implement special measures (provide SED drawings). Induce settlement prior to surfacing through use of surcharge loading.	1	2	2
E4	[E] Earthworks	Compressible Ground (Existing): Damage to embankment/new pavement due to long term secondary consolidation of organic alluvium or thick topsoil.	All	3	3	9	Identify areas of compressible soils. Design/implement special measures/monitoring. Induce settlement prior to surfacing through use of surcharge loading.	1	3	3
E5	[E] Earthworks	Compressible Ground (Existing): Damage to proposed bridge abutment due to lateral loading induced by new approach embankments.	All	2	4	8	Identify areas of compressible soils. Design/implement special measures. Liaise with Bridge Designer.	1	3	3
E6	[E] Earthworks	Compressible Ground (Existing): Damage to existing structures due to settlement of adjacent embankment.	All	3	4	12	Assess impact on adjacent structures. Undertake preconstruction condition assessment of potentially impacted structures. Design solutions and specify construction monitoring.	1	3	3
E7	[E] Earthworks	Compressible Ground (Existing): Damage to existing services caused by settlement of new embankment.	All	3	3	9	Locate services and divert where appropriate. Transmit foundation loads to competent strata beneath services. Protect services from plant/ crane loads.	1	2	2
E8	[E] Earthworks	Compressible Ground (New Fill): Damage to pavement due to insufficient subgrade support from imported fill.	All	3	3	9	Specify type of fill and level of compaction. Specify site testing of subgrade support.	1	3	3
E9	[E] Earthworks	Compressible Ground (New Fill): Damage to pavement due to settlement within imported fill.	All	2	3	6	Specify type of fill and level of compaction.	1	3	3

Geotechnical Risk Register (GRR)

N3 Virginia Bypass

Author	CJO
Approver	DOH
Revision	P04
Date	29/04/2022

Unique Risk ID.	Category	Hazard Description	Route Section	Probability x Severity = Degree of Risk			Design Measures to Manage the Risk	Probability x Severity = Degree of Risk		
				Probability	Severity	Risk		Probability	Severity	Risk
E10	[E] Earthworks	Compressible Ground (New Fill): Damage to pavement due to differential settlements between bridge abutments and new approach embankment.	All	4	3	12	Implement sufficient ground investigation. Specify type of structural fill behind structure. Specify mitigation measures/monitoring requirement.	1	2	2
E11	[E] Earthworks	Groundwater (High water table): Erosion of toe of embankment due to flooding and groundwater seepage.	All	2	3	6	Provide SED drawing for protection of toe in affected areas.	1	2	2
E12	[E] Earthworks	Groundwater (High water table): Unable to traffic soft ground or compact embankment foundation.	All	4	2	8	Provide SED drawing for starter layer where necessary.	1	2	2
E13	[E] Earthworks	Groundwater (High water table): Damage to pavement due to softening of formation (loss of subgrade support CBR)	All	3	3	9	Provide sufficient drainage to prevent inundation of sub- base.	1	2	2
E14	[E] Earthworks	Groundwater (High water table): Loss of efficacy of drainage system due to groundwater inundation/ siltation.	All	3	3	9	Maintain pavement alignment above water table. Provide sufficient capacity to drains/protect drains.	1	2	2
E15	[E] Earthworks	Groundwater (High water table): Potential limitations on disposal of groundwater during construction/ post construction.	All	2	2	4	Maintain road alignment above water table. Provide sufficient capacity to drains/ protect drains.	1	2	2
E16	[E] Earthworks	Groundwater (High water table): Erosion of excavated face due to erosion	All	2	3	6	Implement sufficient ground investigations Specific inspection of excavated slopes Provide SED drawings for slope drainage	1	2	2
E17	[E] Earthworks	Groundwater (High water table): High moisture content renders arisings unacceptable for re-use as bulk fill	All	3	2	6	Specify acceptability criteria for the earthworks materials Make allowance for unacceptable material in Earthworks Schedule Install pre-earthworks drainage and subgrade drainage before excavation of material	1	2	2
E18	[E] Earthworks	Groundwater (High water table): High moisture content renders Landscape Fill/ Unsuitable Fill difficult to handle.	All	3	2	6	Specify acceptability criteria for landscape fill. Zone landscape areas to receive all site arisings. Install pre-earthworks drainage and subgrade drainage before excavation of material.	1	1	1
E19	[E] Earthworks	Groundwater (Changed water table): Reduced groundwater level adversely affecting land drainage / habitat (peat bog)	All	2	3	6	Implement sufficient ground investigation. Specify mitigation measures where necessary. Implement monitoring as required.	1	2	2
E20	[E] Earthworks	Groundwater (Changed water table): Changed groundwater level impacting on new structures.	All	2	4	8	Implement sufficient ground investigation. Specify mitigation measures where necessary. Include groundwater standpipe and piezometer installations and implement monitoring as required.	1	3	3

Geotechnical Risk Register (GRR)

N3 Virginia Bypass

Author	CJO
Approver	DOH
Revision	P04
Date	29/04/2022

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				Probability	Severity	Risk		Probability	Severity	Risk
E21	[E] Earthworks	Groundwater (Changed water table): Changed groundwater level impacting on neighbouring property.	All	2	4	8	Implement sufficient ground investigation. Specify mitigation measures where necessary. Include groundwater standpipe and piezometer installations and implement monitoring as required.	1	2	2
E22	[E] Earthworks	Below Ground Obstructions (Natural): Cobbles/boulders/buried obstructions render site arisings impractical to compact.	All	2	2	4	Implement sufficient ground investigation. Implement monitoring and screening if material re-use required.	1	2	2
E23	[E] Earthworks	Below Ground Obstructions (Natural): Cobbles/boulders/bedrock/buried obstructions delay excavation for cuttings/ foundations/retaining.	All	2	2	4	Implement sufficient ground investigation	1	1	1
E24	[E] Earthworks	Below Ground Obstructions (Natural): Impractical to construct cutting without blasting due to hard bedrock being encountered	All	2	4	8	Implement sufficient ground investigation Investigate rock strength and fracturing properties Specify special measures. Monitor site works	1	3	3
E25	[E] Earthworks	Below Ground Obstructions (Services): Proximity to services restricts ability to construct foundations without damaging services (cables/pipelines).	All	2	3	6	Locate Services and relocate where necessary. Specify special measures where necessary (e.g. dedicated spotters) Monitor site works.	1	2	2
E26	[E] Earthworks	Below Ground Obstructions (Services): Design conflict with known services or uncharted services.	All	3	3	9	Early engagement with utility owners. Locate Services and relocate where necessary. Specify special measures where necessary (e.g. dedicated spotters) Monitor site works.	1	3	3
E27	[E] Earthworks	Below Ground Obstructions (Services): Delay due to long lead times on permanent diversion of services	All	3	3	9	Locate services and relocate where necessary	1	2	2
E28	[E] Earthworks	Below Ground Obstructions (Various): Breakout required of existing foundations, basement structures or storage tanks	All	2	3	6	Implement sufficient ground investigations Investigate buried structures. Specify special measures	1	2	2
E29	[E] Earthworks	Below Ground Obstructions: Unexploded ordnance (UXO)	All	1	5	5	Undertake a desktop review historic records. Agree site protocol for UXO.	1	4	4
E30	[E] Earthworks	Ground Contamination (Soil): Potential for unlicensed landfill or animal burial sites to delay earthworks.	All	2	3	6	Implement sufficient ground investigation to screen for potential contaminants. Agree site protocol for investigation/reporting. Specify special measures which may include waste classification testing.	1	2	2

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E31	[E] Earthworks	Ground Contamination (Soil): Material from unknown land use potentially hazardous to health.	All	2	3	6	Implement sufficient ground investigation to screen for potential contaminants. Agree site protocol for investigation/reporting. Specify special measures which may include waste classification testing.	1	2	2
E32	[E] Earthworks	Ground Contamination (Groundwater): Damage to structures including buried structures arising from chemical agents.	All	2	4	8	Implement sufficient ground investigation. Liaise with Structural Designer to determine appropriate concrete exposure class. Specify protective measures as appropriate.	1	3	3
E33	[E] Earthworks	Ground Contamination (Groundwater): Polluted water harmful to human health and the environment.	All	3	4	12	Implement sufficient ground investigation to understand and quantify the nature of any contamination present. Implement controls to limit/intercept contamination transport. Specify special measures relevant to the nature of the contaminants. Agree site protocol for investigation/monitoring.	1	4	4
E34	[E] Earthworks	Ground Contamination (Groundwater): Site borne leachate requiring disposal/limitations on groundwater discharges.	All	3	3	9	Implement sufficient ground investigation. Implement adequate site drainage. Specify special measures relevant to the nature of the contaminants. Agree site protocol for investigation/monitoring.	1	3	3
E35	[E] Earthworks	Ground Contamination (Groundwater): Site borne leachate polluting neighbouring property.	All	2	4	8	Implement sufficient ground investigation to understand and quantify the nature of any contamination present. Implement controls to limit/intercept contamination transport. Specify special measures relevant to the nature of the contaminants. Agree site protocol for investigation/monitoring.	1	3	3
E36	[E] Earthworks	Ground Contamination (Groundwater): Inflow of contaminated water from off-site source.	All	3	3	9	Implement sufficient ground investigation to understand and quantify the nature of any contamination present. Implement controls to limit/intercept contamination transport. Specify special measures relevant to the nature of the contaminants. Agree site protocol for investigation/monitoring.	1	2	2
E37	[E] Earthworks	Ground Contamination (Groundwater): Hazardous gas arising from contaminated land/organic alluvium.	All	2	3	6	Implement sufficient ground investigation. Specify special measures relevant to the nature of the contaminants (e.g. gas monitoring installations). Agree site protocol for investigation/monitoring.	1	2	2
E38	[E] Earthworks	Unforeseen ground conditions due to Insufficient ground investigation data points in specific areas.	All	3	3	9	Request supplementary ground investigation is undertaken. Undertake a sensitivity assessment of the current design to more worst credible conditions.	1	2	2

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E39	[E] Earthworks	Failure of rock cut slopes Due to structural conditions of rock mass (planar failures, wedge failures, toppling failures).	All	2	4	8	All rock cuts to be inspected by the ER or DSR following excavations Requirement for further scaling works, dentition works, or drainage works will be confirmed by the ER or DSR. Where possible, at detailed design stage of rock cuts an assessment of the structural conditions of the rock shall be made. At construction stage an assessment of the potential for rock structural failures (planar, wedge and toppling failure) shall be made after the rock mass is exposed. An experienced geotechnical engineer or engineering geologist shall record the dip orientation / direction of the exposed rock mass.	1	3	3
E40	[E] Earthworks	Excessive settlement of embankments Where topsoil is below embankments, especially where topsoil is over 0.5m in depth	All	3	3	9	All topsoil below embankments of less than 3m in height is to be removed. Topsoil shall be removed where topsoil depth is of more than 0.5m and is below embankments of over 3m in height. The GIR to identify the areas with topsoil over 0.5m in height along scheme corridor. Locations to be identified in Earthwork Plan & Profile. Requirement to be added to appendix to series 600 specification.	1	3	3
E41	[E] Earthworks	Encountering unexpected geological features, fissures, faults, solution features etc.	All	2	3	6	Investigate geomorphological features. Implement sufficient ground investigations. Specific mitigation measures.	1	2	2
E42	[E] Earthworks	Collapsible Ground (Landslip) Instability of new embankment slopes (Internal stability).	All	2	4	8	Specify appropriate design slope angles. Specify suitable fill material. Bench new fill into existing ground	1	3	3
E43	[E] Earthworks	Collapsible Ground (Landslip) Failure of new embankment due to weak formation (Global Stability)	All	2	4	8	Specify appropriate design slope angles. Specify suitable fill material. Control filling rate for affected embankment	1	3	3
E44	[E] Earthworks	Collapsible Ground (Landslip) Failure of new embankment due to artesian pressure/high water table (Global Stability)	All	2	4	8	Specify appropriate design slope angles. Specify suitable fill material. Control filling rate for affected embankment	1	3	3
E45	[E] Earthworks	Collapsible Ground (Landslip) Damage to cutting due to local instability of loose material in slope or temporary works excavation	All	3	3	9	Specify appropriate design slope angles. Inspect exposed faces Recompact / replace / support during excavation.	1	2	2
E46	[E] Earthworks	Collapsible Ground (Landslip) Failure of rock cutting due to weak zones / fissures (Global Stability)	All	2	4	8	Select appropriate slope angles Inspect exposed faces Recompact / replace / support during excavation	1	2	2

