TECHNICAL NOTE 01

Project: Firlough Wind Farm & Hydrogen Plant – 110kV Grid / Interconnector		Ref:	rev-02
Section: Cable Rating Check		Job No:	05-806
		Date:	29.02.23
Made By: POS	Checked By: DB	Sheet No: 1	of 12

Instruction

Technical Lead: Damien Browne - TLI Group

Date of Writing: 29.02.2023

Scope of Note: Review of the 110kV grid / interconnector cable loading based on the proposed MEC for the project.

Documents & Data Issued for Review: n/a

Overview

TLI Group (the Consultant) were engaged by Jennings O'Donovan (the Client) who are working with Mercury Renewables ("the Developer") on the development of Firlough Wind Farm and Green Hydrogen in county Mayo. The Consultant was engaged to assist the Client in selecting and preparing a planning application for the 110kV grid connection for Firlough Wind Farm and Green Hydrogen interconnector. The Client is currently working on the development of the windfarm and the green hydrogen plant. The proposed Firlough Wind Farm substation will be connected via two 110kV UGC circuits to two tower structures that will intersect with the existing Moy - Glenree 110kV overhead line. The approximate UGC grid connection length is 6.7km.

This cable rating study was completed to assess the suitability of the proposed cable size and cable trench designs for the 110kV UGC grid connection circuit and the Green Hydrogen 110kV UGC grid connection which will be connecting into the proposed Firlough Wind Farm substation.

The cable ratings which have been completed as part of this study include:

- Standard Trefoil Double Circuit Trench Design (Loop In)
- Standard Trefoil Single Circuit Trench Design (Green Hydrogen)
- Parallel Trefoil Triple Circuit Trench Design
- Deep Undercrossing Triple Circuit Trefoil formation
- Existing Cable Crossings

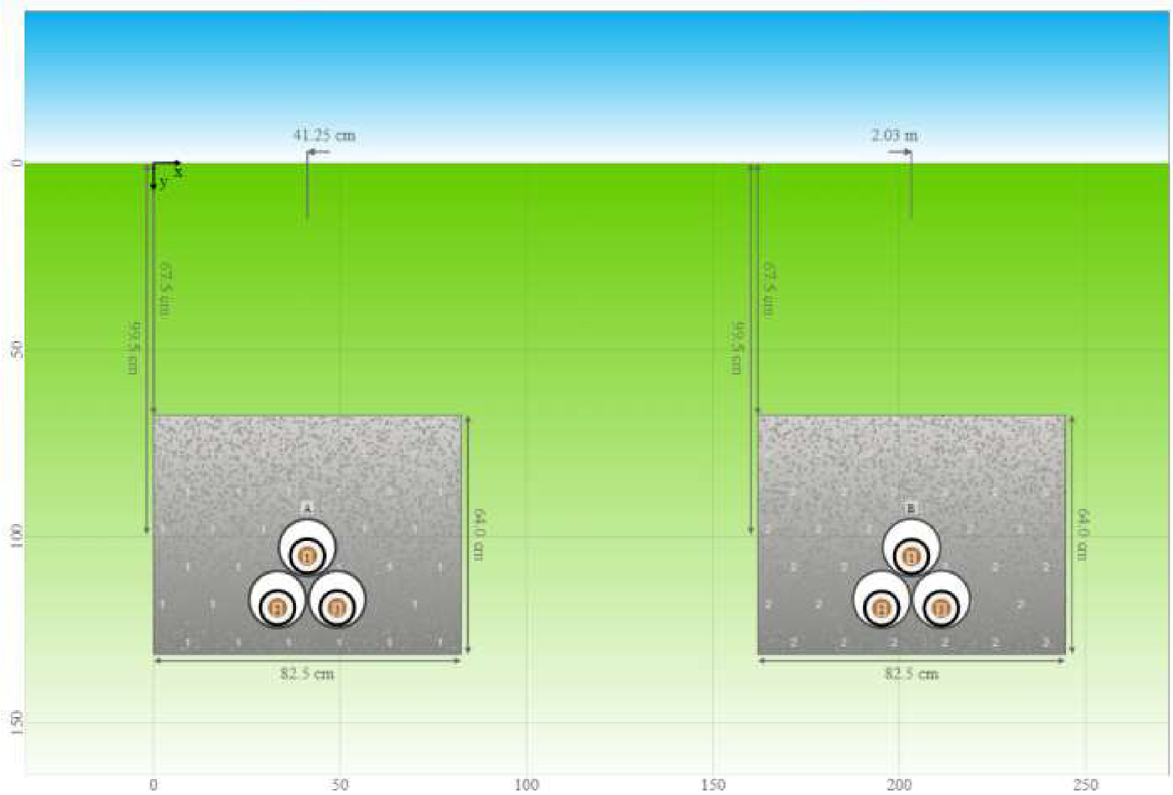
Cable Study Parameters	
Cable Size:	2500mm^2 Cu Cable (for Loop In)/ 1000mm^2 Al Cable (for Green Hydrogen)
Nominal Voltage:	110kV assumed *(Range 105kV to 120kV)*
Power:	Required 178MVA (Loop In) Required 78MW (Green Hydrogen)
Power Factor:	0.95 assumed *(Range 0.85 lag to 0.93 lead)*
Avg. Cable Section Length:	1000m *(trefoil)*
Cable Trench Design:	See Appendix A
Ambient Temp (Soil)	20˚C *(Summer rating)*
Soil Thermal Resistivity	1.2 K·m/W *(Summer rating)*
Backfill Thermal Resistivity	1 K·m/W *(Summer rating)*
Cable Screen Bonding:	Single Point Bonded
Power Duct Size:	200mm (for Loop In)/ 160mm (for Green Hydrogen)

Table 1 - Cable Study General Parameters

Cable Study Analysis

1600mm² Cu Cable - Double 110kV Trefoil Trench (Depth 950mm) Loop In Design (2442.5mm total trench width):

A cable rating study was completed for a **NKT 1600mm² Cu XLPE (110kV) UGC** over a distance of 1km using a **standard trefoil trench design in 160mm ducts** with a **separation of 1350mm** (duct to duct) between the circuits as detailed in Appendix A. Using this arrangement, the circuits are capable of carrying a maximum full load current of **1175.3A** (212.7MW) and **1178.9A** (213.3MW) respectively without exceeding the cables max insulative property of 90°C. Therefore, 1600mm² Cu XLPE (110kV) UGC when installed using the Double trefoil trench design is capable of achieving the required maximum full load (178MVA).



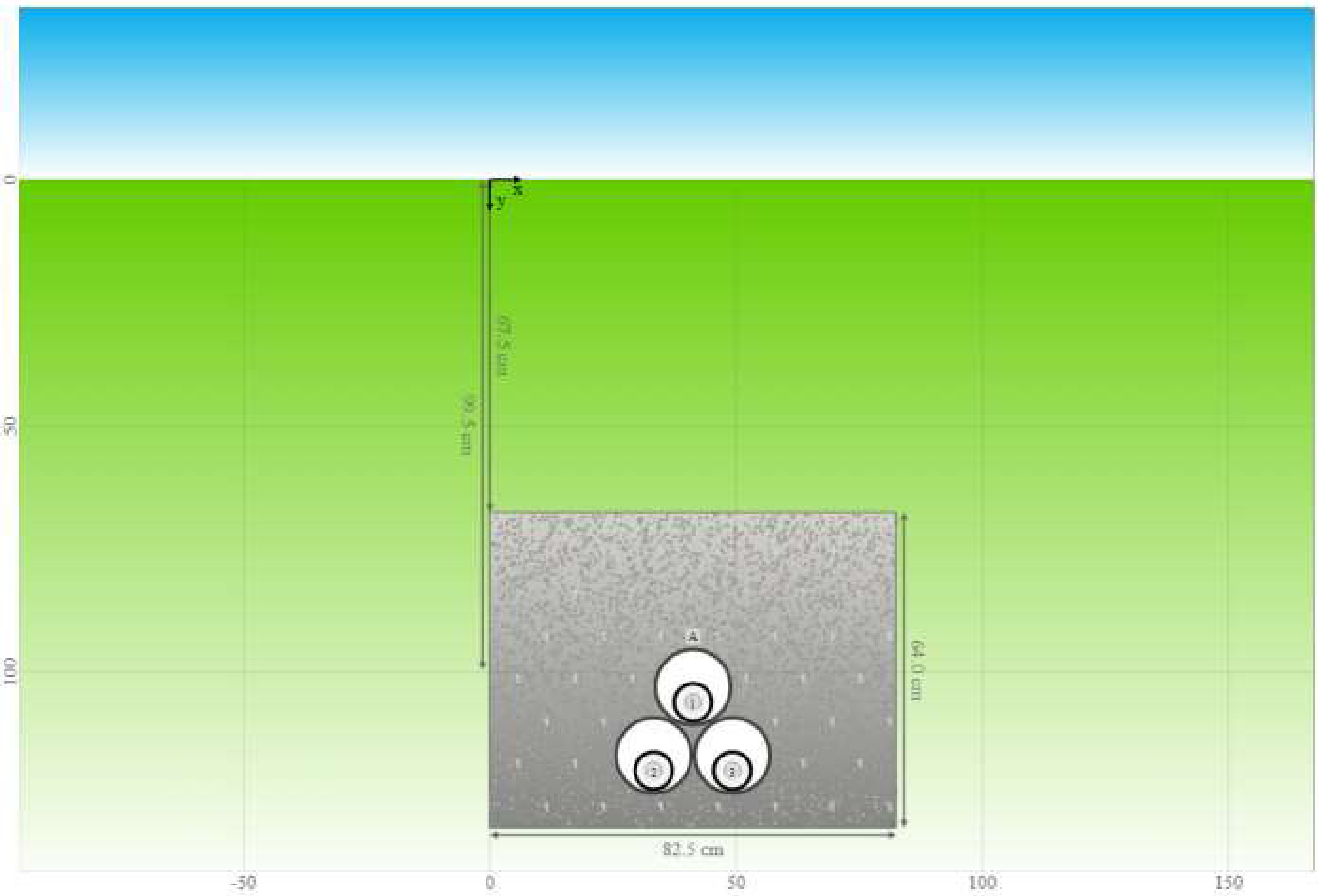
Following systems are active in the arrangement:

System	Object	Current I_c [A]	max Temp. θ_c | θ_e (θ_{de}) [°C]	Losses W_{sys} [W/m]
System A	NKT 1600mm2 Cu XLPE (110kV) [2019]	1175.3	90.0 | 81.1 (72.0)	84.6
System B	NKT 1600mm2 Cu XLPE (110kV) [2019]	1178.9	90.0 | 81.0 (72.2)	85.1

Figure 1 - Cable Rating Model, Double Trefoil Trench Loop In Design, 1600mm.sq Cu

1000mm² Al Cable - Single 110kV Trefoil Trench (Depth 950mm) Green Hydrogen Design (825mm total trench width):

A cable rating study was completed for a **NKT 1000mm² Al XLPE (110kV) UGC** over a distance of 1km using a **standard trefoil trench design in 160mm ducts** as detailed in Appendix B. Using this arrangement, the circuit is capable of carrying a maximum full load current of **854.4A** (154.6MW) without exceeding the cables max insulative property of 90°C. Therefore, 1000mm² Al XLPE (110kV) UGC when installed using the standard trefoil trench design is capable of achieving the required maximum full load of the Green hydrogen plant (78MW).



System	Object	Current I_c [A]	max Temp. θ_c | θ_e (θ_{de}) [°C]	Losses W_{sys} [W/m]
System A	NKT 1000mm2 Al XLPE (110kV) - Al Screen-1 (2019)	854.4	90.0 | 78.3 (66.9)	91.6

Figure 2 - Cable Rating Model, Single Trefoil Trench Green Hydrogen Design, 1000mm.sq Al

Firlough WF 110kV Trefoil Double Circuit parallel run Green Hydrogen 110kV Trefoil Formation Design (3462.5mm total trench width)*:*

A number of cable rating studies were completed for the parallel run of the proposed Firlough WF Double Circuit 110kV UGC ***(System A/B)*** running parallel with the proposed Green Hydrogen Single Circuit 110kV UGC ***(System C).*** A variation of separation distances were assessed between the 3 systems (Outer duct to duct) whilst implementing a trefoil formation trench arrangement throughout over a distance of 1000m, with the goal of achieving the required ratings within the smallest footprint.

System A/B (Loop In) would use **NKT 1600mm² CU XLPE (110kV) UGC** set to operate at **178MVA** (Eirgrid Summer Rating) while ***System C*** (Green Hydrogen) would use **NKT 1000mm² AL XLPE (110kV) UGC** set to operate at **78MW** (Green Hydrogen MEC)**.**

Having completed a number of studies, to fulfil the stated requirements when System A/B is traveling in parallel with System C a minimum separation of **1315mm** (Outer duct to duct) is required between **System A** and **System B** with a minimum separation of **825mm** (Outer duct to duct) required between **System B** and **System C**. From these studies the consultant believes that the overall width required to install these 3 systems should be less than 4000mm as seen in Figure *3* below.

System	Object	Current I_c [A]	max Temp. $\theta_c \mid \theta_e\ (\theta_{de})$ [°C]	Losses W_{sys} [W/m]
System A	NKT 1600mm2 Cu XLPE (110kV) [2019]	934.2	64.5 | 59.1 (53.0)	51.9
System B	NKT 1600mm2 Cu XLPE (110kV) [2019]	934.2	66.9 | 61.5 (55.6)	52.1
System C	NKT 1000mm2 Al XLPE (110kV) - Al Screen-1 (2019)	430.9	48.7 | 46.0 (42.6)	21.7

Figure 3 - Cable Rating Model, Parallel Trefoil Triple Circuit Trench 160mm duct Design

Firlough WF 110kV Trefoil Double Circuit parallel run Green Hydrogen 110kV Trefoil Formation Design (3222.5 mm total trench width)*:*

A further set of cable rating studies were completed for the parallel run of the proposed Firlough WF Double Circuit 110kV UGC ***(System A/B)*** running parallel with the proposed Green Hydrogen Single Circuit 110kV UGC ***(System C).*** Again a variation of separation distances were assessed between the 3 systems (Outer duct to duct) whilst implementing a trefoil formation trench arrangement throughout over a distance of 1000m, with the goal of achieving the required ratings within a further reduced overall footprint than previous.

System A/B (Loop In) would use **NKT 2500mm² CU XLPE (110kV) UGC** within **200mm** ducts set to operate at **178MVA** (EirGrid Summer Rating) while ***System C*** (Green Hydrogen) would use **NKT 1000mm² AL XLPE (110kV) UGC** within **160mm** ducts set to operate at **78MW** (Green Hydrogen MEC)**.**

Having completed the studies, to fulfil the stated requirements when System A/B is traveling in parallel with System C a minimum separation of **880mm** (Outer duct to duct) is required between **System A** and **System B** with a minimum separation of **880mm** (Outer duct to duct) required between **System B** and **System C**. From these studies the consultant believes that the overall width required to install these 3 systems should be less than 3250mm as seen in Figure *4* below.

System	Object	Current I_c [A]	max Temp. $\theta_c \mid \theta_e$ (θ_{de}) [°C]	Losses W_{sys} [W/m]
System A	NKT 2500mm2 Al XLPE (110kV) - Al Wire Scn -TDA3530	934.2	56.7 | 53.0 (48.1)	42.4
System B	NKT 2500mm2 Al XLPE (110kV) - Al Wire Scn -TDA3530	934.2	58.6 | 54.9 (50.0)	42.6
System C	NKT 1000mm2 Al XLPE (110kV) - Al Screen-1 (2019)	430.9	45.7 | 43.0 (39.9)	21.6

Figure 4 - Cable Rating Model, Parallel Trefoil Triple Circuit Trench 200mm/160mm Duct Design

Firlough WF 110kV Trefoil Double Circuit parallel run Green Hydrogen 110kV Trefoil Formation Deep Trench Undercrossing Design (2500 Depth) (3462.5mm total trench width):

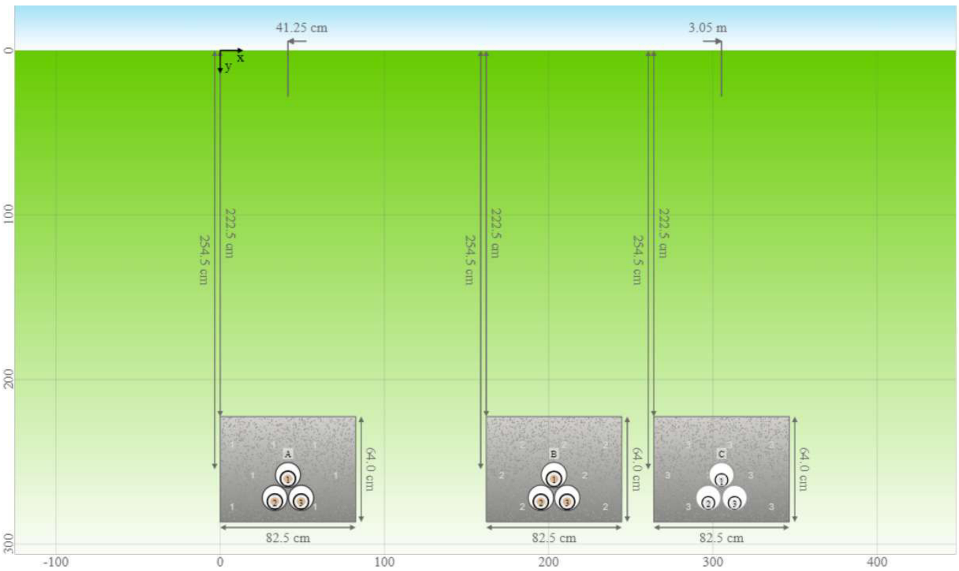
A number of cable rating studies were completed for the parallel run of the proposed Firlough WF Double Circuit 110kV UGC ***(System A/B)*** running parallel with the proposed Green Hydrogen Single Circuit 110kV UGC ***(System C)*** while utilizing a deep undercrossing installation method. This method may be utilized along the proposed UGC route where existing culverts or services may need to be crossed.

A variation of duct depths and separation distances were assessed as part of this set of studies to determine the maximum allowable depth which will allow the achievement of the required ratings whilst traveling within the smallest footprint.

System A/B (Loop In) would use **NKT 1600mm² Cu XLPE (110kV) UGC** set to operate at **178MVA** (EirGrid Summer Rating) while ***System C*** (Green Hydrogen) would use **NKT 1000mm² AL XLPE (110kV) UGC** set to operate at **78MW** (Green Hydrogen MEC)**.**

Having completed a number of studies, to fulfil the stated requirements when System A/B is traveling in parallel with System C the consultant believes that the ducts should not be buried at a depth greater than **2500mm** whist maintaining a minimum separation of **1350mm** (Outer duct to duct) between **System A** and **System B** with a minimum separation of **825mm** (Outer duct to duct) required between **System B** and **System C**.

These studies have shown that when the ducts are buried at a depth greater than 2500mm with the separations as stated above, the installed cables will exceed the cables max insulative property of 90°C.



System	Object	Current I_c [A]	max Temp. θ_c | θ_e (θ_{de}) [°C]	Losses W_{sys} [W/m]
System A	NKT 1600mm2 Cu XLPE (110kV) [2019]	934.2	83.9 | 78.3 (72.5)	53.4
System B	NKT 1600mm2 Cu XLPE (110kV) [2019]	934.2	87.5 | 81.9 (76.4)	53.7
System C	NKT 1000mm2 Al XLPE (110kV) - Al Screen-1 (2019)	430.9	67.1 | 64.3 (61.0)	22.8

Figure 5 - Cable Rating Model, Parallel Trefoil Triple Circuit Deep Trench Design

Firlough WF 110kV Trefoil Double Circuit parallel run Green Hydrogen 110kV Trefoil Formation Deep Trench Undercrossing Design (2500 Depth) (3222.5 mm total trench width):

Further cable rating studies were completed for the parallel run of the proposed Firlough WF Double Circuit 110kV UGC ***(System A/B)*** running parallel with the proposed Green Hydrogen Single Circuit 110kV UGC ***(System C)*** while utilizing a deep undercrossing installation method. This method may be utilized along the proposed UGC route where existing culverts or services may need to be crossed.

A variation of duct depths and separation distances were assessed as part of this set of studies to determine the maximum allowable depth which will allow the achievement of the required ratings whilst traveling within the smallest footprint.

System A/B (Loop In) would use **NKT 2500mm² Al XLPE (110kV) UGC** within **200mm** ducts set to operate at **178MVA** (Eirgrid Summer Rating) while ***System C*** (Green Hydrogen) would use **NKT 1000mm² AL XLPE (110kV) UGC** within **160mm** ducts set to operate at **78MW** (Green Hydrogen MEC)**.**

Having completed a number of studies, to fulfil the stated requirements when System A/B is traveling in parallel with System C the consultant believes that the ducts should not be buried at a depth greater than **2500mm** whist maintaining a minimum separation of **825mm** (Outer duct to duct) between **System A** and **System B** with a minimum separation of **825mm** (Outer duct to duct) required between **System B** and **System C**.

These studies have shown that when the ducts are buried at a depth greater than 2500mm with the separations as stated above, the installed cables will exceed the cables max insulative property of 90°C.

System	Object	Current I_c [A]	max Temp. θ_c | θ_e (θ_{de}) [°C]	Losses W_{sys} [W/m]
System A	NKT 2500mm2 Al XLPE (110kV) - Al Wire Scn -TDA3530	934.2	74.1 | 70.2 (65.4)	44.3
System B	NKT 2500mm2 Al XLPE (110kV) - Al Wire Scn -TDA3530	934.2	76.9 | 73.0 (68.2)	44.6
System C	NKT 1000mm2 Al XLPE (110kV) - Al Screen-1 (2019)	430.9	61.7 | 58.9 (55.9)	22.5

Figure 6 - Cable Rating Model, Parallel Trefoil Triple Circuit Deep Trench 200mm/160mm Duct Design

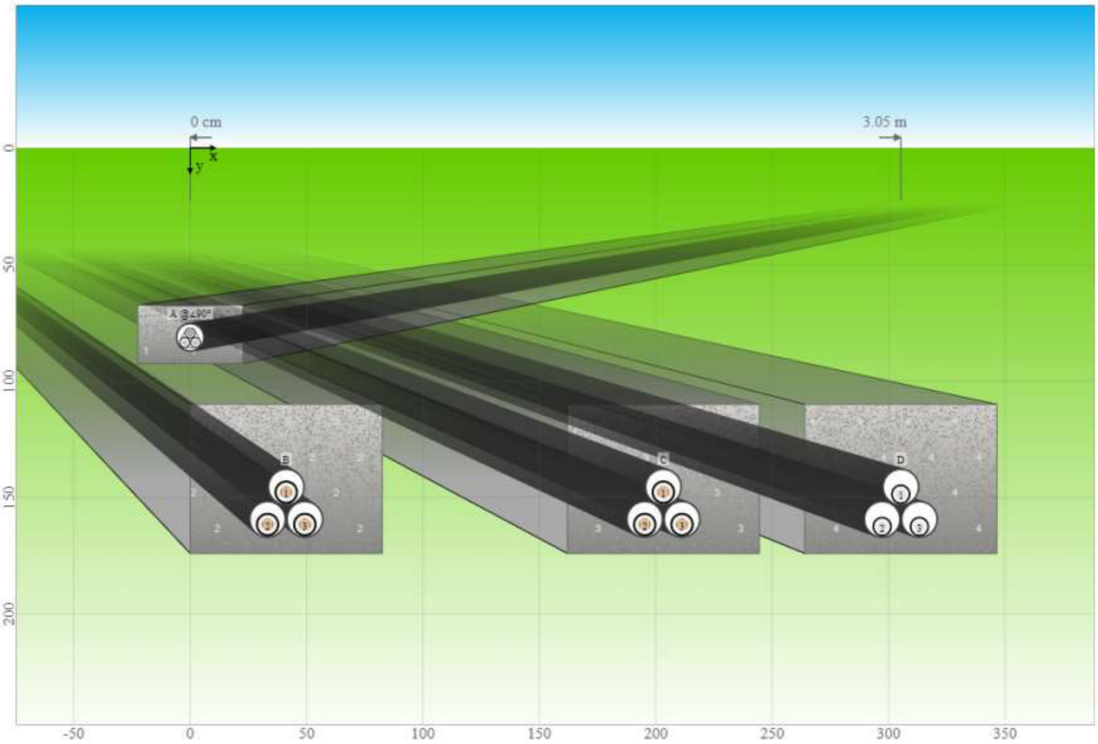
Firlough WF 110kV Trefoil Double Circuit parallel run Green Hydrogen 110kV Trefoil Formation Deep Trench Undercrossing Blacklough WF 20kV UGC Design (2500 Depth) (3462.5mm total trench width):

The Firlough WF UGC and the Green Hydrogen UGC will encounter the existing Blacklough Wind Farm 20kV UGC along the route. The Blacklough WF cable must be undercrossed by the proposed 110kV cables. The following set of studies demonstrate the effect of derating the 4 circuits will have upon each other at varying separation distances. A standard 20kV trench design has been assumed for the Blacklough WF 20kV UGC with 750mm top of duct cover utilised.

A series of cable rating studies were completed for the proposed undercrossing of the Blacklough WF 20kV UGC ***(System A)*** assumed **NKT 400mm² Al XLPE (24kV) UGC.** The proposed Firlough WF Double Circuit 110kV UGC ***(System B/C)*** (Loop In) would use **NKT 1600mm² Cu XLPE (110kV) UGC** set to operate at **178MVA** (Eirgrid Summer Rating) while running parallel with the proposed Green Hydrogen Single Circuit 110kV UGC ***(System D)*** would use **NKT 1000mm² AL XLPE (110kV) UGC** set to operate at **78MW** (Green Hydrogen MEC)***.***

The first study utilised a vertical duct to duct spacing of 500mm between the system A on top and systems B/C/D crossing beneath as seen in figure 5 below. This study showed that the systems could pass beneath without being derated while System A is capable of carrying a maximum full load current of **369.9A** (12.1MW) without exceeding the cables max insulative property of 90°C.

Increasing the separation distance between system A on top and systems B/C/D crossing beneath allows for system A to have an increase of the maximum full load current the cable is capable of carrying without exceeding the cables max insulative property of 90°C.



Following systems are going straight:

System	Object	Current I_c [A]	max Temp. θ_c | θ_e (θ_{de}) [°C]	Losses W_{sys} [W/m]
System B	NKT 1600mm2 Cu XLPE (110kV) [2019]	934.2	76.5 | 71.1 (65.1)	52.8
System C	NKT 1600mm2 Cu XLPE (110kV) [2019]	934.2	79.7 | 74.2 (68.3)	53.1
System D	NKT 1000mm2 Al XLPE (110kV) - Al Screen-1 (2019)	430.9	61.5 | 58.8 (55.7)	22.5

Following systems are crossing with an angle of 90 degrees:

System	Object	Current I_c [A]	max Temp. θ_c | θ_e (θ_{de}) [°C]	Losses W_{sys} [W/m]
System A	NKT 400mm2 Al XLPE (24kV)	1x 369.9	90.0 | 82.4 (59.3)	48.4

Figure 7 - Cable Rating Model, Parallel Trefoil Triple Circuit Deep Undercrossing Blacklough WF 20kV UGC Trench Design

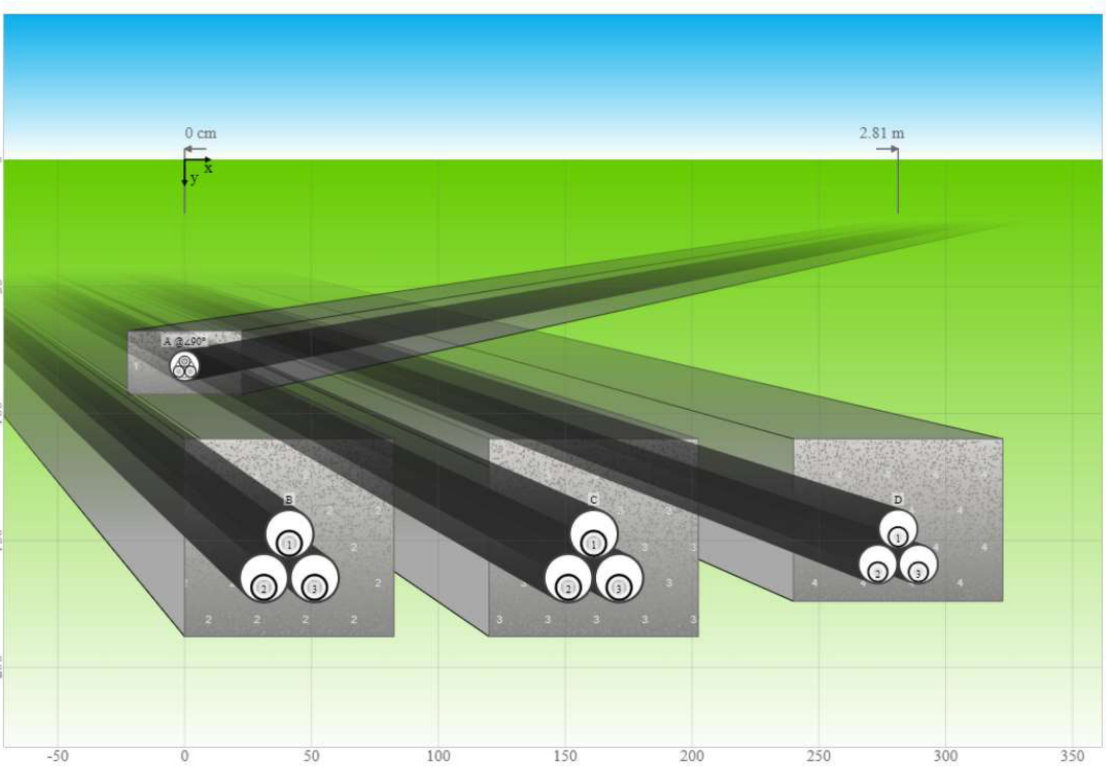
Firlough WF 110kV Trefoil Double Circuit parallel run Green Hydrogen 110kV Trefoil Formation Deep Trench Undercrossing Blacklough WF 20kV UGC Design (2500 Depth) (3222.5 mm total trench width):

The Firlough WF UGC and the Green Hydrogen UGC will encounter the existing Blacklough Wind Farm 20kV UGC along the route. The Blacklough WF cable must be undercrossed by the proposed 110kV cables. The following set of studies demonstrate the effect of derating the 4 circuits will have upon each other at varying separation distances. A standard 20kV trench design has been assumed for the Blacklough WF 20kV UGC with 750mm top of duct cover utilised.