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E47	[E] Earthworks	Collapsible Ground (Landslip) Damage to neighbouring property due to ground movement during construction	All	2	5	10	Select appropriate slope angles Inspect exposed faces Agree contingency measures	1	4	4
E48	[E] Earthworks	Failure of structure or earthworks. Due to use of geotechnical design parameters in detailed design without verification of the validity leading to an unsafe design	All	2	4	8	The use of characteristic parameters is subject to a location and geotechnical design case assessment of the validity in each GDR	1	3	3
E49	[E] Earthworks	Land Use Constraint Hazard (Geoheritage Site) Implications of scheme to Bruse Hill	All	4	3	12	Consultation with GSI Design scheme with sensitivity to the Geoheritage site Specify procedures during development/construction to raise awareness of the geoheritage site's significance	3	2	6
B1	[B] Bridge	Collapsible Ground: Encountering uncollapsed voids associated with karst	All	1	4	4	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures	1	3	3
B2	[B] Bridge	Collapsible Ground Induced collapse of solution feature due to construction activities or change in ground water regime	All	2	4	8	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	4	4
B3	[B] Bridge	Collapsible Ground: Encountering unexpected geological features, fissures, faults, solution features etc.	All	2	3	6	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations.	1	3	3
B4	[B] Bridge	Compressible ground: Damage to bridge caused by settlement/subsidence of foundation.	All	3	4	12	Implement sufficient ground investigation. Identify stratum able to support structural loads and design foundations to limit settlement to acceptable levels (<25mm).	1	4	4
B5	[B] Bridge	Compressible ground: Damage to bridge caused by settlement of adjacent wing wall foundation.	All	3	4	12	Implement sufficient ground investigation. Wing walls to be founded in same stratum or same foundation.	1	3	3
B6	[B] Bridge	Compressible ground: Damage to pavement caused by differential settlement / subsidence between bridge abutment and approach embankment.	All	3	3	9	Implement sufficient ground investigation. Reduce embankment load carried by soft strata. Ensure adequate transition zones within bridge approaches.	1	2	2
B7	[B] Bridge	Compressible ground: Damage to service crossings due to differential settlement at bridge abutment.	All	3	4	12	Investigate location of services and divert where appropriate. Transmit foundation loads to competent strata beneath the services.	1	3	3

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B8	[B] Bridge	Compressible ground: Lateral loading on bridge foundation piles due to compression beneath approach embankment.	All	3	4	12	Where pile foundations are proposed, design to resist lateral loading. Reduce embankment load carried by soft strata at bridge wing walls. Control upfill rate for affected embankment.	1	4	4
B9	[B] Bridge	Compressible ground: Negative skin friction on bridge foundation piles due to compression beneath approach embankment.	All	3	4	12	Where pile foundations are proposed, design to accept negative skin friction.	1	4	4
B10	[B] Bridge	Variable ground: Damage to bridge caused by differential settlement of foundations.	All	3	4	12	Implement sufficient ground investigation. Investigate variability of founding strata. Transmit loads to competent strata.	1	4	4
B11	[B] Bridge	Soft/Loose ground: Damage to bridge due to inadequate bearing capacity of foundation.	All	3	4	12	Identify stratum able to support structural loads and design foundations to limit settlement to acceptable levels (<25mm).	1	4	4
B12	[B] Bridge	Soft/Loose ground: Damage to bridge abutment due to instability of supporting slope.	All	3	4	12	Implement sufficient ground investigation. Design factor of safety against slip failure in bank seat or found bridge at sufficient depth.	1	4	4
B13	[B] Bridge	Soft/Loose ground: Unable to construct foundations due to collapse of saturated ground.	All	3	3	9	Implement sufficient ground investigation and adopt appropriate construction techniques. May need to adopted temporary or permanent casing.	1	2	2
B14	[B] Bridge	Obstructions: Impractical to construct foundations due to obstructions.	All	3	3	9	Adopt appropriate piling techniques with facility to break obstructions.	1	2	2
B15	[B] Bridge	Existing structures: Damage to existing structure during construction.	All	3	3	9	Implement sufficient ground investigation and identify existing structure arrangements. Undertake pre-construction condition surveys.	1	3	3
B16	[B] Bridge	Proximity to services: Impractical to construct foundations without damaging services (overhead cables/pipeline).	All	3	4	12	Locate Services and relocate where necessary. Specify special measures where necessary (e.g. dedicated spotters) Monitor site works. Contractor to use best practice, appropriate plant and equipment.	1	4	4
B17	[B] Bridge	Groundwater (chemical aggressivity): Sulphates/Chloride content	All	3	3	9	Implement sufficient ground investigation. Liaise with Structural Designer to determine appropriate concrete exposure class. Specify protective measures as appropriate.	1	2	2
B18	[B] Bridge	Pollutants in groundwater: Environmental damage such as pollution of aquifer (piling works) and watercourses.	All	2	3	6	Implement sufficient ground investigation to understand potential pollutant pathways. Specify protective measures as appropriate.	1	2	2

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B19	[B] Bridge	Unforeseen ground conditions: Due to Insufficient ground investigation data points in specific areas.	All	3	3	9	Request supplementary ground investigation is undertaken. Undertake a sensitivity assessment of the current design to more worst credible conditions.	1	2	2
B20	[B] Bridge	Failure of Structure Due to use of geotechnical design parameters in detailed design without verification of their validity leading to an unsafe design.	All	3	4	12	The use of characteristic parameters is subject to a location and geotechnical design case assessment of their validity in each GDR.	1	4	4
RW1	[RW] Retaining Walls	Collapsible Ground Encountering uncollapsed void associated with Karst.	All	1	4	4	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	3	3
RW2	[RW] Retaining Walls	Collapsible Ground Induced collapse of solution feature due to change in groundwater regime and/or construction activities.	All	2	4	8	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	4	4
RW3	[RW] Retaining Walls	Collapsible Ground: Encountering unexpected geological features, fissures, faults, solution features etc.	All	2	3	6	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations.	1	2	2
RW4	[RW] Retaining Walls	Compressible ground: Damage to retaining wall caused by settlement/subsidence of foundation.	All	3	4	12	Implement sufficient ground investigation. Identify stratum able to support structural loads and design foundations to limit settlement to acceptable levels (<25mm).	1	4	4
RW5	[RW] Retaining Walls	Compressible ground: Damage to buried services (e.g. brittle pipework) caused by displacement of wall and retained embankment.	All	3	4	12	Investigate location of services and divert where appropriate. Transmit foundation loads to competent strata beneath the services.	1	3	3
RW6	[RW] Retaining Walls	Compressible ground: Lateral loading on retaining wall foundation piles due to compression beneath retained embankment.	All	3	3	9	Where pile foundations are proposed, design to resist lateral loading. Reduce embankment load carried by soft strata at bridge wing walls.	1	2	2
RW7	[RW] Retaining Walls	Compressible ground: Negative skin friction on foundation piles due to compression beneath adjacent embankment.	All	3	4	12	Where pile foundations are proposed, design to accept negative skin friction.	1	3	3
RW8	[RW] Retaining Walls	Variable ground: Damage to retaining walls caused by differential settlement of foundations.	All	3	4	12	Implement sufficient ground investigation. Investigate variability of founding strata. Transmit loads to competent strata.	1	4	4
RW9	[RW] Retaining Walls	Soft/loose ground: Damage to retaining wall due to bearing failure of foundation.	All	3	4	12	Identify stratum able to support structural loads and design foundations with factor of safety against shear failure of supporting soil.	1	4	4

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RW10	[RW] Retaining Walls	Soft/loose ground: Damage to retaining wall due to instability of supporting slope.	All	3	4	12	Design factor of safety against slip failure. Ensure the retaining walls are founded at sufficient depth.	1	4	4
RW11	[RW] Retaining Walls	Soft/loose ground: Unable to construct foundations due to collapse of weak or saturated ground.	All	3	3	9	Investigate slopes for evidence of instability. Control and inspect temporary works excavations.	1	3	3
RW12	[RW] Retaining Walls	Soft/loose ground: Collapse of wall due to instability of retained slope.	All	3	4	12	Investigate slopes for evidence of instability. Ensure adequate design of slopes and inspect founding layer.	1	4	4
RW13	[RW] Retaining Walls	Obstructions: Impractical to construct foundations due to obstructions.	All	3	3	9	Undertake adequate geotechnical investigation to ensure any obstructions are identified in advance and implement appropriate design mitigation.	1	2	2
RW14	[RW] Retaining Walls	Existing Structures: Damage to existing structures during construction.	All	3	3	9	Implement sufficient ground investigation and identify existing structure arrangements. Undertake pre-construction condition surveys.	1	2	2
RW15	[RW] Retaining Walls	Proximity to services: Impractical to construct foundations without damaging services (overhead cables/pipeline).	All	3	3	9	Locate Services and relocate where necessary. Specify special measures where necessary (e.g. dedicated spotters) Monitor site works. Contractor to use best practice, appropriate plant and equipment.	1	3	3
RW16	[RW] Retaining Walls	Groundwater (chemical aggressivity): Sulphates/Chloride content	All	3	3	9	Implement sufficient ground investigation. Liaise with Structural Designer to determine appropriate concrete exposure class. Specify protective measures as appropriate.	1	3	3
RW17	[RW] Retaining Walls	Pollutants in groundwater: Environmental damage such as pollution of aquifer (piling/ground works) and watercourses.	All	3	4	12	Implement sufficient ground investigation to understand potential pollutant pathways. Specify protective measures as appropriate.	1	3	3
RW18	[RW] Retaining Walls	Contaminated Ground: Damage to retaining wall elements arising from exposure to contaminants.	All	2	3	6	Implement sufficient ground investigation. Liaise with Structural Designer to determine appropriate concrete exposure class. Specify protective measures as appropriate.	1	2	2
RW19	[RW] Retaining Walls	Unforeseen ground conditions: Due to Insufficient ground investigation data points in specific areas.	All	3	3	9	Request supplementary ground investigation is undertaken. Undertake a sensitivity assessment of the current design to more worst credible conditions.	1	2	2
RW20	[RW] Retaining Walls	Failure of Structure Due to use of geotechnical design parameters in detailed design without verification of their validity leading to an unsafe design.	All	3	4	12	The use of characteristic parameters is subject to a location and geotechnical design case assessment of their validity in each GDR.	1	4	4

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C1	[C] Culverts	Collapsible Ground Encountering uncollapsed void associated with Karst.	All	1	4	4	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	4	4
C2	[C] Culverts	Collapsible Ground Induced collapse of solution feature due to change in groundwater regime and/or construction activities.	All	1	4	4	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	4	4
C3	[C] Culverts	Collapsible Ground Encountering unexpected geological features, fissures, faults, solution features etc.	All	2	3	6	Investigate geomorphological features. Implement sufficient ground investigation. Inspect formation before placing structural foundations. Specify mitigation measures.	1	2	2
C4	[C] Culverts	Compressible ground Damage to culvert / pipes caused by settlement / subsidence of embankment.	All	3	3	9	Select structure that can accommodate predicted level of settlement. Identify stratum able to support structural loads and design culvert foundations to limit settlement to acceptable levels. Install road drainage when predicted settlement is substantially complete.	1	3	3
C5	[C] Culverts	Compressible ground Loss of capacity to culvert / pipes due to settlement.	All	2	4	8	Oversize culvert / pipes to allow redundant capacity. Install road drainage when predicted settlement is substantially complete.	1	4	4
C6	[C] Culverts	Compressible ground Damage to carriageway where fines washed into culvert / pipe joints from embankment fill.	All	2	4	8	Concrete slab to maintain water- tightness of culvert joints.	1	4	4
C7	[C] Culverts	Compressible ground Loss of profile to culvert/ pipes due to settlement.	All	3	4	12	Accept 'dead water' and possible siltation within culvert / pipes. Install road drainage when predicted settlement is substantially complete. Consider remedial jacking of culvert.	1	4	4
C8	[C] Culverts	Variable ground Damage to culvert caused by differential settlement of foundations.	All	3	4	12	Investigate variability of founding strata. Construct foundation slab to regulate differential movement.	1	4	4
C9	[C] Culverts	Variable ground Damage to carriageway due to differential settlement across structure.	All	3	3	9	Ground treatment to provide transition zone. Construct carriageway when predicted settlements are substantially completed.	1	2	2
C10	[C] Culverts	Soft/loose ground Damage to culvert and wing walls due to instability of supporting slope.	All	3	3	9	Adequate ground investigation and design for overall stability.	1	3	3
C11	[C] Culverts	Soft/loose ground Unable to construct culvert due to collapse of weak or saturated ground.	All	3	3	9	Investigate slopes for evidence of instability. Control and inspect temporary works excavations.	1	2	2

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C12	[C] Culverts	Obstructions - Impractical to construct culvert due to obstructions.	All	2	4	8	Investigate ground conditions (include inspection of plans).	1	3	3
C13	[C] Culverts	Proximity to services Impractical to construct foundations without damaging services (overhead cables / pipeline).	All	3	3	9	Investigate services / contractor to use best practice, appropriate plant and equipment.	1	2	2
C14	[C] Culverts	Sulphate in groundwater Sulphate attack to buried concrete.	All	2	3	6	Investigate groundwater chemistry and protect concrete as necessary.	1	3	3
C15	[C] Culverts	Pollutants in groundwater Egress of pollutants along pipe surround.	All	2	3	6	Assess ground conditions / Consult with Environment Agency / adopt appropriate techniques. See also H&S Risk Assessment.	1	3	3
C16	[C] Culverts	Contaminated ground Damage to buried concrete and pipes arising from exposure to contaminants.	All	2	4	8	Specify appropriate materials for foundations and pipework etc. See also H&S Risk Assessment.	1	3	3
C17	[C] Culverts	Unforeseen ground conditions Due to Insufficient ground investigation data points in specific areas.	All	3	4	12	Additional ground investigation to be requested.	1	3	3
C18	[C] Culverts	Failure of Structure Due to use of geotechnical design parameters in detailed design without verification of their validity leading to an unsafe design.	All	2	4	8	The use of characteristic parameters is subject to a location and geotechnical design case assessment of their validity in each GDR.	1	3	3

Appendix 2: Drawings

N

LEGEND

- Preferred Option Centreline
- PO Corridor
- Contours_11122019

Quat Geomorphology

- SUBGLACIAL_LINEATION_STRIAE

SUBGLACIAL_LINEATION_LARGE

- Crag-and-Tail
- Drumlin
- Streamlined Bedrock

SUBGLACIAL_MORAINES

- Minor Ribbed Moraine
- Ribbed Moraine

DEGLACIAL_LANDFORMS

- Fan
- Glaciofluvial Terrace
- Hummocky Sand and Gravel

14+000 13+500 13+000 12+500 12+000 11+500 11+000 10+500 10+000 9+500 9+000 8+500 8+000 7+500 7+000 6+500 6+000 5+500 5+000 4+500 4+000 3+500 3+000 2+500 2+000 1+500 1+000 0+500 0+000

0 1 2 3 4 5 km

Tionscadal Éireann Project Ireland 2040

Transport Infrastructure Ireland

An Roinn Iompair Department of Transport

Cavan County Council

comhairle chontae na mí meath county council

BARRY TRANSPORTATION

Notes:

DO NOT SCALE, use figured dimensions only.

Base map and data from:
1) OpenStreetMap and OpenStreetMap Foundation available from https://www.openstreetmap.org
2) Google maps available from https://www.google.ie/maps

Rev:	Date	Drawn	Description	Chk'd	Appr
P01	07/02/22	CJO	ISSUE FOR REVIEW AND COMMENT	DOH	DOH

Project Title:	N3 VIRGINIA BYPASS PRELIMINARY SOURCES STUDY REPORT	Status: S3
Drawing Title:	PRELIMINARY SOURCES STUDY REPORT TOPOGRAPHY & GEOMORPHOLOGY	
Designed: CJO	Drawing No: 19408-BT-06-ZZ-DR-C_0101	Rev: P01
Drawn: CJO		
Approved: TC	Scale at A1: 1:25,000	
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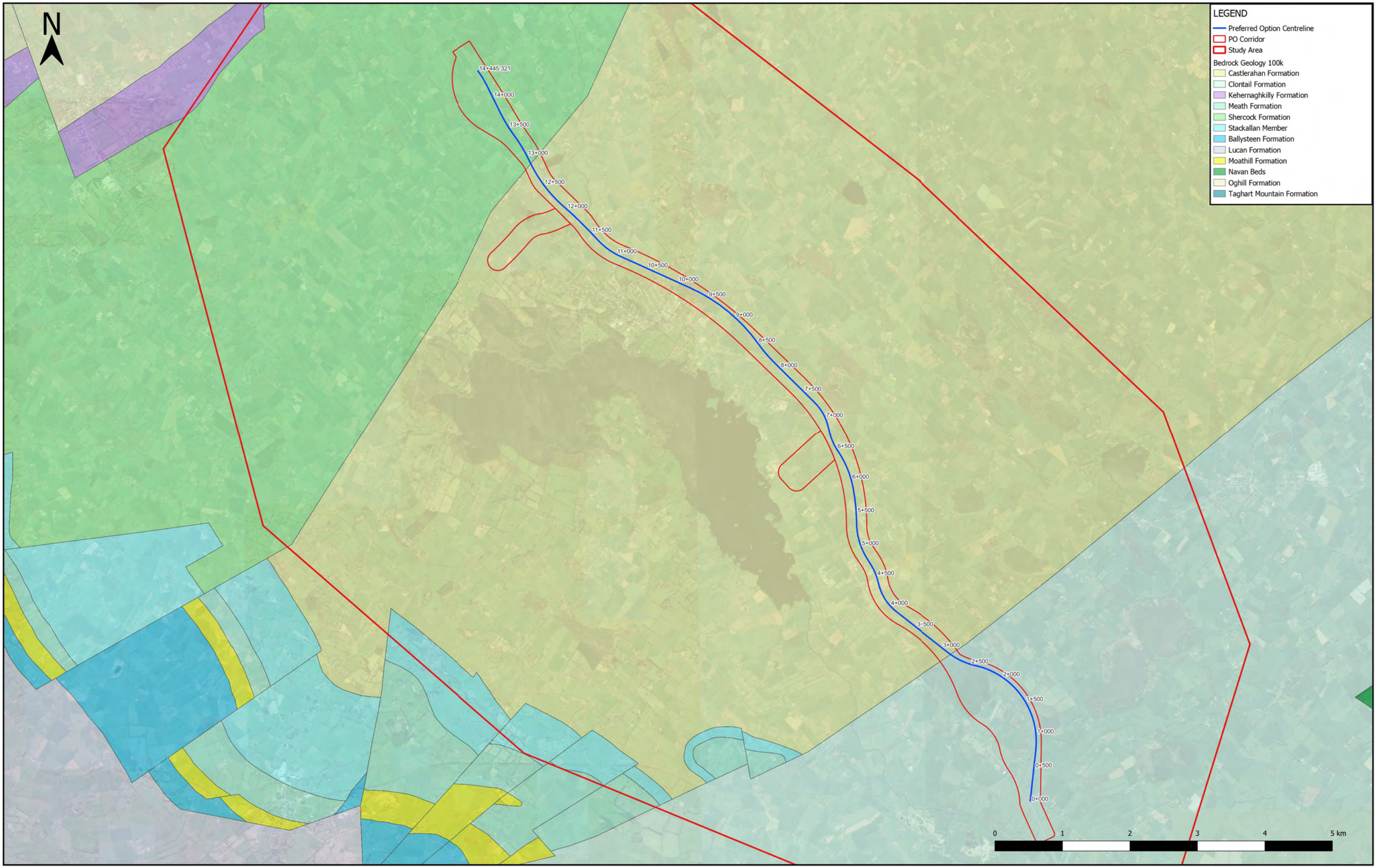

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TII Transport Infrastructure Ireland

An Roinn Iompair Department of Transport

Cavan County Council

comhairle chontae na mí meath county council

BARRY TRANSPORTATION

Notes:

DO NOT SCALE, use figured dimensions only.

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1) OpenStreetMap and OpenStreetMap Foundation available from https://www.openstreetmap.org
2) Google maps available from https://www.google.ie/maps

Rev:	Date	Drawn	Description	Chk'd	Appr.
P01	07/02/22	CJO	ISSUE FOR REVIEW AND COMMENT	DOH	DOH

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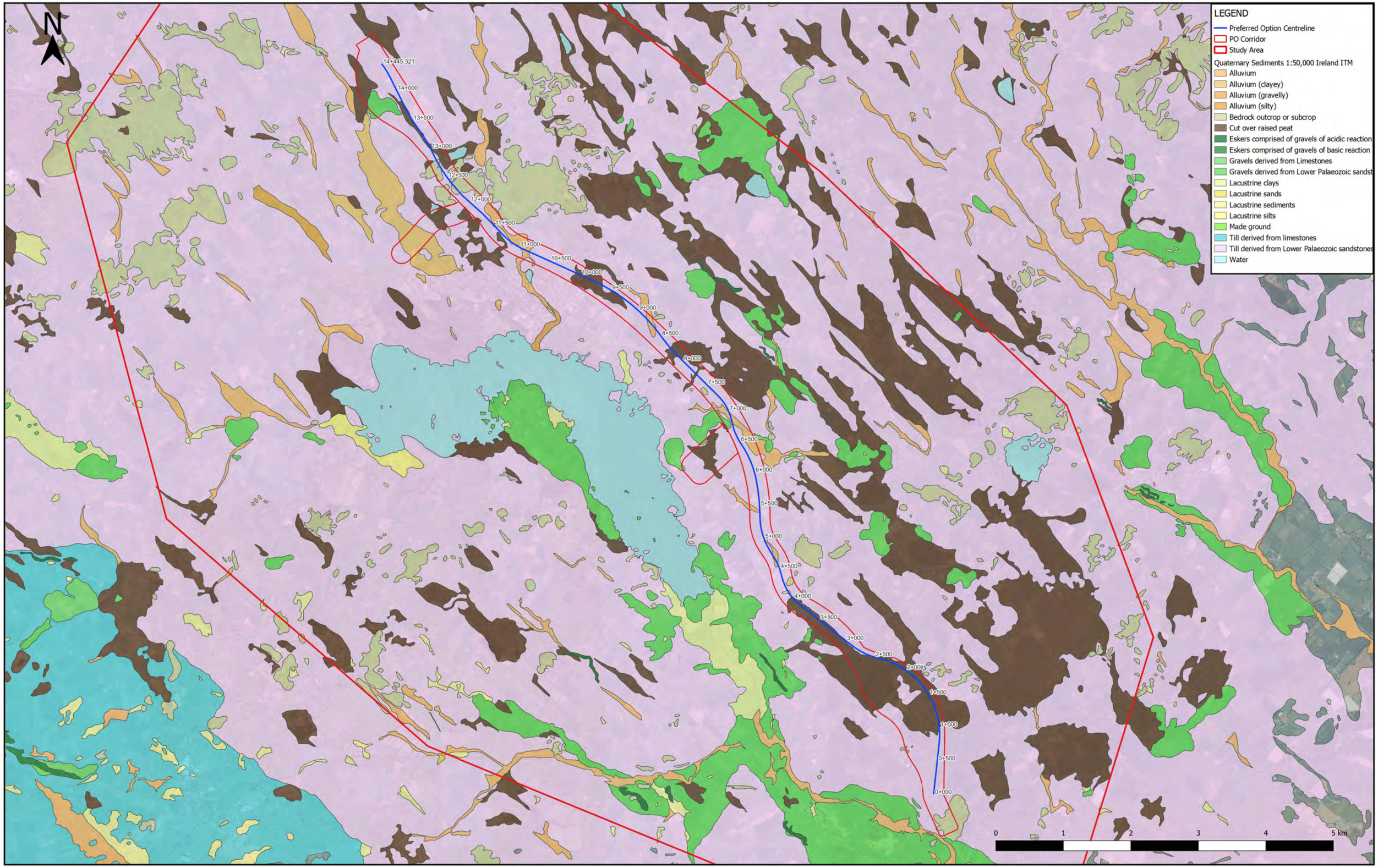