A number of cable rating studies were completed for the proposed undercrossing of the Blacklough WF 20kV UGC ***(System A)*** assumed **NKT 400mm² Al XLPE (24kV) UGC.** The proposed Firlough WF Double Circuit 110kV UGC ***(System B/C)*** (Loop In) would use **NKT 2500mm² Al XLPE (110kV) UGC** within **200mm** ducts set to operate at **178MVA** (Eirgrid Summer Rating) while running parallel with the proposed Green Hydrogen Single Circuit 110kV UGC ***(System D)*** would use **NKT 1000mm² AL XLPE (110kV) UGC** within **160mm** ducts set to operate at **78MW** (Green Hydrogen MEC)**.**

The first study utilised a vertical duct to duct spacing of 500mm between the system A on top and systems B/C/D crossing beneath as *seen in Figure 8 below*. This study showed that the systems could pass beneath without being derated while System A is capable of carrying a maximum full load current of **381.5A** (12.5MW) without exceeding the cables max insulative property of 90°C.

Increasing the separation distance between system A on top and systems B/C/D crossing beneath allows for system A to have an increase of the maximum full load current the cable is capable of carrying without exceeding the cables max insulative property of 90°C.



System	Object	Current I_c [A]	max Temp. θ_c | θ_e (θ_{de}) [°C]	Losses W_{sys} [W/m]
System B	NKT 2500mm2 Al XLPE (110kV) - Al Wire Scn -TDA3530	934.2	68.7 | 64.9 (60.1)	43.7
System C	NKT 2500mm2 Al XLPE (110kV) - Al Wire Scn -TDA3530	934.2	71.0 | 67.2 (62.4)	44.0
System D	NKT 1000mm2 Al XLPE (110kV) - Al Screen-1 (2019)	430.9	58.5 | 55.7 (52.6)	22.3

Following systems are crossing with an angle of 90 degrees:

System	Object	Current I_c [A]	max Temp. θ_c | θ_e (θ_{de}) [°C]	Losses W_{sys} [W/m]
System A	NKT 400mm2 Al XLPE (24kV)	1x 381.5	90.0 | 82.4 (59.3)	51.5

Figure 8 - Cable Rating Model, Parallel Trefoil Triple Circuit Deep Undercrossing Blacklough WF 20kV UGC Trench 200mm/160mm Duct Design

Cable Study Results Summary

The Cable Rating Study Checks completed have indicated that it should be possible to carry the maximum export capacity of the Loop In cable at ***178MVA*** on a standard 110kV double circuit with **1600mm^2 Cu cable** for the duration of the grid connection without exceeding the proposed recommended maximum conductor temperature of 90˚C when using the proposed trench designs, with the exception of traveling parallel with other 110kV circuits.

Where it will be necessary for the Loop In circuit to run in parallel with the Green Hydrogen 110kV UGC circuit, It will be necessary to install **1000mm^2 Al cable** within the Green hydrogen circuit while maintaining a minimum separation of 880mm (Outer duct to duct) to the Loop In circuit. It will also be necessary for the Loop In circuit to install **2500mm^2 Al cable** within both its circuits when travelling in parallel with the Green Hydrogen 110kV UGC circuit while maintaining a minimum separation of 880mm (Outer duct to duct) to the Green Hydrogen circuit.

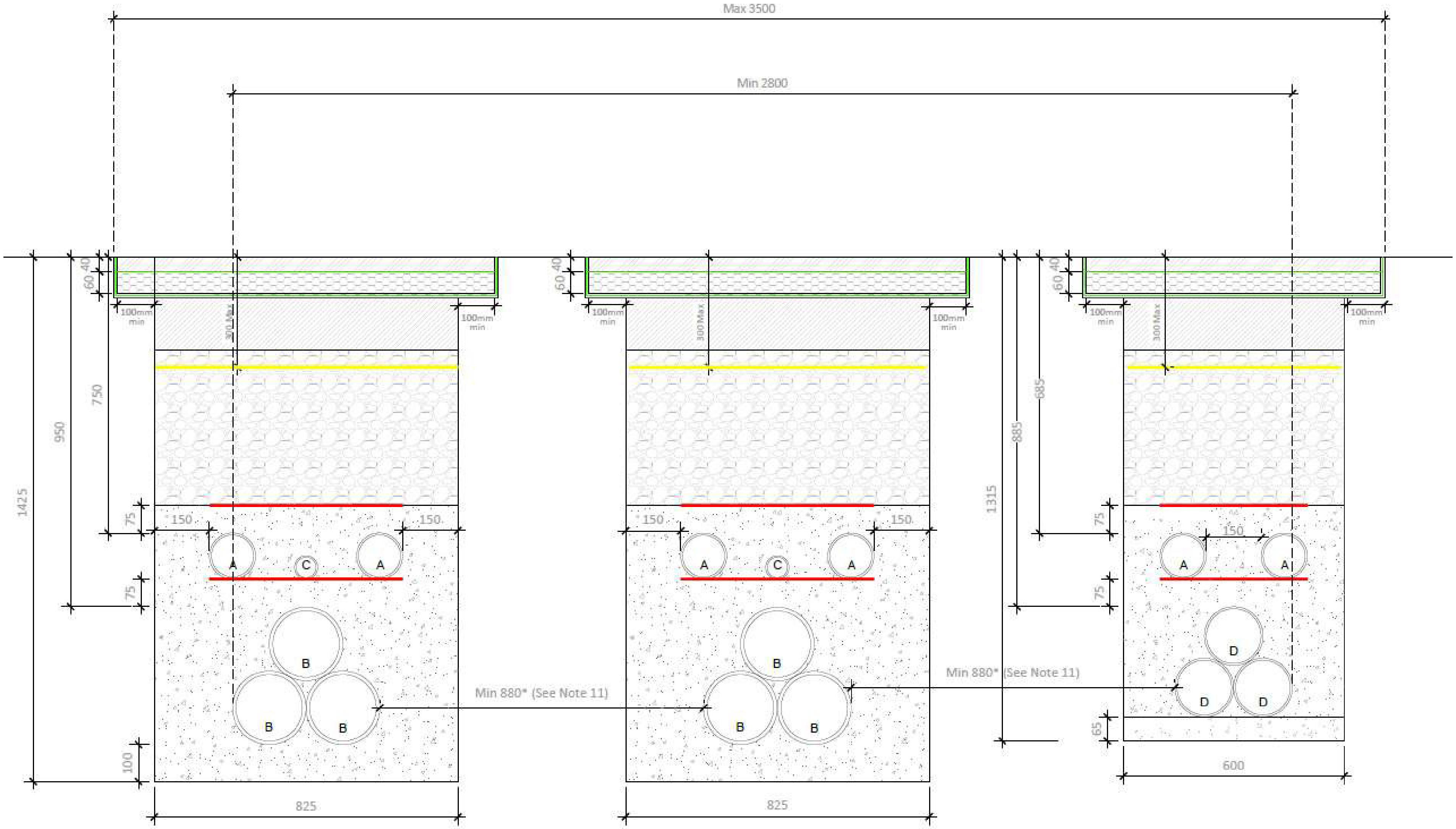
The results from the Blacklough WF cable crossing study also indicate that the use of 2500mm^2 Al cable for the Firlough WF Loop In circuits within these crossings will be required to sufficiently carry the maximum rating of 178MVA when undercrossing the existing circuit in trefoil formation with a minimum of separation of 880mm (Outer duct to duct). The studies have also shown that the use of 1000mm^2 Al cable for the Green Hydrogen UGC circuit within these crossings will be required to sufficiently carry the maximum rating of 78MW when undercrossing the existing circuit in trefoil formation with a minimum of separation of 880mm (Outer duct to duct) to the Loop In circuits.

The max trench width for the Firlough WF 110kV UGC Loop in circuits and the Green Hydrogen 110kV UGC circuit is **3222.5 mm.** This trench width utilises a separation distance of 880mm (Outer duct to duct) between the loop in circuits and between the loop in circuits and the Green Hydrogen circuits. This separation distance will minimise the derating between the three circuits due to mutual heating. Should there be a need to reduce this separation distance at any point in the route it may result in a derating on the cables, this should be accounted in any future calculations.

It should be noted that any additional crossings or parallel runs with other underground cable MV/HV circuits or other services may result in a derating of the Firlough Wind Farm and Green Hydrogen Grid Connection Cables. This derating effect will further decrease the available loading capacity of the cable.

All results at this stage are indicative only, further analysis will be required at the detailed design phase in order to accurately calculate the final loading on the cables.

Appendix A – Triple Circuit 110kV Trench Trefoil Design (200mm & 160mm Ducts)

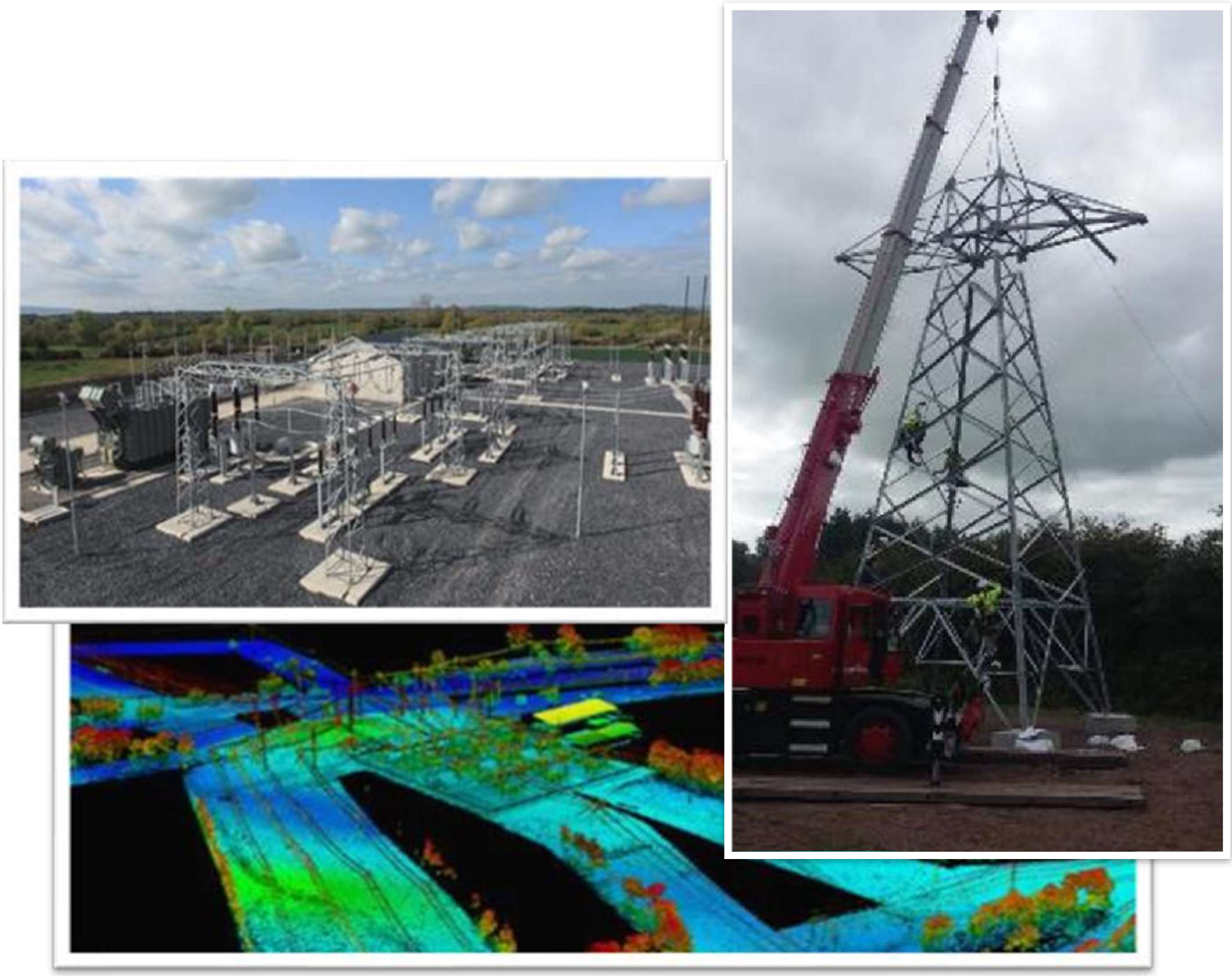


A = 125mm: Outer Diameter HDPE ESB Approved Duct, SDR=17.6
B = 200mm: Outer Diameter HDPE ESB Approved Duct, SDR= 21
C = 63mm: ECC Earth Continuity Conductor

A = 125mm: Outer Diameter HDPE ESB Approved Duct, SDR=17.6
D= 160mm : Outer Diameter HDPE ESB Approved Duct, SDR= 21

Outline Construction Methodology –

Firlough Wind Farm and Hydrogen Plant - Grid Connection and Interconnector



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Client: Jennings O'Donovan

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01	POS	DB	17.06.22	Issued For Planning
02	POS	DB	22.12.22	Issued For Planning
03	JVDP	DB	01.02.23	Issued For Planning
04	JVDP	DB	16.02.23	Issued For Planning
05	JVDP	DB	05.05.23	Issued For Planning
06	*DB*	*RG*	*21.06.23*	*Revised owing to Planning boundary*