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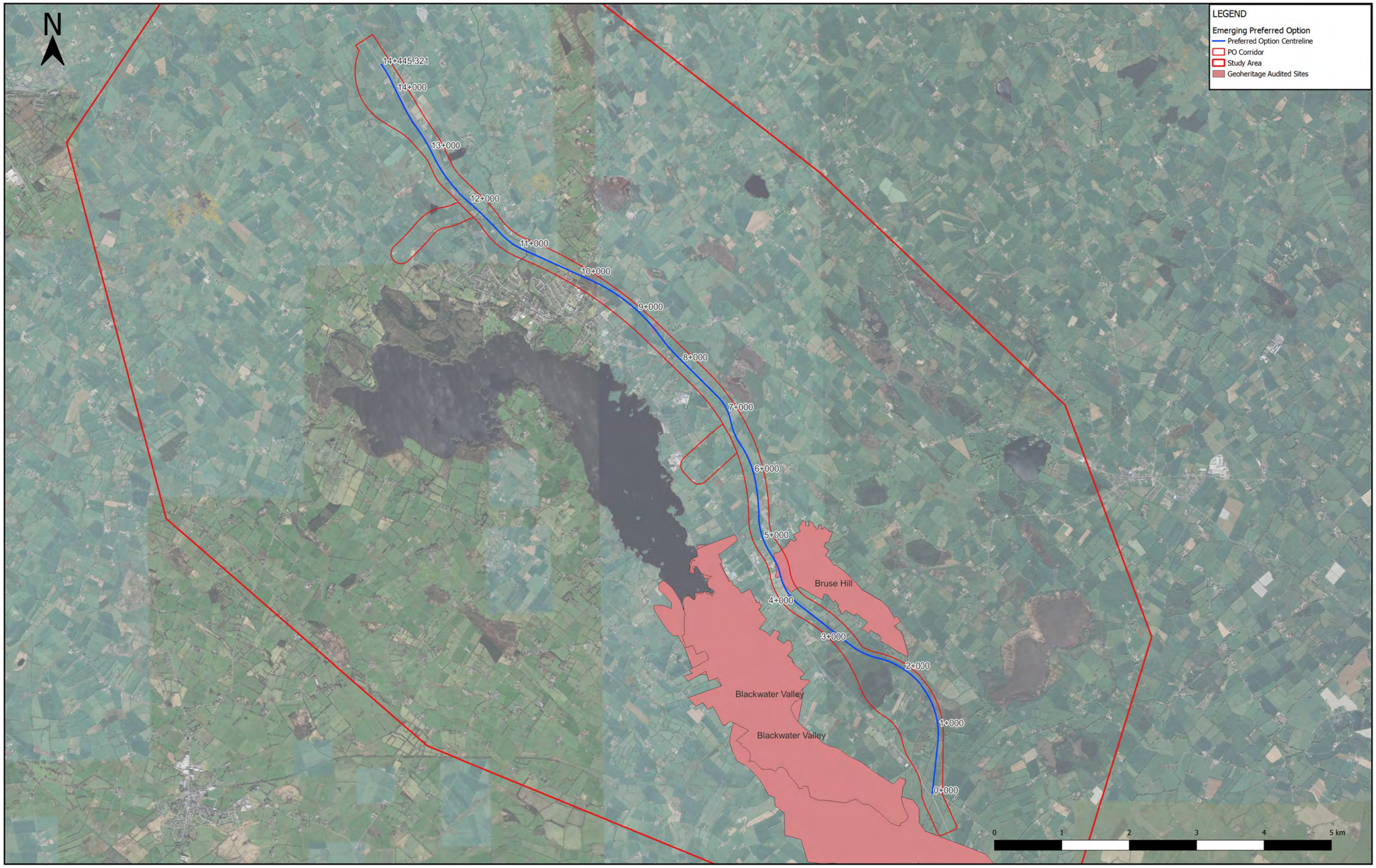

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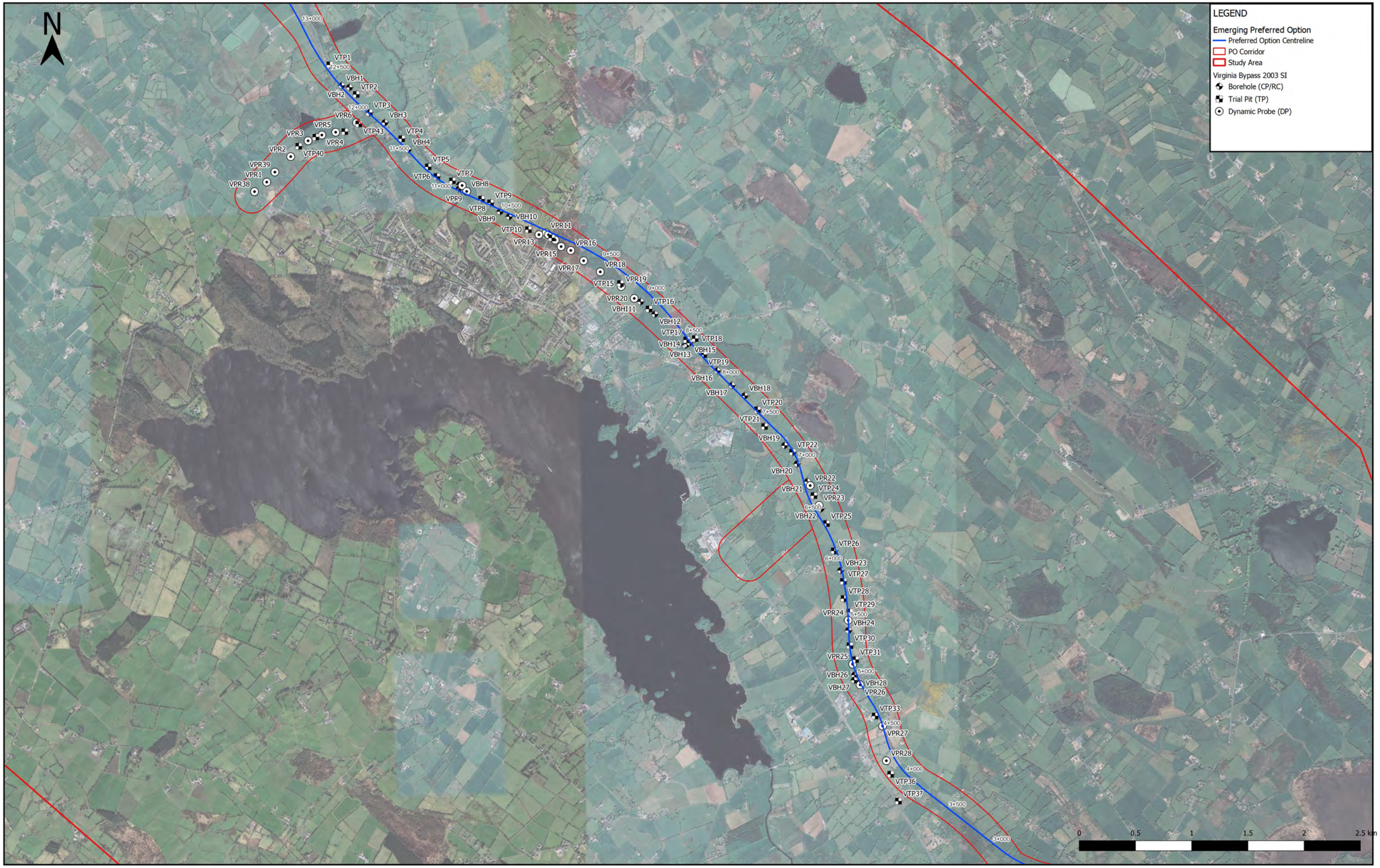

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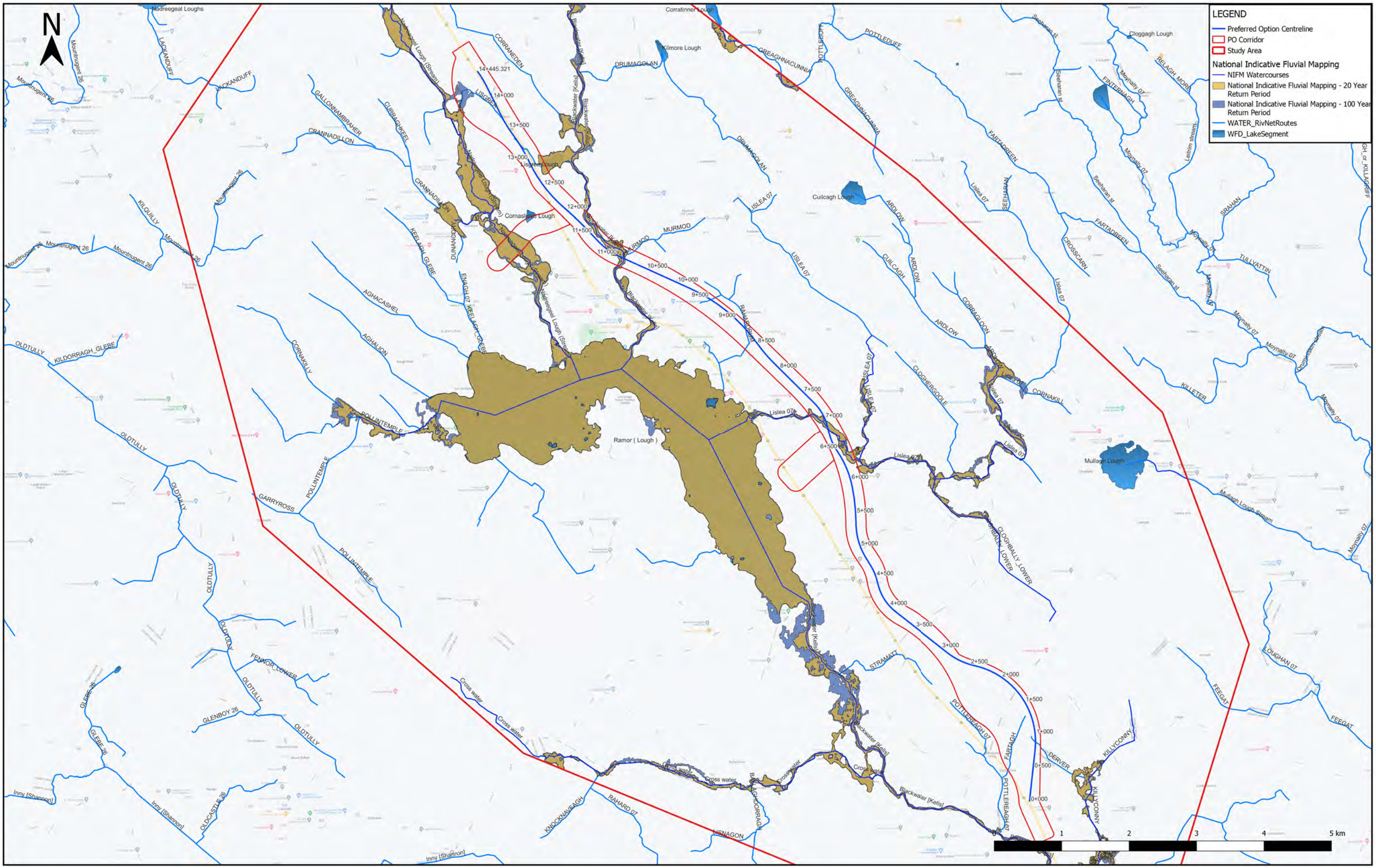

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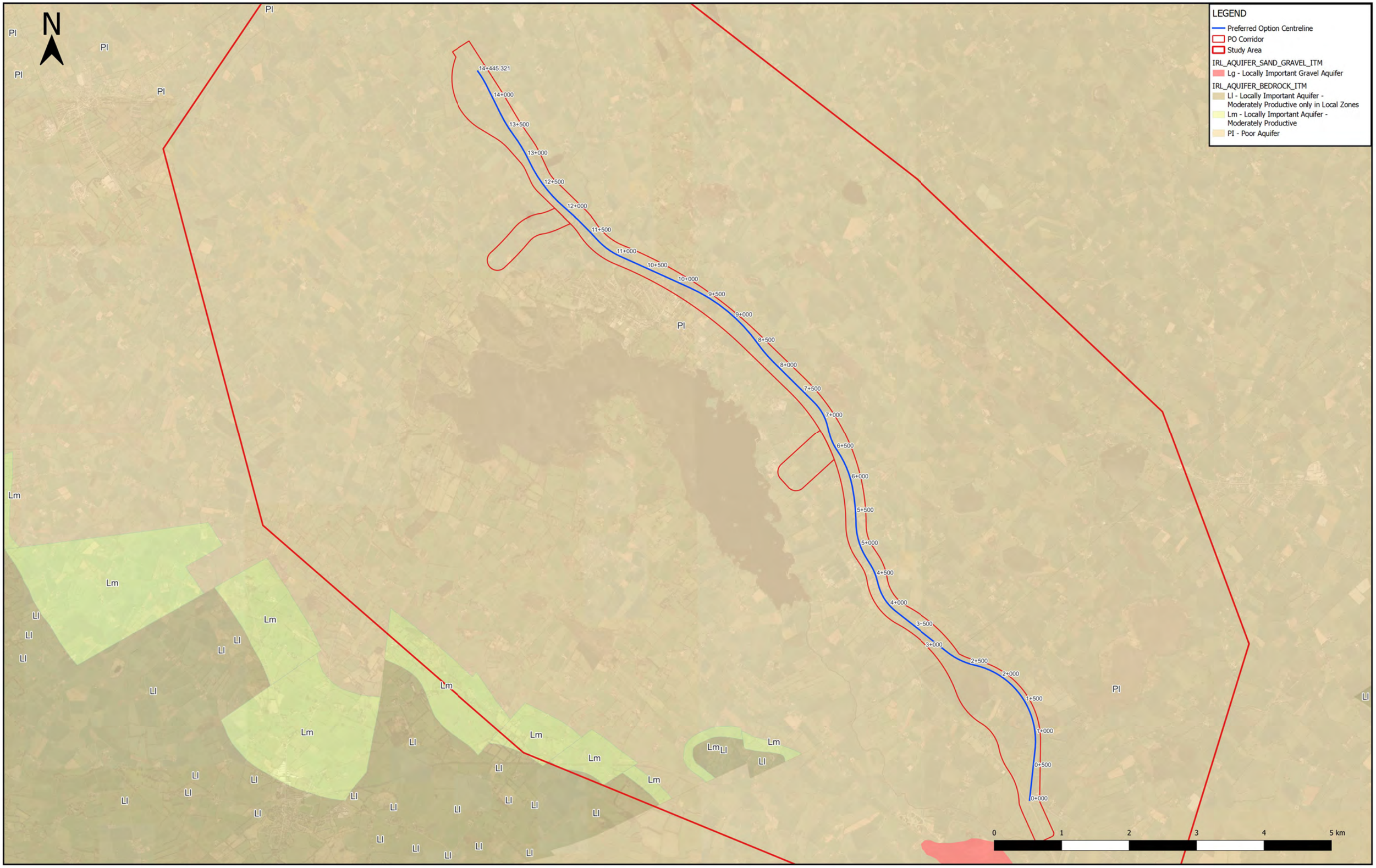

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2) Google maps available from https://www.google.ie/maps

Rev:	Date	Drawn	Description	Chk'd	Appr.
P01	07/02/22	CJO	ISSUE FOR REVIEW AND COMMENT	DOH	DOH

Project Title:	N3 VIRGINIA BYPASS PRELIMINARY SOURCES STUDY REPORT	Status: S3
Drawing Title:	PRELIMINARY SOURCES STUDY REPORT GROUNDWATER AQUIFERS	
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Drawn: CJO		
Approved: TC	Scale at A1: 1:25,000	
Checked: DOH	Date: 07/02/2022	

N

LEGEND
- Preferred Option Centreline
- PO Corridor
- Study Area

Groundwater Vul N3
- Extreme
- High
- Low
- Modertae
- Water
- Rock at or near Surface or Karst

14+445.321
14+000
13+500
13+000
12+500
12+000
11+500
11+000
10+500
10+000
9+500
9+000
8+500
8+000
7+500
7+000
6+500
6+000
5+500
5+000
4+500
4+000
3+500
3+000
2+500
2+000
1+500
1+000
0+500
0+000

0 1 2 3 4 5 km

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Notes:

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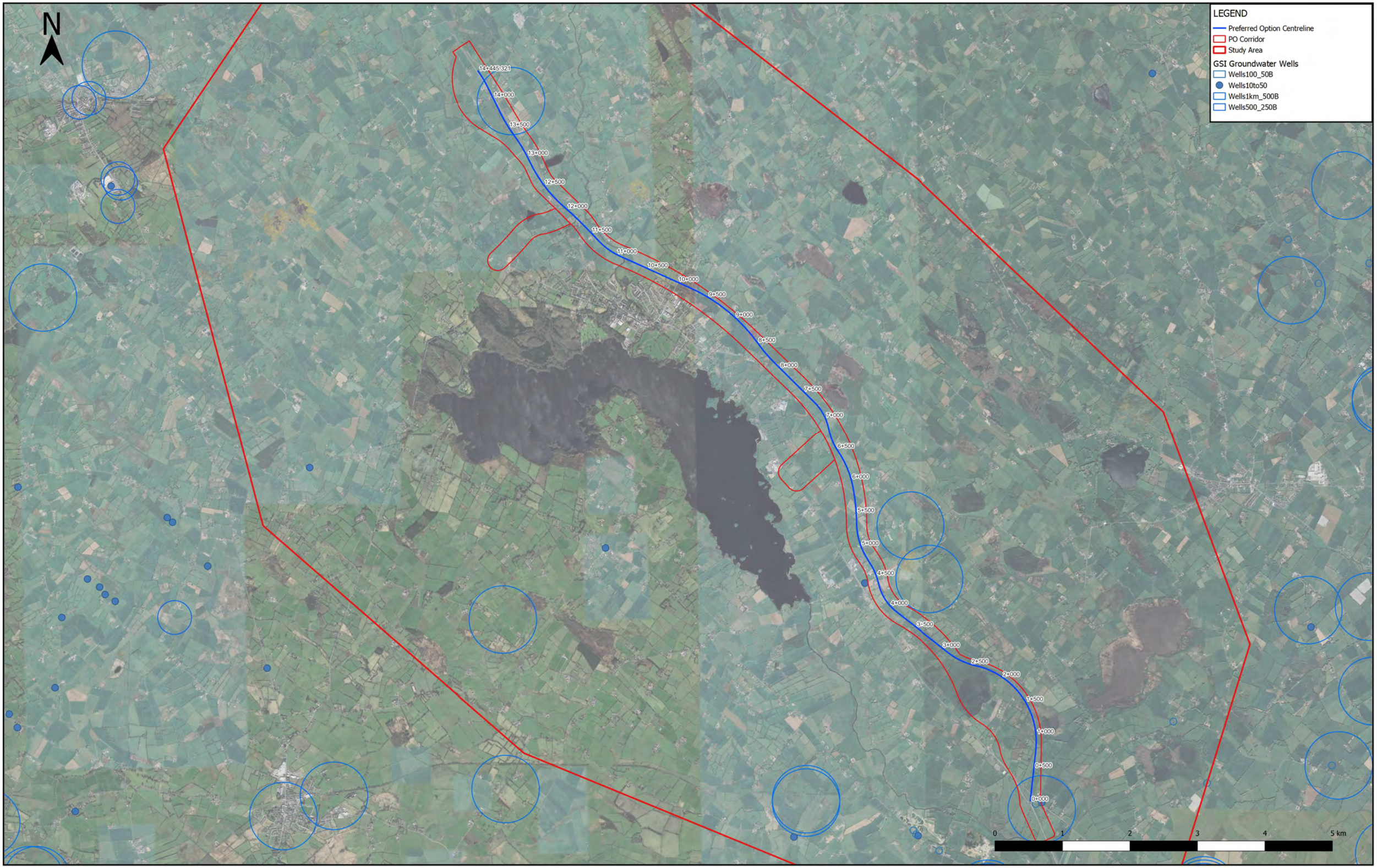

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P01	07/02/22	CJO	ISSUE FOR REVIEW AND COMMENT	DOH	DOH

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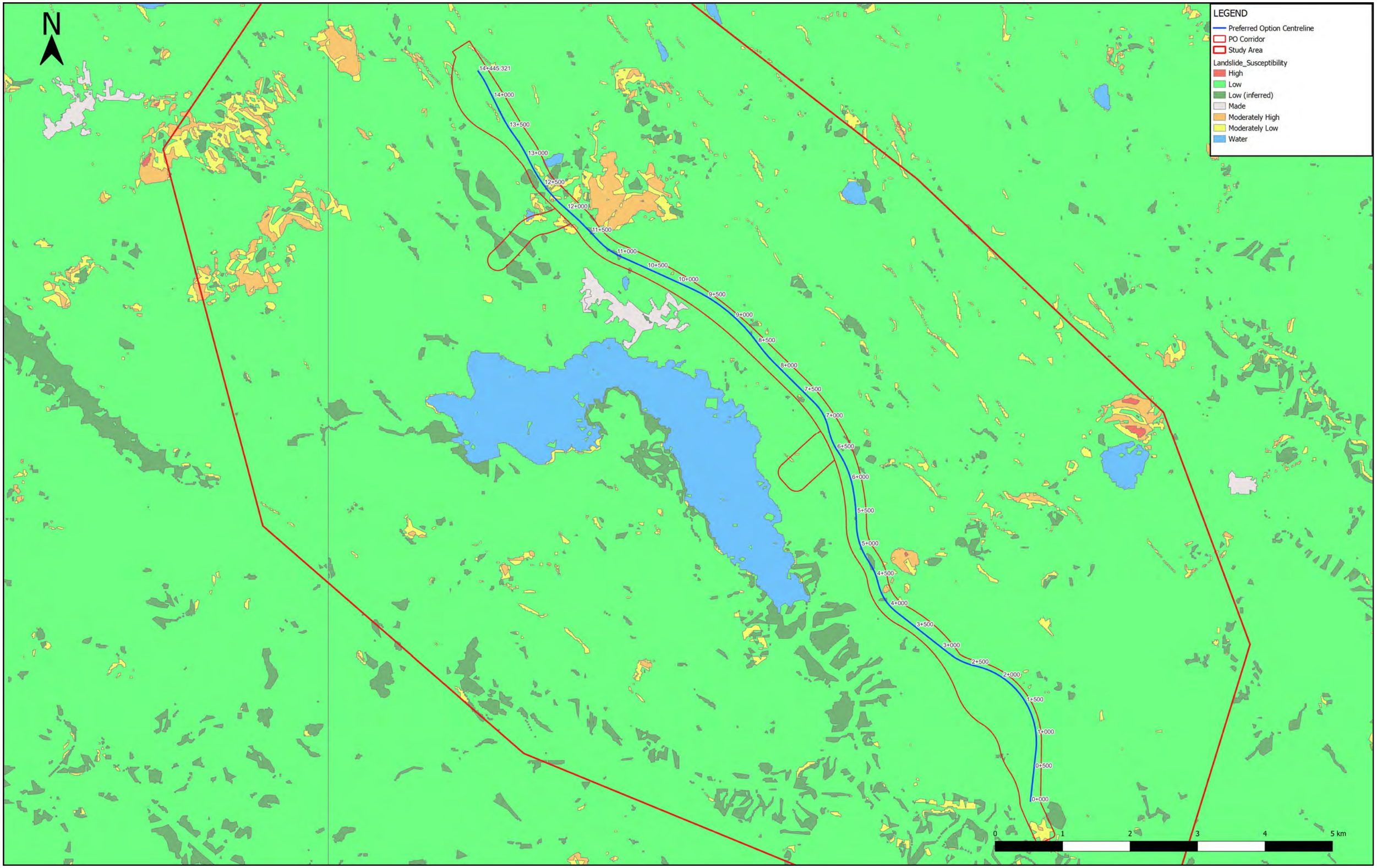