Table of Contents

1.0 Introduction.......5

2.0 Proposed Firlough Wind Farm 110kV Underground Cable Route.......5

3.0 Proposed 110kV Hydrogen Plant Interconnector.......10

4.0 Proposed EirGrid Substations.......13

4.1 EirGrid 110kV AIS 8 Bay (Loop In Substation).......13

4.2 110kV Hydrogen Substation.......15

5.0 UGC Construction Methodology.......18

5.1 Trenching Methodology.......18

5.2 Ducting Installation Methodology.......19

5.3 Managing Excess Material from trench.......21

5.4 Storage of Plant and Machinery.......21

5.5 Horizontal Direction Drilling (HDD).......21

5.6 Joint Bays and Associated Chambers.......22

5.7 Joint Bay Construction and Cable Installation.......23

6.0 Loop-In Interface Mast Design Location.......27

6.1 Existing 110kV OHL.......27

6.2 Loop-In Interface Mast Design.......27

7.0 Substation Construction.......30

8.0 Best Practice Design and Construction & Environmental Management Methodology.......31

9.0 Traffic Management.......33

10.0 New Permanent Access Roads – within the Wind Farm.......33

10.1 Excavated Road Construction Methodology.......33

11.0 Reinstatement of Private Land.......34

12.0 Implementation of Environmental Protection Measures.......34

13.0 Invasive Species Best Practice Measures.......35

14.0 Waste Management.......35

15.0 Construction Hours.......35

Table of Figures

Figure 1: Site Location Map....6
Figure 2: Hydrogen Plant UGC Site Location Map....10
Figure 3: Proposed 110kV AIS Loop In Station Layout....15
Figure 4: Proposed 110kV Hydrogen Substation Layout....17
Figure 5: Double 110kV Underground Duct Installation....19
Figure 6: Typical Trench for two circuits within roadway sections....21
Figure 7: Typical HDD Installation....22
Figure 8: 110kV Joint Bay Plan Layout....23
Figure 9: Typical joint bay under construction (in-situ)....24
Figure 10: Completed joint bay prior to cable installation (in-situ)....24
Figure 11: Typical joint bay under construction (pre-cast)....24
Figure 12: HV cable pulling procedure (Typical drum set-up)....25
Figure 13: HV cable jointing container....25
Figure 14: New Interface Mast Foundation....28
Figure 15: 110kV Interface Mast foundation complete....28
Figure 16: Base of Interface Mast structure backfilled....29
Figure 17: Completed Line/Cable Interface Mast....30
Figure 18: Typical Windfarm Access Road....34

1.0 Introduction

The location of the proposed loop-in grid connection point on the Moy - Glenree 110kV is within the townland of Bunnyconnellan in northwest Co Mayo. The proposed 110kV substation location and Loop-in towers are shown in Figure 1 below.

The grid connection will consist entirely of underground cabling (UGC). Firlough Wind Farm substation will be connected via two 110kV UGC circuits to two tower structures that will intersect with the existing Moy - Glenree 110kV overhead line.

Firlough Wind Farm substation will be connected to the 110kV Hydrogen Plant substation via an additional 110kV UGC interconnector circuit. The UGC works will consist of the installation of ducts in three excavated trenches. The trenches will accommodate power cables enclosed within HDPE ducts with a minimum separation distance of 880mm between power circuits. Fibre communications cable will also be installed to allow communication between Firlough Wind Farm, Hydrogen Plant 110kV Substation, Moy 110kV Substation and Glenree 110kV Substation.

This document is intended to be used as an aid to understand the methodologies to be employed during construction and should be read in conjunction with all other specialist reports which accompany the planning application. Also, this document is in outline form only and will be revised and updated before the commencement of any construction activities. Detailed method statements will be prepared in respect of each aspect of the proposed development.

2.0 Proposed Firlough Wind Farm 110kV Underground Cable Route

The proposed UGC route is approximately 6.7km in length and runs in a north easterly direction from the existing 110kV overhead line to the proposed Firlough Wind Farm substation location utilizing private lands, public local road networks, existing access tracks and private forestry access tracks.

The exact location of the UGC within the proposed site boundary is subject to minor modification following a further detailed assessment to be undertaken prior to construction and following consultation with Mayo County Council and all other relevant stakeholders, having regard to all environmental protection measures outlined in the planning application and accompanying technical reports.

Below (Figure 1) which outlines the proposed UGC route, with each section of the route being formulated in detail within Table 1.

This proposed grid connection route is shown as an Overall Site Layout Map in Drawing No. 05806-DR-200-P03.

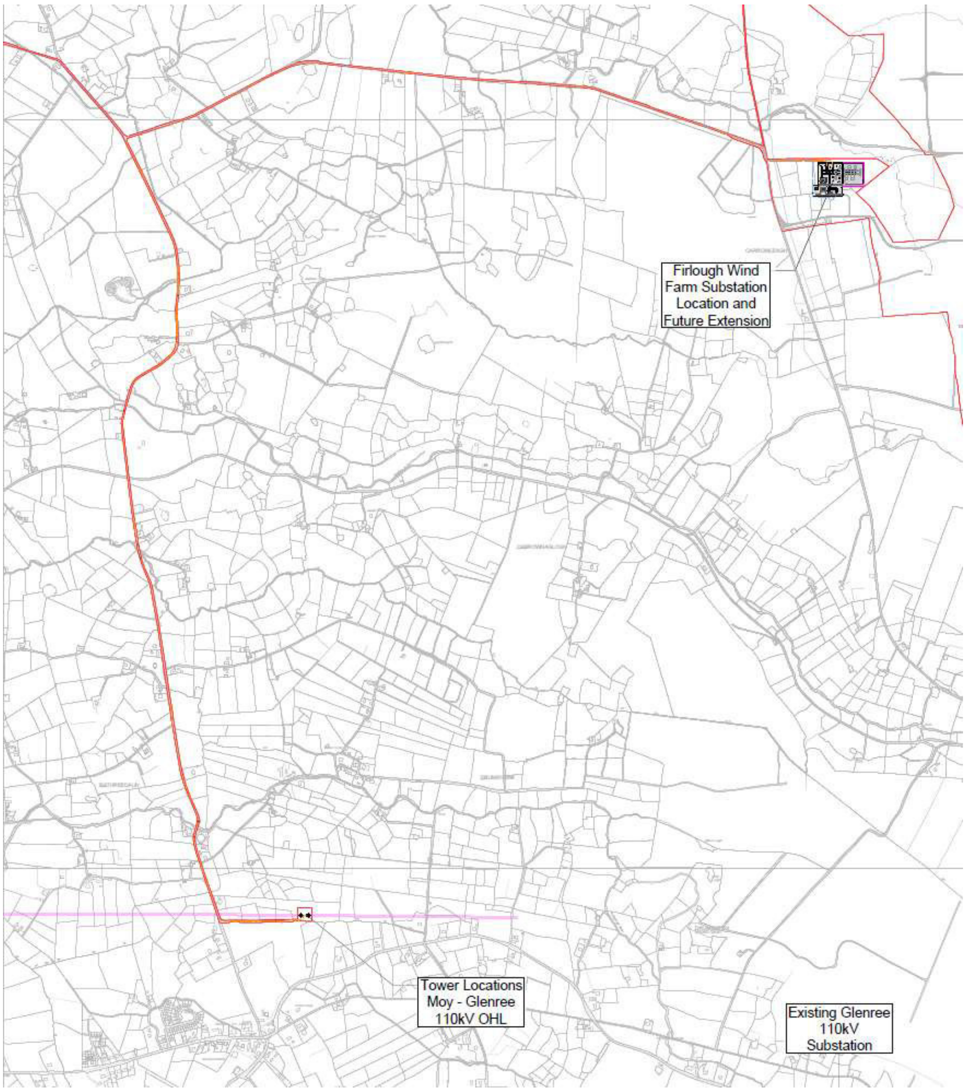

Figure 1: Site Location Map

Table 1 of this report summaries the route location features of the underground cable connection and proposed route.

Table 1 – Approximate Route Location of Preliminary Design:		
Wind Farm Site/Forestry Roads (UGC)	**Public Roads (UGC)**	**Private Land (UGC)**
250m	6040m	355m

Table 1: Firlough Wind Farm Substation to 110kV OHL – UGC Route Location Summary

Table 2 below separates the UGC route into a number of sections and describes the specific construction requirements of each individual section and identifies access routes to the work areas. All plant and equipment employed on the proposed works will be subject to good site organisation and hygiene, particularly during construction activities.

Table 2 - Summary of Preliminary Grid Connection Design Route	
Section	**Description**
Section 1 UGC	**UGC from OHL Tie In location, traversing L-1102 (Chainage 3000m)** The underground cable routes initially begin within the vicinity of the Tie In towers beneath the existing Moy to Glenree OHL in the townland of Rathreedane, north of Bunnyconnellan catchment. The UGC route traverses in a westerly direction along a permanent access track before converging onto the local road network (L-1102-0). Whilst converging on the local road network, the UGC circuits will encounter existing Eir services and water utilities, some of these serving Bunnyconnellan Wastewater Pump station (WWPS). The UGC's continue northwards for approximately 385m before encountering the first drill crossing beneath the Srafaungal River. The bridge in situ has insufficient deck coverage to accommodate ducting for the cables and a Horizontal Directional Drill (HDD) method is required to navigate the watercourse. Subsequent to cross the Srafaungal River, the UGC's carry with relatively flat, straight carriageway for an additional 1140m, at the point of encountering a second bridge crossing across the Fiddaun Stream at chainage 1850m. Again, consistent with the previous bridge crossing, this second bridge in situ has insufficient deck coverage also to accommodate ducting for the cables and a drilling method is required to navigate the Fiddaun watercourse. The UGC routes continue northwards for 600m, carrying through a cross roads junction at 2125m before approaching the Glenree stream crossing at 2425m. Again, from survey investigation works carried out on this over arching structure, insufficient deck cover exists, and the mobilisation of an HDD would be required to allow the UGC navigate beneath the stream. Continuing with the L-1102-0, the UGC carries for an additional 585m which brings the circuits into the townland of Carha. At chainage 3000m, the UGC's will encounter a further watercourse crossing. ***Features*** Section 1 contains 8 no. joint bays (allocated between the two Firlough WF circuits). Joint bays will be located below ground and finished/reinstated to the local authority's satisfaction and as per the Purple book road reinstatements specification. Joint bays will have associated communication chambers and link boxes which will have a surface access hatch which will match existing ground levels. • Joint Bay 01A (JB-01A) will be located approx. 470m west of the Loop In (Tie In) tower locations. The joint bay will be installed within a widened verge with the emergences of a local secondary converging onto the L-1102-0. *[Chainage – 500m]* • Joint Bay 01B (JB-01B) will be located approx. 80m north of JB-01A within the L-1102-0. The joint bay will be installed within local roads network. *[Chainage – 580m]* • Joint Bay 02B (JB-02B) will be located approx. 625m north of JB-02A positioning the joint bay within local road network with considerable grass verges at either side of the carriageway. *[Chainage – 1150m]*

	• Joint Bay 02A (JB-02A) will be located approx. 40m north of JB-02B, again within a generous section of widened roadway. *[Chainage – 1190m]* • Joint Bay 03B (JB-03B) will be located approx. 700m north of JB-02A. The location of the Joint Bay will be in the middle of the roadway. *[Chainage – 1930m]* • Joint Bay 03A (JB-03A) will be located approx. 22m north of JB-03B within the road network, located within a road shoulder with an agricultural gated entrance. *[Chainage – 1950m]* • Joint Bay 04B (JB-04B) will be located approx. 760m north east of JB-03A. *[Chainage – 2720m]* • Joint Bay 04A (JB-04A) will be located approx. 22m north east of JB-04B within the road network, located within a road shoulder of the L1102-30. *[Chainage – 2745m]* Section 1 contains 3 HDD which is required to cross under existing watercourses, all of which will be completed within local roads network. Boreholes will be required at these locations to determine the composition of the ground to establish drilling durations at each works area. Section 1 has 1 No. culvert crossings: • Culvert 1 is a 200mm concrete pipe culvert which will be crossed using an overcrossing method.
Section 2 UGC	**Loughnagore Stream Crossing, traversing L-1102-30, L-5136-0, L-5137-9 and on toward Firlough Wind farm Substation (Chainage 3700m)** The underground cable encounters a fourth bridge crossing across the Loughnagore watercourse. This bridge in situ has insufficient deck coverage to accommodate ducting for the cables and a Horizontal Directional Drill (HDD) method is required to navigate the watercourse open the road corridor. Subsequent to crossing the Loughnagore stream, the UGC's continue north westerly for 600m for the remainder of the L-1102-30 before converging onto a local secondary roadway L-5136-0 at chainage 3625m to traverse eastwards through the townland of Glenree. Water services within the junction prior to access the local secondary. The UGC routes carry within this carriageway for an additional 2720m before approaching the L-5136-0 roadway. On converging onto the L5137-9, the UG cables will be required to cross beneath existing ESBN cables and furthermore existing water utilities. The circuits navigate these crossings and access lands via a disused access track to be upgraded as a permanent roadway to allow entrance into the Wind farm at Carrowleagh townland. The UGC routes continue for the remaining 250m before reaching the location of the Firlough Wind farm Loop In Substation. ***Features*** Section 2 contains 8 no. joint bays (allocated between the two Firlough WF circuits). Joint bays will be located below ground and finished/reinstated to the local authority's satisfaction and as per the Purple book road reinstatements specification. Joint bays will have associated communication chambers and link boxes which will have a surface access hatch which will match existing ground levels. • Joint Bay 05B (JB-05B) will be located approximately 430m north of the Loughnagore Stream crossing. *[Chainage – 3480m]*

	• Joint Bay 05A (JB-05A) will be located approx. 40m north of JB-05B within the L-1102-30. The joint bay will be installed within the verge way of the local road network. *[Chainage – 3520m]* • Joint Bay 06B (JB-06B) will be located approximately 787m east of JB-05B within the Kilbride local secondary roadway *[Chainage – 4275m]* • Joint Bay 06A (JB-06A) will be located approximately 786m east of JB-05A within the Kilbride local secondary roadway *L-5136-0* *[Chainage – 4300m]* • Joint Bay 07B (JB-07B) will be located approximately 788m east of JB-06B within the Kilbride local secondary roadway *L-5136-0* *[Chainage – 5060m]* • Joint Bay 07A (JB-07A) will be located approximately 785m east of JB-06A within the Kilbride local secondary roadway *L-5136-0* *[Chainage – 5090m]* • Joint Bay 08B (JB-08B) will be located approximately 785m east of JB-07B within the Kilbride local secondary roadway *L-5136-0* *[Chainage – 5900m]* • Joint Bay 08A (JB-08A) will be located approximately 785m east of JB-07A within the Kilbride local secondary roadway *L-5136-0* *[Chainage – 5925m]* Section 2 contains 1 HDD which is required to cross under existing watercourse, this can be completed within local road network. Boreholes will be required at this location to determine the composition of the ground to establish drilling durations at this work site. Section 2 has 3 No. culvert crossings: • Culvert 2 is a 200mm concrete pipe culvert which will be crossed using an undercrossing method. • Culvert 3 is a 200mm concrete pipe culvert which will be crossed using an undercrossing method. • A new Twin wall culvert to be installed with access road to allow for overcrossing method.
Refer to Figure 1 and to the planning drawings submitted for location details. Note: The precise location of the proposed route within the planning application boundary is subject to change as result of existing services/utility locations, ground conditions and any environmental constraints.	