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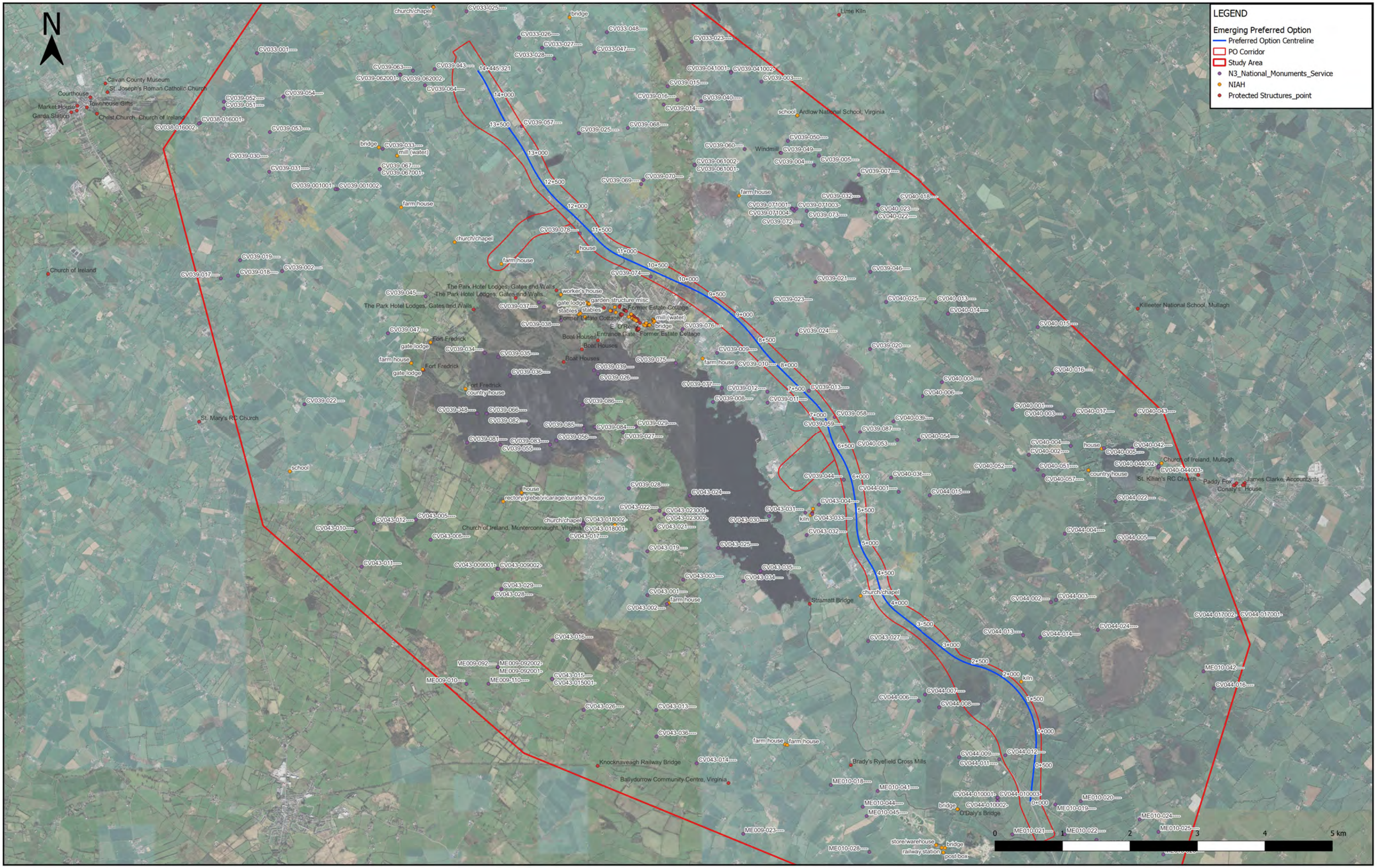

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Project Ireland
2040

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Department of Transport

cavan
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meath county council

BARRY
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Approved: TC	Scale at A1: 1:25,000	
Checked: DOH	Date: 07/02/2022	

N

LEGEND

- Preferred Option Centreline
- PO Corridor
- Study Area

Historic Pits and Quarries with PO Corridor

- Early to Mid-20thC: Pits
- Mid-Late 19thC: Pits
- Mid-Late 19thC: Quarries
- Mid-Late 20thC: Quarries

Historic Pits and Quarries with Study Area

- Early to Mid-20thC: Pits
- Early to Mid-20thC: Quarries
- Late 19th to Mid-20thC: Pits

14+445.321
14+000
13+500
13+000
Q-01
P-02
12+500
P-03
12+000
11+500
P-01
11+000
10+500
10+000
9+500
9+000
8+500
8+000
Q-02
7+500
7+000
6+500
6+000
5+500
5+000
4+500
4+000
3+500
3+000
2+500
2+000
1+500
1+000
0+500
0+000

0 1 2 3 4 5 km

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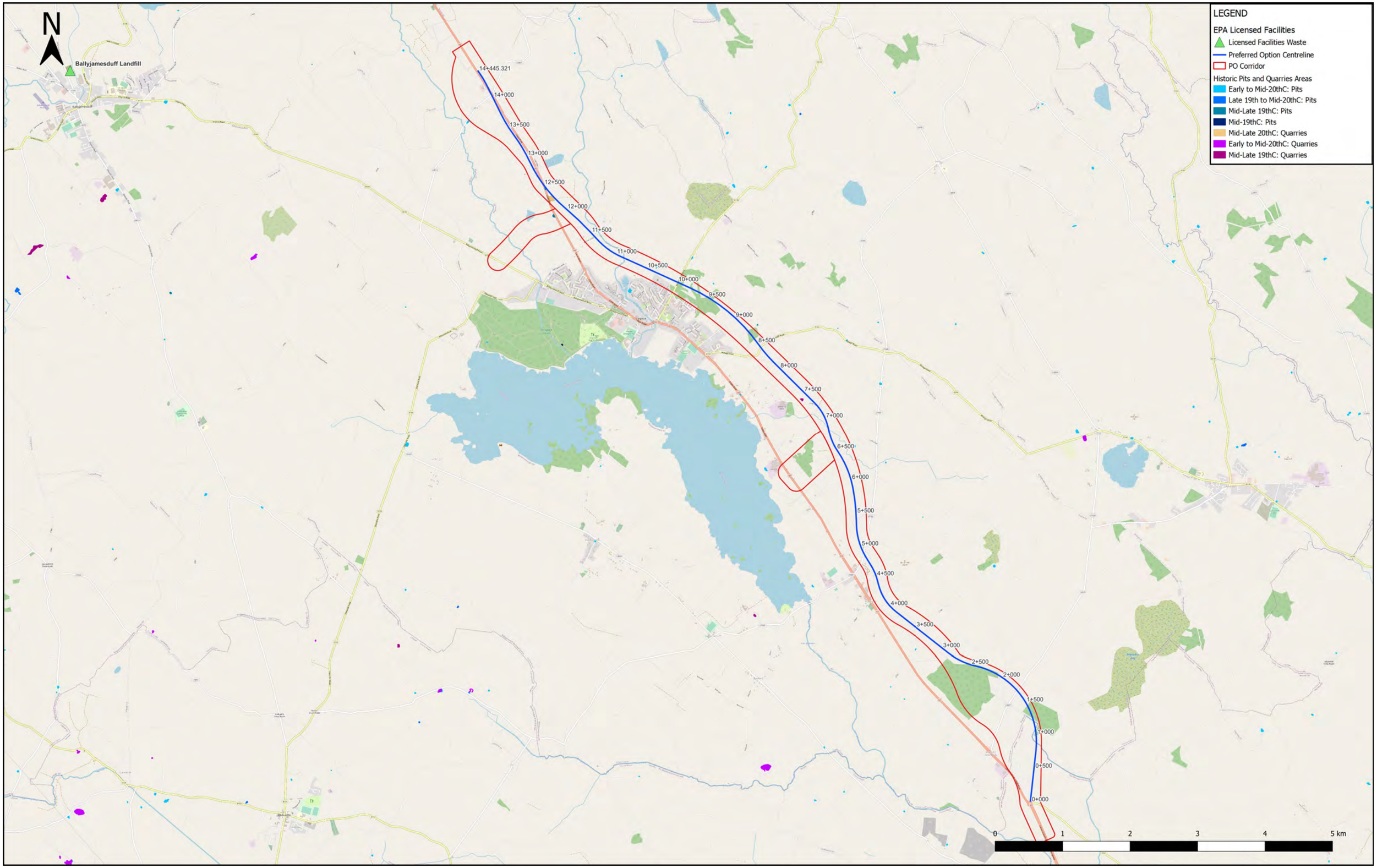

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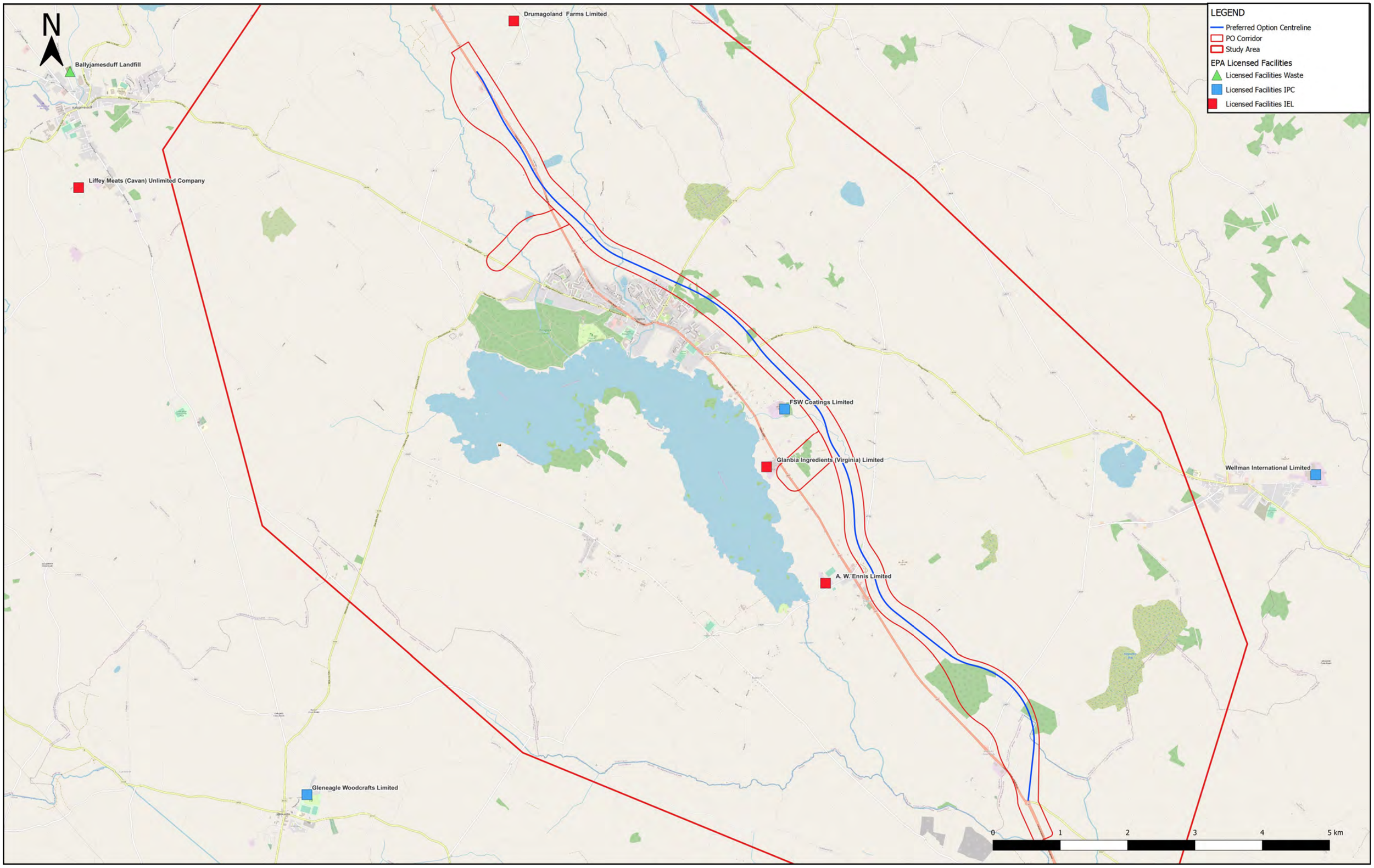
Checked: DOH	Date: 07/02/2022		



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Approved: TC	Scale at A1: 1:25,000	
Checked: DOH	Date: 07/02/2022	

N

LEGEND

- Preferred Option Centreline
- PO Corridor
- Study Area

Potential_Crushed_Rock_Aggregate

- Very High potential
- High potential
- Moderate potential
- Low potential
- Very Low potential

14+445.321
14+000
13+500
13+000
12+500
12+000
11+500
11+000
10+500
10+000
9+500
9+000
8+500
8+000
7+500
7+000
6+500
6+000
5+500
5+000
4+500
4+000
3+500
3+000
2+500
2+000
1+500
1+000
0+500
0+000