3.0 Proposed 110kV Hydrogen Plant Interconnector

The project's scope also proposes a 110kV Cable Network, interlinking the Hydrogen Plant substation and the Firlough Wind Farm substation. The proposed UGC connection is discussed in detail below, utilizing the same methodology as section **2.0 Proposed Firlough Wind Farm 110kV Underground Cable Route.**

The proposed UGC route is approximately 8.2km in length and runs in a westerly direction from the proposed Windfarm substation to the Hydrogen Plant substation location, utilising local road networks, existing access tracks and private access tracks.

The exact location of the UGC within the proposed site boundary is subject to minor modification following a further detailed assessment to be undertaken prior to construction and following consultation with Mayo County Council and all other relevant stakeholders, having regard to all environmental protection measures outlined in the planning application and accompanying technical reports.

Below **(Figure 2)** which outlines the proposed Hydrogen Plant interconnector route, with each section of the route being formulated in detail within Table 2.

This proposed grid connection route is shown as an Overall Site Layout Map in Drawing No. 05806-DR-200-P03.

Figure 2: Hydrogen Plant UGC Site Location Map

Table 3 of this report summaries the route location features of the underground cable connection and proposed route.

Table 3 – Approximate Route Location of Preliminary Design:		
Wind Farm Site/Forestry Roads (UGC)	**Public Roads (UGC)**	**Private Land (UGC)**
435m	6690m	1050m

Table 3: Hydrogen Plant Substation to Firlough Wind Farm Substation – UGC Route Location Summary

Table 4 below separates the UGC route into a number of sections and describes the specific construction requirements of each individual section and identifies access routes to the work areas. All plant and equipment employed on the proposed works will be subject to good site organisation and hygiene, particularly during construction activities.

<table>
<tr><th colspan="2">Table 4 - Summary of Preliminary Interconnector Design Route</th></tr>
<tr><th>Section</th><th>Description</th></tr>
<tr><td>Section 1
UGC</td><td>UGC from proposed Firlough WF substation, until the L6612/L5131 Crossroads (Chainage 4300m)

The underground cable route initiates at the southern periphery of the proposed Firlough WF substation.

The UGC route utilizes the Forestry and Wind Farm access tracks to exit the Firlough WF boundary, continuing in a northwest direction for approximately 435m prior to joining the public roadway via the L5137-9 local road, following it north for a short section circa 60m.

The route diverges onto the L-5136-0 local road, wherein it remains with a north-western heading for approximately 2670m. Within this section, the route encounters multiple existing services, namely Watermains and an ESBN cable crossing. It is proposed that the UGC route will cross beneath these services in flat formation, reference drawings 05806-DR-267 & 05806-DR-266.

The route then encounters a T-junction, where it proceeds turning right onto the L-1102-30 local road which it follows northwest for approximately 400m. At this point the UGC route keeps left onto the adjoining L6612 local road. The route passes in close proximity to Carra National School prior to joining the L6612. Additional measures regarding traffic management and scheduling of works will need to be adhered to, such as performing works during out-of-school periods (i.e. summer). This section requires the traversal of Eir & Water service crossings, reference drawings 05869-DR-229 & 05806-DR-231.

The UGC route continues northwest along the L6612 local road for approximately 735m before the UGC reaches the L6612/L5131 Crossroads, located at chainage 4300m.

<u>Features</u>

Section 1 contains 6 no. joint bays. Joint bays will be located below ground and finished/reinstated to the local authority’s satisfaction and as per the Purple book road reinstatements specification.

Joint bays will have associated communication chambers and link boxes which will have a surface access hatch which will match existing ground levels.

• Joint Bay 01C (JB-01C) will be located approx. 735m northwest of the Loop proposed Firlough WF substation location. The joint bay will be installed within local roads network. <u>[Chainage – 775m]</u>
• Joint Bay 02C (JB-02C) will be located approx. 735m northwest of JB-01C, positioning the joint bay within local road network. <u>[Chainage – 1590m]</u>
• Joint Bay 03C (JB-03C) will be located approx. 735m west of JB-02C, again within a section of the local roads network. <u>[Chainage – 2400m]</u></td></tr>
</table>

<table>
<tr><td></td><td>

- Joint Bay 04C (JB-04C) will be located approx. 435m southwest of JB-03C. The location of the Joint Bay will be in the middle of the roadway. *[Chainage – 3175m]*
- Joint Bay 05C (JB-05C) will be located approx. 800m west of JB-04C within the road network. *[Chainage – 4000m]*
- Joint Bay 06C (JB-06C) will be located approx. 840m northwest of JB-05C, within the public road network. [Chainage – 4175m]

</td></tr>
<tr><td>

Section 2

UGC

</td><td>

L6612/L5131 Crossroads, to the proposed 110kV Hydrogen Plant substation location (Chainage 8180m)

The underground cable route continues west through the crossroads, remaining within the L6612 local road for an additional 2470m. Along the L6612 local road, the UGC route encounters a bridge over the Brusna River, located at chainage 4775m. The proposed traversal method of this bridge crossing is an HDD undercrossing (Reference drawing 05806-DR-258), due to the aforementioned bridge being incapable of supporting the proposed 110kV connection as it contains insufficient cover.

The UGC route then changes direction, heading southwest via the L66121 local road for the final section of the route within the public roadway, circa 360m in length. The UGC leaves the public roadway, utilizing the proposed 110kV Hydrogen Plant access track, traveling southeast for approx. 1050m before reaching the Hydrogen Plant substation location.

Features

Section 2 contains 4 no. joint bays. Joint bays will be located below ground and finished/reinstated to the local authority's satisfaction and as per the Purple book road reinstatements specification.

Joint bays will have associated communication chambers and link boxes which will have a surface access hatch which will match existing ground levels.

- Joint Bay 07C (JB-07C) will be located approx. 820m northwest of JB-06C. The joint bay will be installed within the local secondary roadway. *[Chainage – 5600m]*
- Joint Bay 08C (JB-08C) will be located approximately 840m northwest of JB-07C. The joint bay will be installed within the local secondary roadway. *[Chainage – 6440m]*
- Joint Bay 09C (JB-09C) will be located approximately 850m west of JB-08C. The joint bay will be installed within the local secondary roadway. *[Chainage – 7265m]*
- Joint Bay 10 (JB-10C) will be located approximately 850m southeast of JB-09C. The joint bay will be installed within the Hydrogen Plant substation access track. *[Chainage – 8070m]*

Section 2 contains 1 HDD which is required to cross under existing watercourse, this can be completed within local road network. Boreholes will be required at this location to determine the composition of the ground to establish drilling durations at this work site.

</td></tr>
<tr><td colspan="2">

Refer to Figure 2 and to the planning drawings submitted for location details.

Note: The precise location of the proposed route within the planning application boundary is subject to change as result of existing services/utility locations, ground conditions and any environmental constraints.

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</table>

4.0 Proposed EirGrid Substations

4.1 EirGrid 110kV AIS 8 Bay (Loop In Substation)

The proposed substation will be designed and constructed to meet all the required EirGrid standards. An area will be levelled and built to the required level with stone fill material, capped by high quality compacted stone. Two control buildings will be constructed using traditional techniques for constructing small buildings (i.e. concrete block walls, timber and slate tile roof). Foundations will be built for all of the proposed electrical infrastructure. All the electrical equipment will be installed to EirGrid requirements. Perimeter fencing will be constructed around the substation compound for security and safety purposes.

This substation will connect via underground cable circuits to accommodate a grid connection via the Moy - Glenree 110kV overhead line (OHL). Firlough 110kV substation will be made up of 1 No. Control building, 1 No. IPP MV Switch room, Transformer compound and Busbar compound.

The control building works will consist of foundation works, block work, roofing, low voltage electrical fit out, cladding and building finishing works. The transformer, gantry and structural steelwork will be installed in the transformer compound. Three cable sealing ends will be installed to incorporate the radial underground circuits in and out of the station. The busbar compound structural steelwork will be erected with lightning masts also installed. Substation electrical equipment will be installed once the control building and compound is complete. Fencing will be erected around the compound for security/protection. Permanent access roads will also be installed to allow trafficking in and out of the proposed substation compound, access road to loop in interface mast structures and internal access road for compound use.

The expected duration of works is expected to be approximately 12 months. The proposed construction scope will require the personal, machinery and materials as follows: -

Equipment

- Up to 10 Electrical/Civil Crews
- Excavators
- 360˚ tracked excavators (13 ton normally, 22 ton for rock breaker)
- Tracked dumpers / tractors and trailers
- Crane
- Hoist
- Power Tools
- Generator
- Scaffolding
- Substation Electrical Equipment

Materials:

- Stone
- Geotextile
- Lighting
- Paving.
- Fencing.
- Steel
- Concrete
- Timber
- Cladding
- Doors

The following section outlines the methodology to be followed during construction works of the new 110kV Firlough substation which will be constructed adjacent to the existing 110kV overhead line.

1. This new substation will be in a compound of circa 117m x 131m plan area secured by a 2.6m high palisadefence.
2. The substation compound and drainage will be marked out by a qualified engineer.
3. A drainage system will be excavated and installed around the compound area.
4. Topsoil and subsoil will be removed from the footprint of the compound using an excavator. The excavatedmaterial will be temporarily stored in adjacent berms for later use during reinstatement works.
5. A layer of geotextile material will be laid over the footprint of the compound.
6. Using an excavator, a base layer of Clause 804 material will be laid followed by a 6F2 capping layer which willprovide the finished surface.
7. Each layer will be compacted using a vibrating roller.
8. Earthing cable will be laid underground around the substation for connection to the various electricalcomponents during the electrical fit out phase.
9. The construction of an 15327m² substation compound comprising of approximately 450m² single storey 110kV substation control building, 216m^2 single storey MV building and associated outdoor electrical equipment, including 1 no. 33/110kV transformer, associated internal access road, including 2.6m high station perimeter fencing will be built.
10. Permanent access road will be constructed to allow site vehicular activity in and out of construction area.
11. Adequate lighting will be installed around the compound on the lighting masts within the compound.
12. A 110kV cable sealing ends and associated accessories will be required to incorporate the Moy to Glenree 110kV line into the substation. The support structures will be located outdoors.
13. Transformers will be installed in bunded enclosures within the substation compound.

The electrical installation is expected to take 20 weeks and includes the following:

- Delivery and installation of 33/110kV transformer. These are unusually large, and the deliveries will be managed in accordance with regulations governing the movement of large loads.
- Delivery and installation of all other HV equipment.
- Wiring and cabling of HV/LV equipment, protection and control cabinets.
- Commissioning of all newly installed equipment.

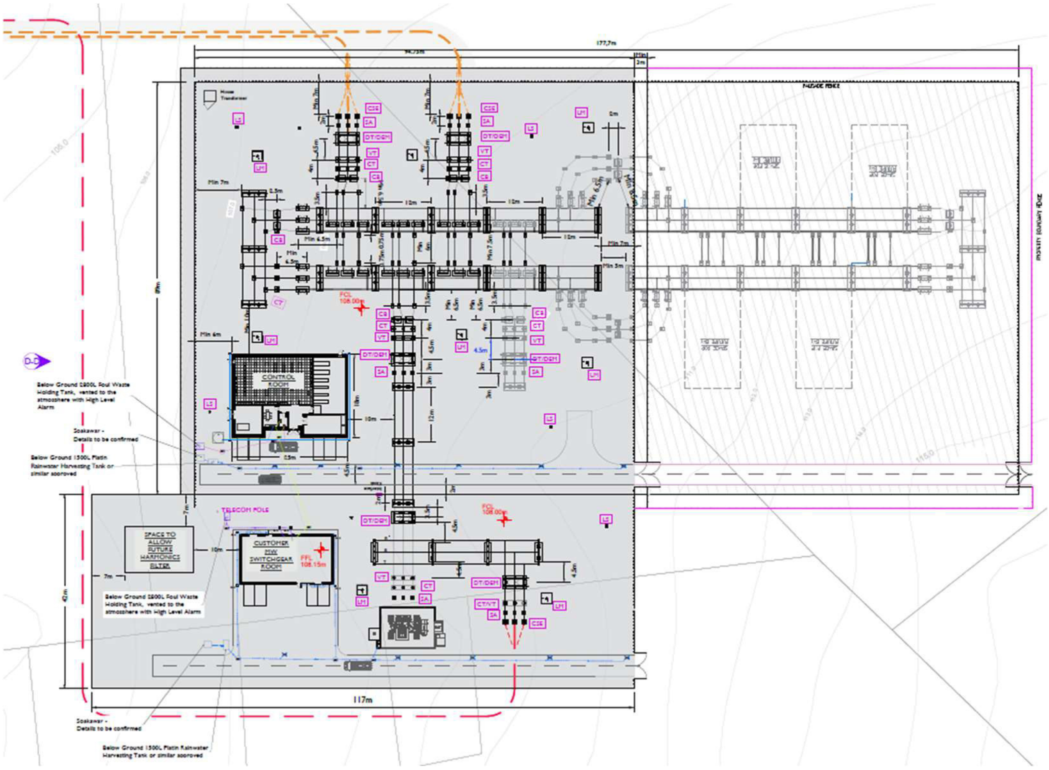


Figure 3: Proposed 110kV AIS Loop In Station Layout

4.2 110kV Hydrogen Substation

The proposed substation will be designed and constructed to meet all the required EirGrid standards. An area will be levelled and built to the required level with stone fill material, capped by high quality compacted stone. Two control buildings will be constructed using traditional techniques for constructing small buildings (i.e. concrete block walls, timber and slate tile roof). Foundations will be built for all of the proposed electrical infrastructure. All the electrical equipment will be installed to EirGrid requirements. Perimeter fencing will be constructed around the substation compound for security and safety purposes.

This substation will connect via underground cable circuits to accommodate a grid connection to the aforementioned Firlough Windfarm substation. The Hydrogen 110kV substation will be made up of 1 No. Control building, 1 No. IPP MV Switch room, Transformer compound and Busbar compound.

The control building works will consist of foundation works, block work, roofing, low voltage electrical fit out, cladding and building finishing works. The transformer, gantry and structural steelwork will be installed in the transformer compound. One cable sealing end will be installed to incorporate the radial underground circuit in and out of the station. The busbar compound structural steelwork will be erected with lightning masts also installed. Substation electrical equipment will be installed once the control building and compound is complete. Fencing will be erected around the compound for security/protection. Permanent access roads will also be installed to allow trafficking in and out of the proposed substation compound, access road to loop in interface mast structures and internal access road for compound use.