0 1 2 3 4 5 km

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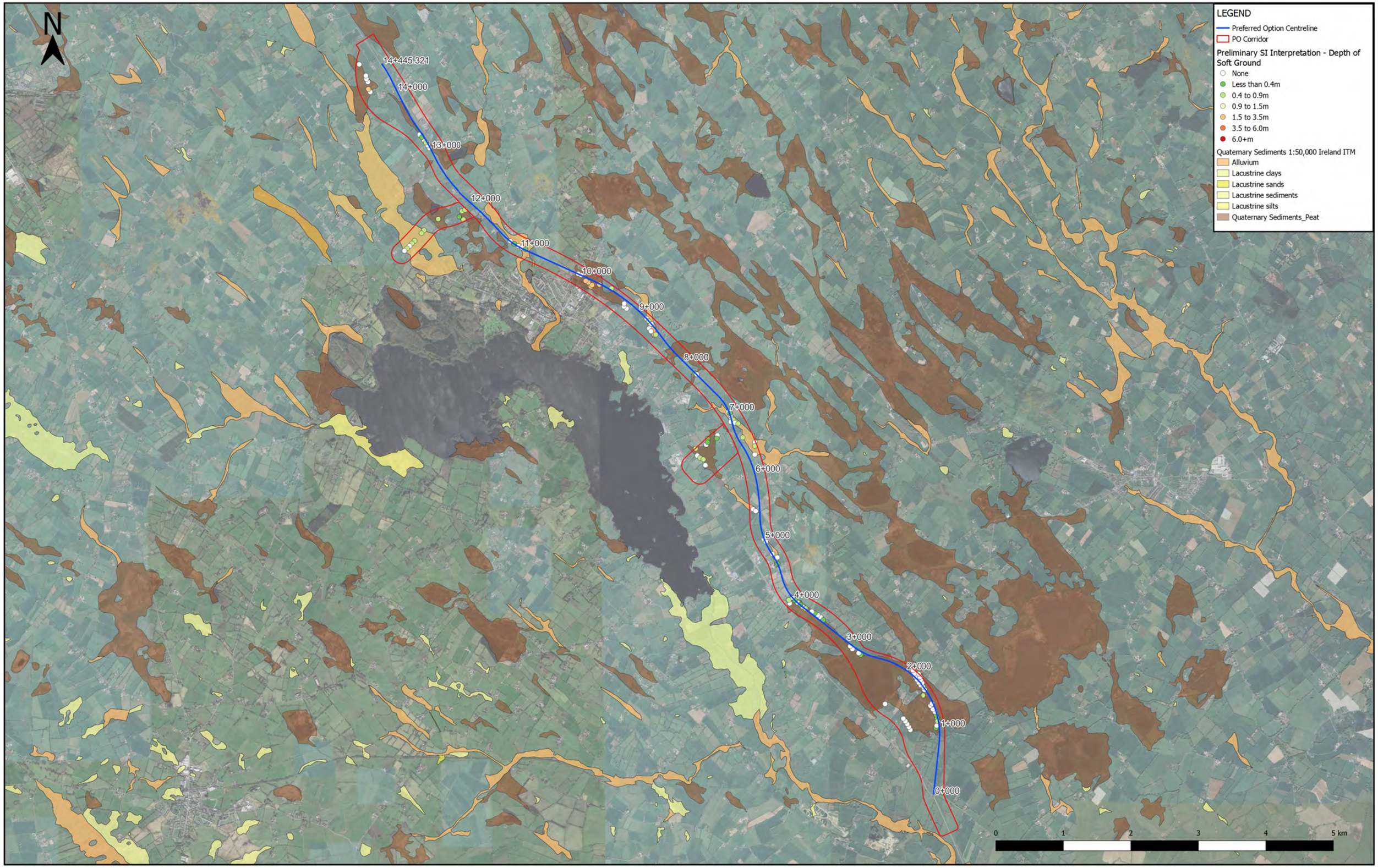

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Approved: TC	Scale at A1: 1:25,000	
Checked: DOH	Date: 07/02/2022	

Appendix 3: Annex A to PSSR (19408-BT-06-ZZ-RP-C)

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meath county council

Cavan
Comhairle Contae an Chabháin
Cavan County Council

N3 Virginia Bypass

Annex A to Preliminary Sources Study Report

May 2022

BARRY
TRANSPORTATION

An Roinn Iompair
Department of Transport

Tionscadal Éireann
Project Ireland
2040

Document Control Sheet

Client:	Cavan County Council
Project Title:	N3 Virginia Bypass
Document Title:	Annex A to Preliminary Sources Study Report
File Name:	19408-BT-06-ZZ-RP-C_0003_Annex A to PSSR

Table of Contents *(incl. Y/N)*	**List of Tables** *(incl. Y/N)*	**List of Figures** *(incl. Y/N)*	**Pages of Text** *(No.)*	**Appendices** *(No.)*
Y	N	N	11	N/A

Document Revision				**Document Verification**			
Issue Date *(DD/MM/YY)*	**Revision Code**	**Suitability Code**	**Author** *(Initials)*	**Checker** *(Initials)*	***Reviewer*** As Per PMP *(Initials)*	**Approver** *As Per PMP (Initials)*	**Peer Review** *(Initials or N/A)*
11/05/2022	P01	S3	CJO	DOH	DOH	TC	N/A

Table of Contents

Glossary of Terms

Some of the terms explained hereunder have more precise, technical explanations in the relevant technical documents (referred to where applicable). The definitions included here are valid in the context of this report.

Term	Acronym (where applicable)	Definition
Preferred Option	PO	The current proposed design alignment which has been presented for stakeholder consultation. This alignment is based on the recommendations outlined in the Option Selection Report – Stage 2.
Preferred Option Corridor	PO Corridor	The PO corridor is a nominal 300m wide corridor along the PO however it is locally widened at the southern and northern tie-ins of the scheme and at the Burrencarragh Link Road. The PO Corridor is indicative, and the project team may undertake some studies/surveys beyond the PO Corridor.
Preliminary Sources Study Report	PSSR	A report including the geotechnical risks, implications, and feasibility of all the project options being considered. The report is required for all projects which involve works covered by the TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk*, and follows the requirements detailed in Appendix C of that document.
Project Liaison Officer	PLO	The individual appointed to liaise with land and property owners, the public and the Local Authority. (TII Publication PE-PMG-02041 (December 2020) Project Management Guidelines)
Site Investigation	SI	Site Investigation Works

SECTION 1: OBJECTIVES AND FORMAT OF INVESTIGATIONS

1.1 Introduction

This report has been prepared in accordance with the information required for Annex A to Preliminary Sources Study Report (PSSR) as specified in TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk.*

In order to confirm and amplify the geotechnical and geomorphological findings of the Preliminary Sources Study, and to obtain detailed knowledge of the soils encountered and their likely behaviour and acceptability, a site investigation is proposed to be undertaken within the footprint of the Preferred Option (PO). The proposed site investigation is hereafter referred to as Site Investigation 2022.

1.2 Objective

The objectives of the Site Investigation 2022 are:

- To confirm, supplement and expand on the geotechnical and geomorphological findings of the PSSR.
- To reduce the risk of unforeseen ground conditions which could negatively impact the design of the scheme. This will be achieved by undertaking a sequence of exploratory holes using a variety of SI techniques (including boreholes, trial pits, slit trenches, dynamic probing and peat probing)
- To acquire ground and groundwater information in areas not covered by historical ground investigations and other published sources.
- To provide and initial assessment of the hydrogeological and geo-environmental characteristics along the Preferred Option (PO).
- To install instrumentation necessary to capture the long-term behaviour and seasonal variations experienced at key areas across the site
- To ascertain locations of underground workings (if any).

1.3 Format

The proposed SI is designed to undertake exploratory holes at a maximum spacing of 100m between each hole for the entire length of the PO to provide sufficient data in order to interpret the ground profile underlying the PO utilising a variety of site investigation techniques and industry best practice.

SECTION 2: SPECIAL PROBLEMS TO BE INVESTIGATED

Based on the GSI geological maps for the area and both historic SI and Option Selection Stage SI, the near surface materials beneath the PO Corridor are likely to comprise

- Cohesive and Granular Glacial Tills derived from Lower Palaezonic sandstones and shales
- Peat
- Alluvium
- Made Ground
- Bedrock at Near Surface

Based on the GSI database mapping "Bedrock Geology 100k", the PO Corridor is located over 3 main bedrock formations, including:

- Clontail Formation (grey to green-grey greywacke) – PO Ch. 0+000 to 2+850m
- Castlerahan Formation (dark greywacke) – PO Ch. 2+850 to 12+870m
- Shercock Formation (fine to coarse grained turbidite) – PO Ch. 12+870 to 14+445m

Some of the ground related hazards/risks identified for investigation are discussed below.

2.1 Geotechnical

The ground conditions likely to be present within the footprint of the PO are anticipated to be generally favourable in terms of earthworks' activities however site investigations will be required give a more accurate indication.

Some of the hazards/risks to be investigated include:

- The extent and depth of soft or highly compressible soils (particularly in areas where structures or high fill embankments are proposed).
- The presence of uncontrolled fill (made ground) which may also include contaminated material
- The assessment of strength profiles within the near surface materials
- The assessment of the bedrock in areas of deep cuttings to determine rock stability problems, rock excitability and re-usability.

2.2 Environmental

Based on the available GSI mapping database, contaminated land and made ground is not expected to be encountered along the PO. If contaminated ground is encountered during the proposed SI, the SI shall be updated to investigate such ground and allow for definitive conclusions.

Notwithstanding this, made ground was encountered in 2No. exploratory holes during the historic SI undertaken as part of the N3 Virginia Bypass, 2003. As a result, there is potential that contaminated material may be present within this made ground.

The proposed scheme is underlain by a Poor Aquifer as outlined on GSI mapping database. The Poor Aquifer is described as bedrock which is generally unproductive except for local zones.

Poor Aquifers generally provide little groundwater for water supply or for baseflow to surface water bodies, however, they are sometimes used for local supply for individual houses/farms. While the impact on the environment of locating a transport scheme on a Poor Aquifer will be significantly less than that on a Regionally Important Aquifer, it will require consideration and mitigation against impacts during the design and construction stages.

SECTION 3: PROPOSED INVESTIGATION

3.1 General

The proposed site investigation (Site Investigation 2022) has been designed and developed to take into consideration the requirements of the proposed scheme design, the potential operational constraints, and the anticipated geology as indicated by geological mapping and historical site investigation data available within and adjacent to the footprint of the PO.

The proposed site investigations will comprise exploratory drilling, excavations and probing, geotechnical and environmental sampling, in-situ testing, laboratory testing and post fieldwork monitoring.

3.2 Fieldwork

The proposed SI works are summarised in the table below.

Table 1: Proposed Exploratory Holes and Investigation Methods

Project Element	Proposed Investigation	Purpose of Exploratory Holes
Preferred Option Alignment including cuttings, fill embankments, side road overbridge structures, accommodation overbridge/underbridge structures, river and stream culverts/underbridges	Combined use of trial pits (ranging from 4.5 to 6m bgl), dynamic probe (with window sampler), cable percussive with rotary core follow-on (with in-situ testing) to a max depth of 25m, peat probes and slit trenching.	To identify any geotechnical features which could affect a dramatic change in the design approach To obtain site specific information on stratigraphy, ground and groundwater conditions To facilitate sampling for laboratory testing Determination of in-situ engineering parameters to supplement laboratory test data
Groundwater Regime	Instrumented boreholes (standpipe), which extends through both overburden and the underlying bedrock	Establish a preliminary site-specific groundwater model to inform design development
Location of Gas Transmission Line	Excavation of slit trenches to confirm presence of Gas Transmission Line/Gas Distribution Main and record findings such as type of service, depth, size and plan location.	To enable accurate records of service be achieved To allow for the suitable design of service re-location (if required). To avoid potential strike of services

The proposed SI for the PO (Site Investigation 2022) is summarised below:

- 43 No. Cable Percussion boreholes with rotary coring follow-on
- 8 No. Cable Percussion boreholes
- 9 No. Rotary Core Only
- 156 No. Trial Pits (up to 4.5m bgl)
- 2 No. Deep Trial Pits (up to 6.0m bgl)
- 42 No. Dynamic Probes
- 21 No. Window Samples
- 145 No. Peat Probes

- 5 No. Slit Trenches (2 No. x Gas Transmission Line and 3 No. x Gas Distribution Main)
- 20 No. Groundwater monitoring installations (Standpipes)
- 6 No. Soil Infiltration Tests
- 6 No. Surface Water Sample locations
- In-situ testing (Standard Penetration Test, Dynamic Cone Penetration, Hand Shear Vane)

Further details of the proposed SI are summarised Table 2 below, listing the proposed exploratory holes for each cutting and fill embankment (including structures) and proposed link roads:

Table 2: Proposed Site Investigations Works

Project Element	Proposed Investigation	Proposed Max Depths
Mainline – Cuttings (including overbridge structures)	15 No. Cable Percussive boreholes with Rotary Core Follow-on	20m bgl
	5 No. Cable Percussive boreholes	16m bgl
	5 No. Rotary Core boreholes	16m bgl
	37 No. Trial Pits	4.5m bgl
	2 No. Deep Trial Pits	6.0m bgl
	1 No. Dynamic Probes	5.0m bgl
	3 No. Slit Trenches	2.0m bgl
	11 No. Standpipes	20.0m bgl
Mainline - Embankment Fills (including underbridge, river bridge, accommodation underpass and culvert structures)	24 No. Cable Percussive boreholes with Rotary Core Follow-on	25.0m bgl
	2 No. Cable Percussive boreholes	13m bgl
	4 No. Rotary Core boreholes	10m bgl
	71 No. Trial Pits	4.5m bgl
	34 No. Dynamic Probes	25.0m bgl
	21 no. Window Samples	10.0m bgl
	130 No. Peat Probes	10.0m bgl
	7 No. Standpipes	20.0m bgl
	3 No. Soil Infiltration Tests	1.5m bgl
Link Roads	4 No. Cable Percussive boreholes with Rotary Core Follow-on	15m bgl
	1 No. Cable Percussive boreholes	10m bgl
	48 No. Trial Pits	4.5m bgl
	7 No. Dynamic Probes	25.0m bgl

	7 no. Window Samples	10.0m bgl
	15 No. Peat Probes	10.0m bgl
	2 No. Standpipes	15.0m bgl
	3 No. Soil Infiltration Tests	1.5m bgl
	2 No. Slit Trenches	1.50m bgl

Inspection pits are to be excavated at the location of each exploratory hole prior to sinking the exploratory hole and a Cable Avoidance Tool (CAT) and signal generator (Genny) is to be used to ensure no services are present beneath the proposed exploratory borehole position.