The expected duration of works is expected to be approximately 12 months. The proposed construction scope will require the personal, machinery and materials as follows: -

Equipment

- Up to 10 Electrical/Civil Crews
- Excavators
- 360˚ tracked excavators (13 ton normally, 22 ton for rock breaker)
- Tracked dumpers / tractors and trailers
- Crane
- Hoist
- Power Tools
- Generator
- Scaffolding
- Substation Electrical Equipment

Materials:

- Stone
- Geotextile
- Lighting
- Paving.
- Fencing.
- Steel
- Concrete
- Timber
- Cladding
- Doors

The following section outlines the methodology to be followed during construction works of the new 110kV Hydrogen substation which will connect via UGC to the Firlough WF substation.

1. This new substation will be in a compound of circa 40m x 88m plan area secured by a 2.6m high palisadefence, with possible space to allow for future harmonics filter.
2. The substation compound and drainage will be marked out by a qualified engineer.
3. A drainage system will be excavated and installed around the compound area.
4. Topsoil and subsoil will be removed from the footprint of the compound using an excavator. The excavatedmaterial will be temporarily stored in adjacent berms for later use during reinstatement works.
5. A layer of geotextile material will be laid over the footprint of the compound.
6. Using an excavator, a base layer of Clause 804 material will be laid followed by a 6F2 capping layer which willprovide the finished surface.
7. Each layer will be compacted using a vibrating roller.
8. Earthing cable will be laid underground around the substation for connection to the various electricalcomponents during the electrical fit out phase.
9. The construction of an 3520m² substation compound comprising of approximately 195m² single storey 110kV substation control building, 83m² single storey MV building and associated outdoor electrical equipment, including 1 no. 33/110kV transformer, associated internal access road, including 2.6m high station perimeter fencing will be built.
10. Permanent access road will be constructed to allow site vehicular activity in and out of construction area.
11. Adequate lighting will be installed around the compound on the lighting masts within the compound.
12. A 110kV cable sealing ends and associated accessories will be required to incorporate the Firlough WF UGC into the substation. The support structures will be located outdoors.
13. Transformers will be installed in bunded enclosures within the substation compound.

The electrical installation is expected to take 20 weeks and includes the following:

- Delivery and installation of 33/110kV transformer. These are unusually large, and the deliveries will be managed in accordance with regulations governing the movement of large loads.
- Delivery and installation of all other HV equipment.
- Wiring and cabling of HV/LV equipment, protection and control cabinets.
- Commissioning of all newly installed equipment.

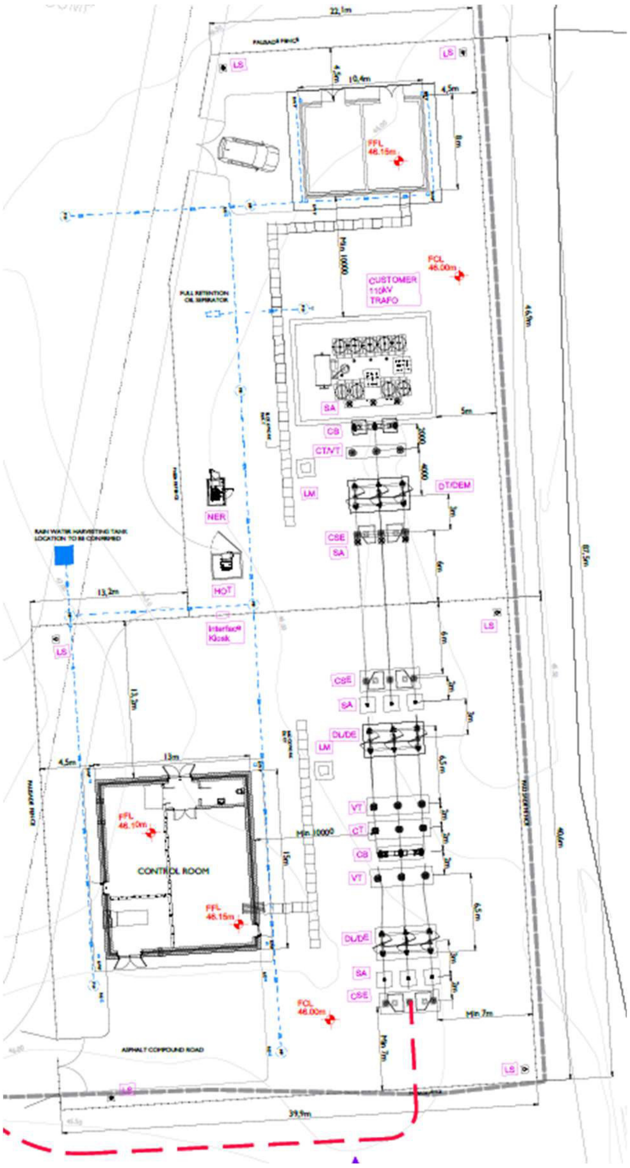


Figure 4: Proposed 110kV Hydrogen Substation Layout

5.0 UGC Construction Methodology

The proposed Firlough Wind Farm double circuit sections of UGC will consist of 2 circuits of 3 No. 200mm diameter HDPE power cable ducts and 2 No. 125mm diameter HDPE communications duct to be installed in excavated trenches. Each trench will typically be 825mm wide by 1425mm deep (See Figure 6 for further details). The cable ducts will accommodate 1 No. power cable per duct.

The proposed Hydrogen Plant single circuit sections of UGC will consist of 1 circuit of 3 No. 160mm diameter HDPE power cable ducts and 2 No. 125mm diameter HDPE communications duct to be installed in excavated trenches. The trench will typically be 600mm wide by 1315mm deep (See Figure 6 for further details). The cable ducts will accommodate 1 No. power cable per duct.

The proposed Firlough Wind Farm and Hydrogen Plant triple circuit sections of UGC will consist of 3 circuits in individual trenches. The trenches will accommodate power cables enclosed within 3 No. HDPE ducts and 2 No. HDPE communications ducts, with a minimum separation distance of 880mm between power circuits (See Figure 6 for further details). The combined trench width, including power circuit separation, will be approximately 3300mm.

The communications duct will accommodate a fibre cable to allow future communications between Firlough WF, the Hydrogen Plant, Moy and Glenree. A concrete communication chamber will be installed at each joint bay location. Whilst the trench is open the ducts will be surveyed to accurately record the location of the buried cable for future identification and as-built records. The ducts will be installed, and the trench reinstated in accordance with the landowner requirements and then the electrical cabling/fibre cable is pulled through the installed ducts. Construction method statements and templates will be implemented to ensure that the UGC is installed in accordance with the correct requirements, materials, and specifications of ESBN and EirGrid.

5.1 Trenching Methodology

The following section outlines the methodology to be followed during trenching works:-

- The Contractor, and their appointed Site Manager, will prepare a targeted Method Statement concisely outlining the construction methodology and incorporating all mitigation and control measures included within the planning application and accompanying reports and as required by planning conditions where relevant;
- All existing underground services shall be identified on site prior to the commencement of construction works;
- The excavated trench will be dewatered if required, from a sump installed within the low section of the opened trench. Where dewatering is required, dirty water will be fully and appropriately attenuated, through silt bags, before being appropriately discharged to vegetation or surface water drainage feature;
- Where required, grass will be reinstated by either seeding or by replacing with grass turves;
- No more than a 100m section of the trench will be opened at any one time. The second 100 metres will only be excavated once the majority of reinstatement has been completed on the first;
- The excavation, installation, and reinstatement process will take on an average of 1 no. day to complete a 100m section;
- Where the cable is being installed in a roadway, temporary reinstatement may be provided to allow larger sections of road to be permanently reinstated together;
- The excavation, installation and reinstatement process will take on average of 1 no. day to complete a 100m section;

Equipment:

- 360˚ tracked excavators (13 ton normally, 22 ton for rock breaker)
- Tracked dumpers / tractors and trailers

Materials:

- Sand for pipe bedding;
- Ready-mix Concrete where necessary (delivered to site);
- Trench backfilling material (excavated material and aggregates) to relevant specifications;
- Cable ducting;
- Permanent Surface Reinstatement Asphalt Material.
- Temporary Surface Reinstatement Materials.
- ESB Marker tape & Marker posts

Figure 5: Double 110kV Underground Duct Installation

5.2 Ducting Installation Methodology

For the trenching and ducting works the following step by step methodology will apply:

1. Grade, smooth and trim trench floor when the required depth and width have been obtained.
2. Place bedding layer of Cement Bound Granular Mixture B (CBGM B) material in accordance with the specification and compact it so that the compacted thickness is as per the drawings.
3. Lay the bottom row of ducts in trefoil formation as detailed on the design drawings. Use spacers as appropriate to establish horizontal duct spacing. Fit a secure cap / bung to the end of each duct run to prevent the ingress of dirt or water.
4. Carefully surround and cover ducts with CBGM B in accordance with the design drawings and specifications and thoroughly compact without damaging ducts.
5. Place cable protection strips on compacted CBGM B directly over the ducts.
6. Lay the top row of ducts onto the freshly compacted CBGM B including the cable protection strips above the bottom row of ducts. Place a secure cap at the end of each duct to prevent the ingress of dirt or water.

7. Carefully surround and cover ducts with CBGM B material in accordance with the drawings and thoroughly compact without damaging ducts.
8. Place red cable protection strip on top of compacted CBGM B over each set of ducts as shown on the drawings.
9. Place and thoroughly compact CBGM B material or Clause 804 backfill, or soil backfill as specified and place warning tape at the depth shown on the drawings.
10. For unsurfaced/grass sections, backfill with suitable excavated material to ground level leaving at least 100 mm topsoil or match existing level at the top to allow for seeding or replace turves as per the specification of the local authority or landowner.
11. Clean and test the ducts in accordance with the specification by pulling through a brush and mandrel. Install 12 mm polypropylene draw rope in each duct and seal all ducts using robust duct end seals fitted with rope attachment eyes in preparation for cable installation at a later date.

The proposed trenching and ducting installation scope will require the relative personal, machinery and materials which is as follows:-

Equipment	**Materials:**
• 2-3 General Operatives • 1 Excavator Operator • 360˚ tracked excavators (13 ton normally, 22 ton for rock breaker) • Tracked dumpers / tractors and trailers	• Sand for pipe bedding Insulators • 200mm diameter HDPE ducting; • 160mm diameter HDPE ducting; • 125mm diameter HDPE ducting; • Temporary Surface Reinstatement Materials • Trench backfilling material (excavated material) • Ready-mix Concrete where necessary (delivered to site) • Aggregate

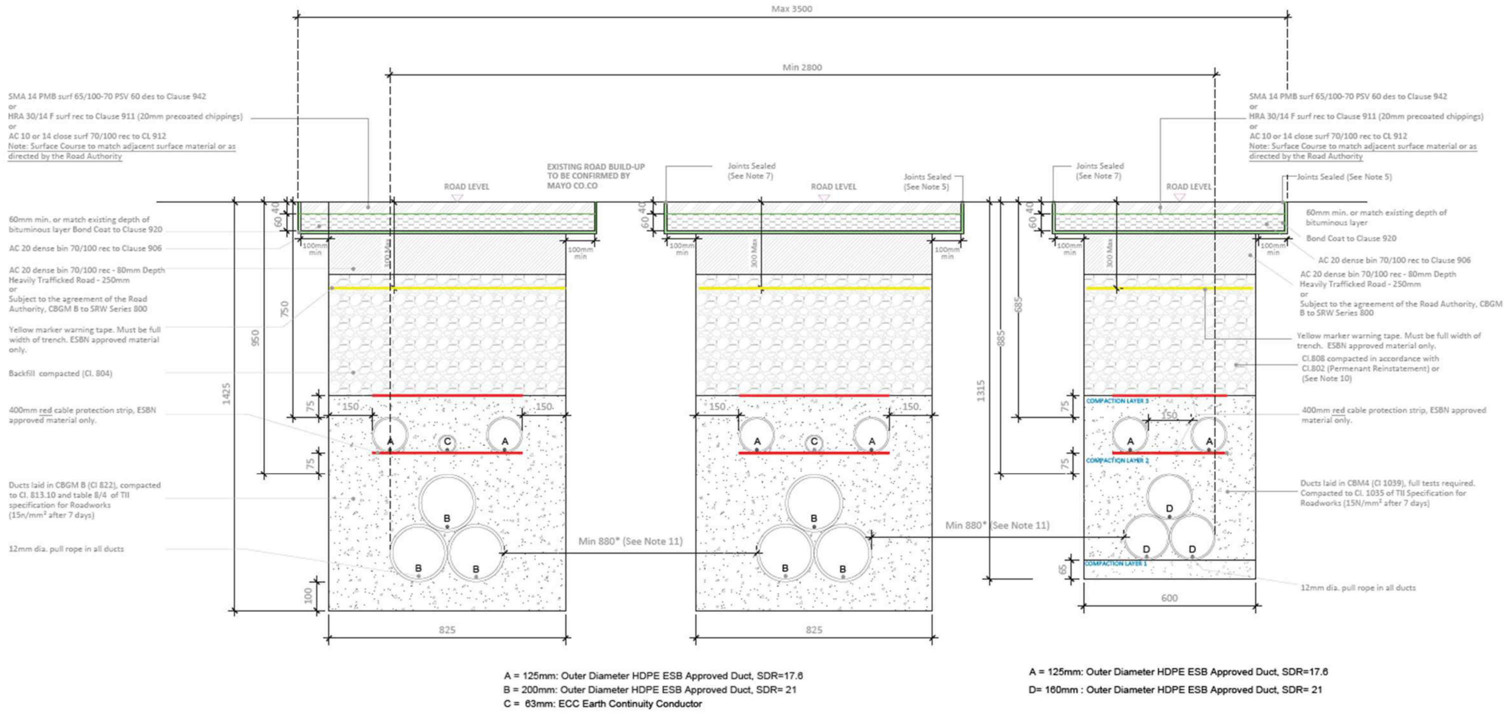


Figure 6: Typical Trench for three circuits within roadway sections

5.3 Managing Excess Material from trench

All excavated material will be temporarily stored adjacent to the trench before re-use in the trench reinstatement (where applicable). Stockpiles will be restricted to less than 2m in height. Where excess material exists, it may be used in the reinstatement of the Firlough Wind Farm sites or disposed of to a licensed facility.

5.4 Storage of Plant and Machinery

All plant, machinery, and equipment will be stored on-site within the works area or within the consented temporary construction compounds located within Firlough Wind Farm site. Oils and fuels will be stored in an appropriately bunded area within the consented temporary construction compounds.

5.5 Horizontal Direction Drilling (HDD)

Horizontal Direction Drilling (HDD) is a method of drilling under obstacles such as bridges, railways, water courses, etc. in order to install cable ducts under the obstacle. This method is employed where installing the ducts using standard installation methods is not possible. There are two bridges on this UGC route which will require HDD due to there being insufficient cover and depth in the bridge to cross within the bridge deck. The proposed drilling methodology is as follows: -

1. A works area of circa .40m^2 will be fenced on both sides of the stream crossing,
2. The drilling rig and fluid handling units will be located on one side of the bridge and will be stored on double bunded 0.5mm PVC bunds which will contain any fluid spills and storm water run-off.
3. Entry and exit pits (1m x 1m x 2m) will be excavated using an excavator, the excavated material will be temporarily stored within the works area and used for reinstatement or disposed of to a licensed facility.

4. A 1m x 1m x 2m steel box will be placed in each pit. This box will contain any drilling fluid returns from the borehole.
5. The drill bit will be set up by a surveyor, and the driller will push the drill string into the ground and will steer the bore path under the watercourse.
6. A surveyor will monitor drilling works to ensure that the modelled stresses and collapse pressures are not exceeded.
7. The drilled cuttings will be flushed back by drilling fluid to the steel box in the entry pit.
8. Once the first pilot hole has been completed a hole-opener or back reamer will be fitted in the exit pit and will pull a drill pipe back through the bore to the entry side.
9. Once all bore holes have been completed, a towing assembly will be set up on the drill and this will pull the ducting into the bore.
10. The steel boxes will be removed, with the drilling fluid disposed of to a licensed facility.
11. The duct will be cleaned and proven, and their installed location surveyed.
12. The entry and exit pits will be reinstated to the specification of ESB Networks and Mayo County Council.
13. A transition chamber will be installed on either side of the bridge following the horizontal directional drilling as per ESB requirements.

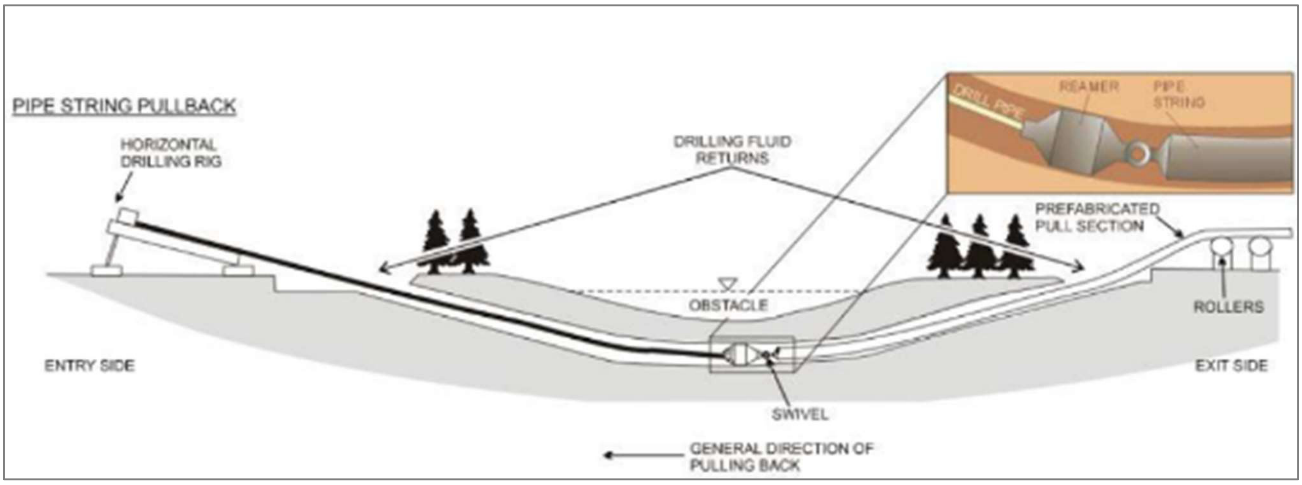


Figure 7: Typical HDD Installation

5.6 Joint Bays and Associated Chambers

Joints Bays are to be installed approximately every 700m - 850m along the UGC route to facilitate the jointing of 2 No. lengths of UGC. Joint Bays are typically 2.5m x 6m x 1.75m pre-cast concrete structures installed below finished ground level.

In association with Joint Bays, Communication Chambers are required at every joint bay location to facilitate communication links between the Firlough Wind Farm substation and the existing 110kV overhead line. Earth Sheath Link Chambers are also required at every second joint bay along the cable route. Earth Sheath Links are used for earthing and bonding cable sheaths of underground power cables, so that the circulating currents and induced voltages are eliminated or reduced. Earth Sheath Link Chambers and Communication Chambers are located in close proximity to Joint Bays. Earth Sheath Link Chambers and Communication Chambers will typically be pre-cast concrete structures with an access cover at finished surface level.

The precise siting of all Joint Bays, Earth Sheath Link Chambers and Communication Chambers is subject to approval by ESBN. Marker posts will be used on non-roadway routes to delineate the duct route and joint bay positions.

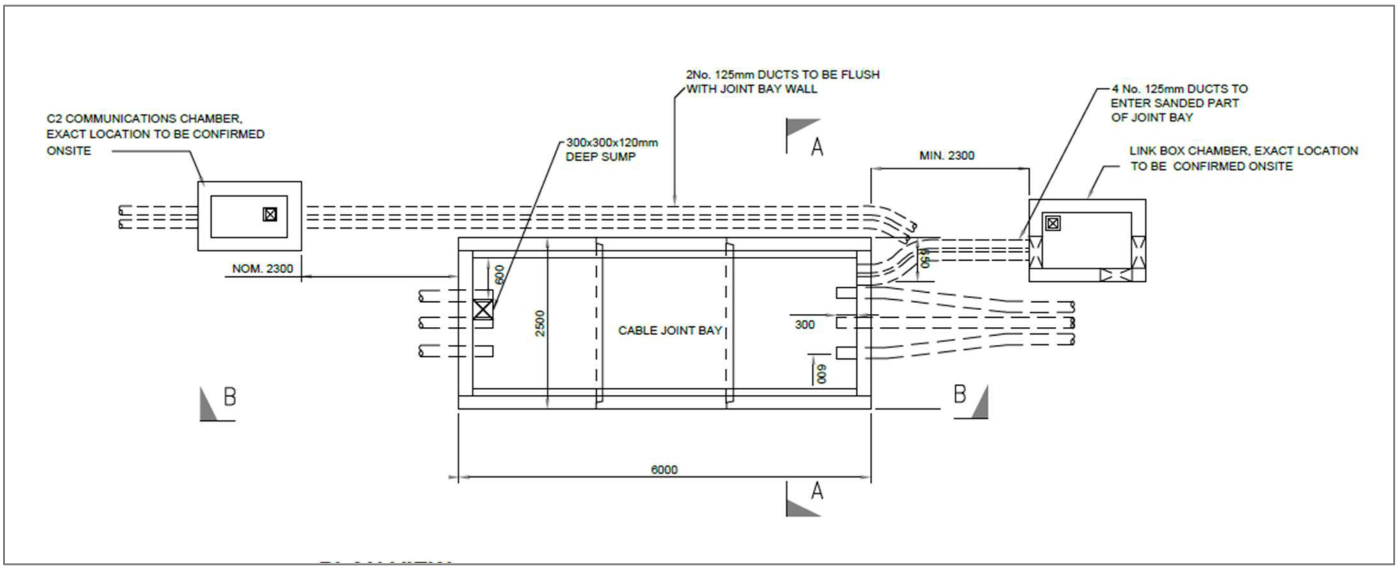


Figure 8: 110kV Joint Bay Plan Layout

5.7 Joint Bay Construction and Cable Installation

Before starting to construct, the area around the edge of the proposed joint bay which will be used by heavy vehicles will be surfaced with a terram cover if required and stone aggregate to minimise ground damage. Any roadside drains within the temporary works area will be culverted and check dams made from stone or sandbags covered with terram will be inserted upstream and downstream of these culverts to intercept any solids generated during the insertion or which wash out during the works. If the ground slopes from the working area toward a watercourse or if there is evidence of solids washing off the works area toward nearby watercourses or drains, a silt fence with straw bales, will be interposed between the works area and the watercourse.

All excavated material will be stored near the excavations and reused for reinstatement works. Any soil required for reinstatement that will be temporarily stockpiled on site will be placed at least 15m back from the nearest watercourse on level ground and will be ringed at the base by silt fencing and be regularly monitored by a designated competent person for signs of solids escape. In which case an additional line of silt fencing with straw bales will be added in line with the relevant ECM.

If the joint bay needs to be dewatered, this will be pumped to a percolation area if the soil is not saturated, otherwise a settlement tank will be used to remove any solids from the dewatering process to comply with the ECM.

The risk of concrete reaching surface waters is considered very low given that all concrete will be poured into the pit excavated for the joint bay so that spills will be contained. The basic requirement therefore is that all pouring operations be constantly supervised to prevent accidental spillages occurring outside the pit.

Temporary storage of cement bound sand (if required) will be on hardstand areas only where there is no direct drainage to surface waters and where the area has been bunded e.g., using sandbags and geotextile sheeting or silt fencing to contain any solids in run-off.

The following steps outline the methodology for joint bay construction and reinstatement:

1. The contractor will excavate a pit for joint bay construction, including for a sump in one corner.
2. Grade and smooth floor; then lay a 75 mm depth of blinding concrete (for in situ construction) or 50 mm thick sand (for pre-cast concrete construction) on 200 mm thick Clause 804 granular material.

3. In situ construction. Construct 200 mm thick reinforced concrete floor slab with sump and starter bars placed for walls as detailed on the drawings.
4. In situ construction. Construct 200 mm thick reinforced concrete sidewalls as detailed on the drawings. (Figure 9)

Figure 9: Typical joint bay under construction (in-situ)

5. In situ construction. Remove formwork and backfill with suitable backfill material in grassed areas or Clause 804 material once ducting has been placed in the bay. Backfill externally with granular material to Co. Council/TII Specification for Roadworks. (Figure 10)

Figure 10: Completed joint bay prior to cable installation (in-situ)

6. Pre-cast concrete construction. Place pre-cast concrete sections on sand bedding. (Figure 11)

Figure 11: Typical joint bay under construction (pre-cast)

7. Where joint bays are located under the road surface the joint bay will be backfilled with compacted layers of Clause 804 and the road surface temporarily reinstated as specified by the local authority.
8. Precast concrete covers may be used as temporary reinstatement of joint bays at off road locations. These covers are placed over the constructed joint bay and are then removed at the cable installation stage of the project.
9. At a later date to facilitate cable installation and jointing, reinstate traffic management signage, secure individual sites, re-excavate three consecutive joint bays and store excavated material for reuse.
10. The cable is supplied in pre-ordered lengths on large cable drums (Figure 12). Installing "one section" of cable normally involves pulling three individual conductors into three separate ducts. The cable pulling winch must be set at a predetermined cut off pulling tension as specified by the designer. The cable will be connected to the winch rope using approved suitably sized and rated cable pulling stocking and swivel or the pulling head fitted by the cable manufacturer**.** A sponge may also be secured to the winch rope to disperse lubricant through the duct. Lubrication is also applied to the cable in the joint bay before it enters the duct.

Figure 12: HV cable pulling procedure (Typical drum set-up)

11. Once the "two sections" of cable (total of 6 conductors) are pulled into the joint bay, a jointing container is positioned over the joint bay and the cable jointing procedure is carried out in this controlled environment. (Figure 13)

Figure 13: HV cable jointing container

12. Following the completion of jointing and duct sealing works in the joint bay, place and thoroughly compact cement-bound sand in approximately 200 mm layers to the level of the cable joint base to provide vertical support. Install additional layers of cement-bound sand and compact each layer until the cement-bound sand is level with the top of the joint. Install an additional 100 mm cement-bound sand layer. Install cable protection strip. Backfill with cement-bound sand to a depth of 250 mm below surface and carry out permanent reinstatement including placement of warning tape at 400 mm depth below finished surface.

Equipment:

- 1 Excavator Operator
- 360˚ wheeled excavator (13 ton normally, 22 ton for rock breaker)
- 1 no. dumper or tractor and trailer

Materials:

- Sand for pipe bedding
- Blinding Concrete where necessary
- Clause 804 Material
- 200mm diameter HDPE ducting;
- 125mm diameter HDPE ducting;
- Precast Chamber Units / Relevant construction materials for chambers
- Link Box

6.0 Loop-In Interface Mast Design Location

6.1 Existing 110kV OHL

The 110kV loop-in option is proposed to be carried out on the existing Moy - Glenree 110kV overhead transmission line. The loop-in will be completed in the proximity of Poleset structures No. 15 and No. 16 located within the land parcel Folio. MY33444. Polesets surplus to requirement will be removed by ESBN once the UGC is energised. These poles will be recycled as part of Networks best practice procedures. They will be removed by a 13-tonne excavator, with no cutting involved.

6.2 Loop-In Interface Mast Design

The proposed design for the 110kV Loop-In from the existing OHL will require two new Interface Mast structures which will be constructed under the existing Moy - Glenree 110kV OHL. The existing OHL conductor will be terminated at these two new structures in order to transition from an overhead line to an underground cable arrangement to facilitate the loop into Firlough Wind Farm 110kV Substation via cable chairs. The existing conductor will be removed between the Interface Mast structures with the new connection looped through to the new Firlough Wind Farm 110kV Substation.

The new interface mast structure locations have been selected based on ground surveys, ground profiles, allowable angles and ruling span checks. The expected duration of works is expected to be approx. 4 weeks. Construction of foundation circa. 7 days each with time allowing for curing of the concrete, erection of the Interface masts circa 5 days, weather dependant.

The proposed construction scope will require the relative personal, machinery and materials which is as follows:-

Equipment	**Materials:**
• 5 operatives • 4x4 vehicle • Winch • Tractor and trailer • Crane • Teleporter • Chains / small tools • Tracked Excavator • Tracked Dumper	• Lattice steel tower • Insulators • Dropper conductors • Connection clamps • Surge Arrestors • Electrical connections • Concrete (foundation) • Aggregate

The following section outlines the methodology to be followed during construction works of the new Interface Mast structures which will be constructed underneath the existing 110kV overhead line in the townland of Bunnyconnellan in Co. Mayo.

1. Interface Mast sites are scanned for underground services such as cables, water pipes etc. Consultation with the landowner will help to identify and ensure there are no unidentified services in the area.
2. For each leg of 2 No. towers (8 in total) a foundation circa. 3m x 3.6m x 3.6m is excavated and the formation levels (depths) will be checked by the onsite foreman. The excavated material will be temporarily stored close to the excavation and excess material will be used as berms along the site access roads.