Safe drilling practices such as bentonite seals and telescopic casing shall be employed to prevent cross contamination of aquifers.

Geotechnical laboratory testing for the determination of geotechnical design paraments will depend on materials encountered during the site investigation, but it is likely to consist of the testing listed below:

In-situ Testing:

- SPT at 1.5 to 3m intervals depending on material
- Dynamic Probing
- Hand shear vane (HSV) testing
- Soil infiltration tests

Laboratory Testing:

- Natural Moisture Content (NMC)
- Bulk Density
- MCVs
- Compaction Testing
- Organic matter
- Atterberg
- Grading
- 1D consolidation
- Shear Box
- Unconsolidated undrained triaxial
- Consolidated undrained triaxial with pore pressure measurement
- Uniaxial compression strength with moduli
- Point Load index
- Chemical Testing for buried concrete
- Peat Classification

Environmental Testing:

- Baseline Water Quality (Suites F1 and F2) testing
- Chemical testing (Suites E) if required
- Waste Acceptance Criteria testing (Suite H and I) if required

The quantity of testing shall be confirmed at a later stage and will depend on the type and number of samples recovered during the ground investigation and ground conditions observed/field screening completed during the site investigation process.

Chemical laboratory testing will provide an initial assessment on the types of contamination present along the alignment. Chemical laboratory testing will also be utilised to confirm concentrations of sulphates and acidity for aggressivity to buried concrete.

Selected soil and groundwater samples will be scheduled for chemical/environmental testing.

3.3 Sampling

The geotechnical sampling technique used during the site investigation will be governed by the type of soil encountered and the sample Quality Class for specific testing, as per BS 5930:2015 and EN ISO 22475-1:2006. Full details of the soil sampling techniques to be used will be finalised during the development of the Specification for Site Investigation.

3.4 In-Situ Testing

While recovery of high quality core samples is a site investigation priority, a number of standard penetration tests (SPT) will be carried out in the boreholes to establish SPT profiles. SPT 'N' value is the parameter traditionally used to assess strength profile with depth. Similarly, dynamic probing will be carried out at select locations. Where appropriate, hand shear vane testing will also be carried out in trial pits.

3.5 Instrumentation

Select exploratory holes will incorporate instrumentation. The groundwater equipment will typically comprise a traditional standpipe with a slotted section surrounded by a gravel filter pack and/or Casagrande type piezometers. Contaminated ground is not expected, however if it is encountered during the SI, ground gas monitoring instrumentation will be installed.

Monitoring of the instrumentation will commence during the fieldwork and continue for a minimum of 12 months at monthly intervals. Instrumentation monitoring will be undertaken by the SI contractor.

3.6 Requirements for Factual Report

The exploratory borehole records together with the results of the in-situ and laboratory testing will be presented in a factual report prepared by the SI contractor. To facilitate efficient processing and interpretation of the SI data, the SI contractor will provide the factual report in the Association of Geotechnical and Geo-environmental Specialists (AGS) digital format 4.0.1. The locations of the exploratory holes shall be recorded and presented in an As-Built drawing provided in both Auto CAD format (dwg) and portable document file format (PDF). The AGS and Auto CAD data shall be supplied when supplying preliminary logs and test results and when supplying the final factual report, corrected as necessary.

The contractor's Factual Report and test data will be presented in hard copy and additionally in PDF digital format (Indexed).

The contractor's factual report should include, but not limited to, the following:

- Details of the scheme and objectives of the investigation
- Reading of ground level in meters above ordnance datum (m AOD)
- Geological details of the strata encountered
- Fieldwork details including in-situ testing
- Laboratory test results
- Recorded groundwater level in exploratory holes
- Exploratory hole location plans (As-Built drawings)
- Photographic records of core sections and trial pits

SECTION 4: SITE WORKING AND RESTRICTIONS

4.1 Traffic Management

Traffic management is envisaged to be required on the N3, L3007 and L28245 to accommodate the proposed SI works. The traffic management measures will likely include lane closures however two way traffic is to be maintained at all times. The details of the required traffic management shall be discussed and agreed upon with Cavan County Council/Meath County Council and the chosen SI contractor.

4.2 Difficult Access

Several areas across the site have been identified as potentially difficult to access. These include areas in, or adjacent to:

- Soft ground areas (raised peat bog)
- Forest Plantations
- Third party land
- Buried utilities and overhead power lines
- Geological Heritage Sites / Cultural Heritage Sites

Access to the proposed exploratory hole locations will be reviewed during the site walk over survey and discussions held with the relevant stakeholders and subject matter before commencement of any site works.

Site clearance of some areas comprising forest plantations and highly vegetated areas is required to provide access for the SI contractor. Site clearance cannot commence until the 1st September 2022 due to restrictions outlined in Section 40 of the Wildlife Act 1976 (as amended by Section 46 of the Wildlife (Amendment) Act 2000), which restricts the cutting, grubbing, burning or destruction by other means of vegetation growing on cultivated land or in hedges or ditches during the nesting and breeding season for birds and wildlife, from 1 March to 31 August.

In areas of soft ground, bog mats will be required to allow the SI personnel and machinery to safely traverse across the ground and gain access to the proposed exploratory holes.

In other instances, temporary bridges (Bailey Bridges) will need to be erected to enable SI personnel and machinery to cross over ditches and minor steams / dykes.

4.3 Statutory Undertakers

Statutory Undertaker's service plans will be provided by CCC/BT to the SI contractor and their site investigation personnel prior to any intrusive works. Consideration will be given to positioning exploratory holes away from any known asset and observing any required clearance, as defined by the asset owner. A number of slit trenches will be excavated to provide positive identification of the Gas Transmission and Distributor lines and verify asset's locations and alignments are consistent with the current utility drawings.

The exploratory hole positions will be agreed on site by a BT representative following discussions with the SI contractor and upon confirmation of buried service locations. If a service exists in the locality of a proposed exploratory hole, it is to be expected that the service owner will impose a minimum safe working distance.

A number of proposed exploratory holes are located adjacent to medium voltage overhead power cables. As a result, the clearance between the overhead cables and the SI machinery and personnel will be maintained in accordance with the owner's requirements as set out in the site-specific Health and Safety documentation.

4.4 Flora and Fauna

An ecologist specialist will carry out Appropriate Assessment (AA) Screening for the proposed site investigation works. This process will identify if likely significant effects will arise on Natura 2000 sites from the proposed SI, as required by the Habitats Directive.

4.5 Designated Sites

Several designated sites have been identified in the PSSR. These include cultural heritage constraints such as Records of Monuments and Places (RMP) and Natural Inventory Architectural Heritage (NIAH)/National Monuments.

The proposed exploratory hole locations are to be assessed by the relevant archaeological specialists. Subject to the findings of this review, some of the proposed locations may be carried out under archaeological watching brief while others may have to be repositioned.

4.6 Geological Heritage Sites

As mentioned in Section 4.2.4 of the PSSR, the footprint of the geological heritage site at Bruse Hill is intersected on its outer western limits by the PO. Bruse Hill is described as an example of a 'crag and tail' ridge with the proposed road development potentially impacting on the 'crag' section of the western side of Bruse Hill.

The proposed exploratory hole locations are to be assessed by the relevant GSI specialists. Subject to the findings of this review, some of the proposed locations may be carried out under archaeological watching brief while others may have to be repositioned.

Following consultation, the GSI have requested that:

"Any development should try to enhance the significance and general awareness of this site. Raising awareness, strengthening their significance, and enhancing our scientific understanding of them can be done by allowing Geological Survey Ireland staff or representatives access to them during any development/construction type works, by providing signage/viewpoints/tourist information at the development site where possible."

SECTION 5: SPECIALIST CONSULTATION

As outlined in Section 4, due to the proximity of the proposed holes to existing assets, a number of stakeholders will need to be consulted in advance of carrying out the works.

These include, but are not limited to:

- Cavan County Council
- Meath County Council
- TII Archaeology
- Utility providers and Statutory Undertakers, including ESB and Gas Networks Ireland.
- Coillte – Forestry Plantations
- GSI – Geological Heritage Sites

SECTION 6: PROGRAMME, COST AND CONSTRACT ARRANGEMENTS

6.1 Programme

It is anticipated that the procurement period for the site investigation works could be in the order of fourteen weeks.

Subsequent to the contract award, the appointed site investigation contractor is likely to require up to four weeks mobilisation including preparing all the Health, Safety and Environmental management plans, site documentation (including traffic management plans etc.) and obtaining the relevant permits, licences (e.g. road openings).

The key activities following the appointment of the site investigation contractor will include:

Table 3: Site Investigation Programme

Activity	Duration
Mobilisation to site and completion of fieldworks	14 weeks (assuming 2 rigs)
Completion of laboratory testing and delivery of final Factual Report (includes review of the report before final issue)	6 weeks following completion of fieldwork

It should be noted that site clearance of areas comprising forest plantations and highly vegetated areas is required to provide access for the SI contractor to undertake the required exploratory holes. Site clearance cannot commence until the 1st September 2022 due to restrictions outlined in Section 40 of the Wildlife Act 1976 (as amended by Section 46 of the Wildlife (Amendment) Act 2000), which restricts the cutting, grubbing, burning or destruction by other means of vegetation growing on cultivated land or in hedges or ditches during the nesting and breeding season for birds and wildlife, from 1 March to 31 August. To accommodate this, it may be necessary to split the SI programme into two phases. The first phase, which comprises majority of the exploratory holes, may be commenced immediately. The second phase, comprising of exploratory holes located within forested areas, cannot be commenced until the site clearance has been undertaken. It is estimated that site clearance will take 2-3 weeks.

The timescales listed above do not include for any application periods for consents from the Statutory Bodies, local authorities or any affected parties. They also assume that the implementation of the traffic management (if required) and the access to the proposed positions will be relatively straightforward. BT will assist the PLO in engaging with the affected stakeholders and the site investigation works will only commence when the necessary consents have been granted.

6.2 Cost

Based on recent site investigation contracts, the proposed scope of ground investigation works outlined in Section 3 is estimated to cost in the order of €400,000 to €500,000 excluding VAT. Once the relevant tender documentation and bill of quantities have been prepared, a more thorough cost estimate will be prepared.

6.3 Contract Arrangements

The SI contract will be issued for tender online via E-Tenders by Cavan County Council.

SECTION 7: REPORTING

7.1 Factual Reporting

The site investigation contractor will produce a Factual report that complies with IS EN 1997-2 and the Site Investigation Specification document. Digital reporting is to be in AGS format and in portable document file format (PDF). The As-Built drawings are tb be provided in both Auto CAD format (dwg) and portable document file format (PDF)

7.2 Interpretive Reporting

Following completion of the site investigation and receipt of the final Factual Report, BT will prepare a Ground Investigation Report (GIR) in accordance with TII Publication (Standards) DN-ERW-03083 (October 2019) *Managing Geotechnical Risk* and meeting the requirements of *IS EN 1997-1.*