3. To aid construction, a concrete pipe is placed into each excavation to allow operatives level the mast at the bottom of the excavation. The frame of the reinforcing bars will be prepared and strapped to a concrete pipe with spacers as required. The reinforcing bars will be lifted into each excavated foundation using the excavator and chains/slings. The base and body section of each tower will then be assembled next to excavation.
4. Concrete trucks will pour concrete directly into each excavation in distinct stages.
5. A third pour for the leg of the tower 1m x 1m and will be 300mm over ground level.
6. Once the main concrete pour is cured after circa five days, a preformed metal panel is set in place to contain the concrete called shuttering while it sets. During each pour, the concrete will be vibrated thoroughly using a vibrating poker.
7. Once the concrete is set after the five days the shuttering is removed.

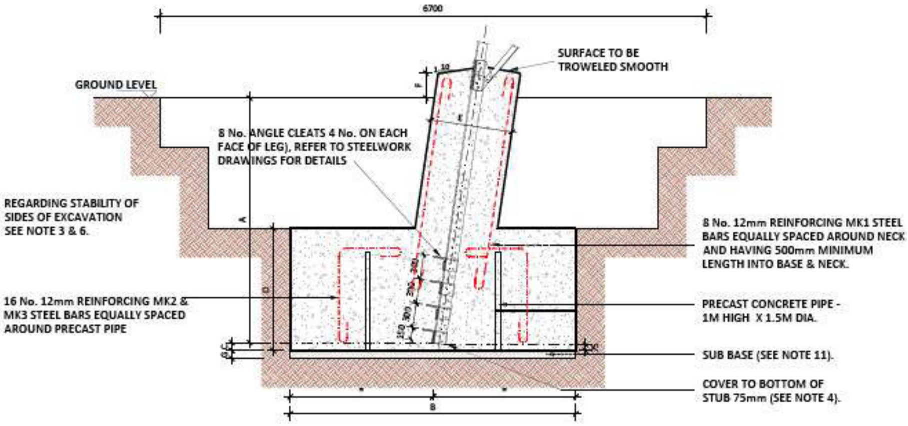


Figure 14: New Interface Mast Foundation

Figure 15: 110kV Interface Mast foundation complete

8. The Interface Mast foundations will be backfilled one leg at a time with the material already excavated at the location. The backfill will be placed and compacted in layers. All dimensions will be checked following the backfilling process. If the excavated material is deemed unsuitable for backfilling other excavated material from the footprint of the Firlough Wind Farm 110kV Substation or from the new permanent access road in Bunnyconnellan will be used. All surplus excavated material and removed from the tower locations and stored in berms adjacent to the Substation Compound.

Figure 16: Base of Interface Mast structure backfilled

9. The existing overhead line will be de-energised by ESB so work can commence on the construction of the towers.
10. An earth mat consisting of copper or aluminium wire will be laid circa 400mm below ground around the tower. This earth mat is a requirement for the electrical connection of the equipment on the tower structure.
11. Once the base section of each tower is completed and the concrete sufficiently cured, it is ready to receive the tower body.
12. A hardstand area for the crane will be created by laying geogrid material on the ground surface and overlaying this geogrid with a suitable grade of aggregate.
13. A physical barrier (Heras Fence Site Boundary) will be put in place to restrict plant from coming too close to the OHL.
14. The tower will be constructed lying flat on the ground beside the recently installed tower base.
15. The conductor will be moved off centre using a stay wire and weights to anchor the stay wire to ground.
16. The tower section will be lifted into place using the crane and guide ropes.
17. The body sections will be bolted into position.
18. The conductor will be centred over the towers and held in place. Once the conductor is secured at both ends it is then cut and attached onto each tower. The section of conductor in between the two towers will be removed and utilised as connector wire for the new towers.
19. Down dropper conductors (For Electrical Connections, Insulators, Surge arrestors), shackles and all associated accessories required for transition from line to cable will be installed on the interface towers.
20. The circuit will be tested in both directions before the line is re-energised.

Figure 17: Completed Line/Cable Interface Mast

7.0 Substation Construction

The proposed construction scope will require the relative personal, machinery and materials which is as follows:

Equipment	**Materials:**
• Up to 10 Electrical/Civil Crews • Excavators • 360˚ tracked excavators (13 ton normally, 22 ton for rock breaker) • Tracked dumpers / tractors and trailers • Crane • Hoist • Power Tools • Generator • Scaffolding	• Stone • Geotextile • Lighting • Paving. • Fencing. • Steel • Concrete • Timber • Cladding • Doors

1. This new substation will be in a compound of circa 200m x 140m plan area secured by a 2.6m high palisade fence.
2. The substation compound and drainage will be marked out by a qualified engineer.
3. A drainage system will be excavated and installed around the compound area.
4. Topsoil and subsoil will be removed from the footprint of the compound using an excavator. The excavated material will be temporarily stored in adjacent berms for later use during reinstatement works.
5. A layer of geotextile material will be laid over the footprint of the compound.
6. Using an excavator, a base layer of Clause 804 material will be laid followed by a 6F2 capping layer which will provide the finished surface.
7. Each layer will be compacted using a vibrating roller.
8. Earthing cable will be laid underground around the substation for connection to the various electrical components during the electrical fit out phase.
9. The construction of an 21754m² substation compound comprising of approx. 435m² single storey 110kV substation control building and associated outdoor electrical equipment, including 1no. 110kV transformer, associated internal access road, including 2.6m high station perimeter fencing will be built.
10. Cable ducting will be installed from the end mast to the gantry in the substation compound.
11. Adequate lighting will be installed around the compound on the lighting masts within the compound.
12. A 110kV cable chair and associated line equipment will be required to divert the existing Moy - Glenree 110kV overhead lines into the substation. The support structures will be located outdoors. These will be positioned in bunded enclosures in the substation compound.
13. The electrical installation is expected to take 20 weeks and includes the following:
    - Delivery and installation of 33/110kV transformer. These are unusually large, and the deliveries will be managed in line with regulations governing the movement of large loads.
    - Delivery and installation of all other HV equipment.
    - Wiring and cabling of HV/LV equipment, protection and control cabinets.
    - Commissioning of all newly installed equipment.

8.0 Best Practice Design and Construction & Environmental Management Methodology

Prior to commencement of construction works the contractor will draw up detailed Method Statements which will be informed by this Outline Construction Methodology, environmental protection measures included within the planning application, measures proposed within the CEMP, and the guidance documents and best practice measures listed below. This method statement will be adhered to by the contractors and will be overseen by the Project Manager, Environmental Manager and ECoW where relevant.

The following documents will contribute to the preparation of the method statements in addition to those measures proposed below:-

- Inland Fisheries Ireland (2016) *Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters*. Inland Fisheries Ireland*, Dublin,*
- *National Roads Authority (2008) Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes*. National Roads Authority, Dublin;
- E. Murnane, A. Heap and A. Swain. (2006) *Control of water pollution from linear construction projects.* Technical guidance (C648). CIRIA;
- E. Murnane et al., (2006) *Control of water pollution from linear construction projects*. Site guide (C649). CIRIA.
- Murphy, D. (2004) Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites. Eastern Regional Fisheries Board, Dublin;

- H. Masters-Williams et al (2001) *Control of water pollution from construction sites. Guidance for consultants and contractors* (C532);
- Enterprise Ireland (unknown). *Best Practice Guide (BPGCS005) Oil storage guidelines;*
- Law, C. and D'Aleo, S. (2016) *Environmental good practice on site pocketbook*. (C762) 4th edition. CIRIA;
- CIRIA *Environmental Good Practice on Site (fourth edition) (C741) 2015*.

The proposed works will be carried out by employing accepted good work practices during construction, and environmental management measures such as those discussed below. Please note that the following measures will be supplemented by further specific environmental protection measures that will be included in method statements prepared for specific tasks during the works and will form part of the detailed CEMP.

- All materials shall be stored at the temporary compound within the Firlough Windfarm site and transported to the works zone immediately prior to construction;
- Weather conditions will be taken into consideration when planning construction activities to minimise risk of run off from site;
- Provision of 50m exclusion zones and barriers (silt fences) between any excavated material and any surface water features to prevent sediment washing into the receiving water environment;
- If dewatering is required as part of the proposed works e.g. in wet areas, water must be treated prior to discharge;
- The contractor shall ensure that silt fences are regularly inspected and maintained during the construction phase;
- If very wet ground must be accessed during the construction process bog mats/aluminium panel tracks will be used to enable access to these areas by machinery. However, works will be scheduled to minimise access requirements during winter months;
- The contractor shall ensure that all personnel working on site are trained in pollution incident control response. A regular review of weather forecasts of heavy rainfall is required and the Contractor is required to prepare a contingency plan for before and after such events;
- The contractor will carry out visual examinations of local watercourses from the proposed works during the construction phase to ensure that sediment is not above baseline conditions. In the unlikely event of water quality concerns, the Environmental Manager and ECoW will be consulted;
- Excavations will be left open for minimal periods to avoid acting as a conduit for surface water flows.
- Only emergency breakdown maintenance will be carried out on site. Emergency procedures and spillage kits will be available and construction staff will be familiar with emergency procedures.
- Appropriate containment facilities will be provided to ensure that any spills from vehicles are contained and removed off site. Adequate stocks of absorbent materials, such as sand or commercially available spill kits shall be available;
- Concrete or potential concrete contaminated water run-off will not be allowed to enter any watercourses. Any pouring of concrete (delivered to site ready mixed) will only be carried out in dry weather. Washout of concrete trucks shall be strictly confined to a designated and controlled wash-out area within the Firlough Windfarm site; remote from watercourses, drainage channels and other surface water features;
- Entry by plant equipment, machinery, vehicles and construction personnel into watercourses or wet drainage ditches shall not be permitted. All routes used for construction traffic shall be protected against migration of soil or wastewater into watercourses;
- Cabins, containers, workshops, plant, materials storage and storage tanks shall not be located near any surface water channels and will be located beyond the 50m hydrological buffer at all times.

9.0 Traffic Management

Traffic management and road signage will be in accordance with the Department of Transport: Traffic Signs Manual - Chapter 8: Temporary Traffic Measures and Signs for Road Works and in agreement with Mayo County Council. All work on public roads will be subject to the approval of a road opening license application. The contractor will prepare detailed traffic management plans for inclusion as part of the road opening licence applications.

All traffic management measures will comply with those outlined in the accompanying Outline Construction Traffic Management Plan and will be incorporated into a detailed Traffic Management Plan to be prepared, in consultation with Mayo County Council, before the commencement of development.

Note; It should be noted that a contractor has yet to be appointed for the construction phase of the project. The contractor, once appointed, will be required to adopt and comply with the contents of this Outline CTMP.

10.0 New Permanent Access Roads – within the Wind Farm

Prior to the construction of any access roads on site a detailed design will need to be carried out. The access roads will be marked out by the Site Engineer. Permanent access roads will have widths of 5m/5.5m to allow all machinery to access all work areas.

10.1 Excavated Road Construction Methodology

Given the flat topography and relatively shallow peat on site, excavated access roads are deemed an appropriate construction technique.

Prior to commencing the construction of the excavated roads movement monitoring posts will be installed in areas where the peat depth is greater than 2.0m. An excavator will excavate the width of the new access road which will include a roadside drainage channel with silt traps, soakage areas, interceptor drains along the access road alignment which will be designed in accordance with BRE guidelines.

All organic material and soft subsoil will be removed to formation level with excavated material to be reused and stored on site. Layers of geogrid/geotextile will be required at the surface of the competent stratum, a minimum sub-base will be laid on the geotextile membrane which will consist of 200mm of crushed granular material. A surface layer will be laid which will consist of 75mm compacted 40mm material to accommodate HGV traffic.

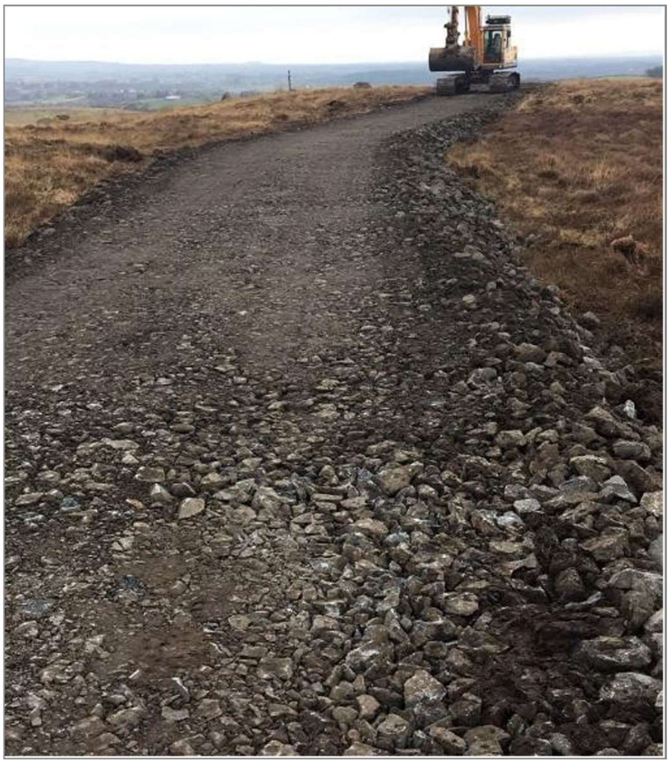


Figure 18: Typical Windfarm Access Road

11.0 Reinstatement of Private Land

Once all construction works are complete, the work areas will be reinstated with excavated soil and either seeded out with native species, allowed to vegetate naturally or reinstated with excavated grass turves and will be restored to their original condition. This work will be carried out in in consultation with the landowner and in line with any relevant measures outlined in the planning application, CEMP and planning conditions.

12.0 Implementation of Environmental Protection Measures

All environmental protection measures contained with the EIAR/EIS which accompanies the planning application will be incorporated into a detailed CEMP and construction method statements prior to the commencement of development and will be implemented in full during the construction phase. The Project Manager and Site Manager will be responsible for the implementation of measures following consultation with the Environmental Manager and ECoW where necessary.

13.0 Invasive Species Best Practice Measures

Invasive species can be introduced into a location by contaminated plant, machinery and equipment which were previously used in locations that contained invasive species. Good site organisation and hygiene management shall be maintained always on site, and best practice measures will be implemented, as follows:

- The contractor will prepare an Invasive Species Action Plan to be implemented during construction, and all personnel will be made aware of the requirements contained within;
- Plant and machinery will be inspected upon arrival and departure from site and cleaned/washed as necessary to prevent the spread of invasive aquatic / riparian species such as Japanese knotweed *Fallopia japonica* and Himalayan Balsam *Impatiens glandulifera*. A sign off sheet will be maintained by the contractor to confirm the implementation of measures;
- Site hygiene signage will be erected in relation to the management of non-native invasive material.

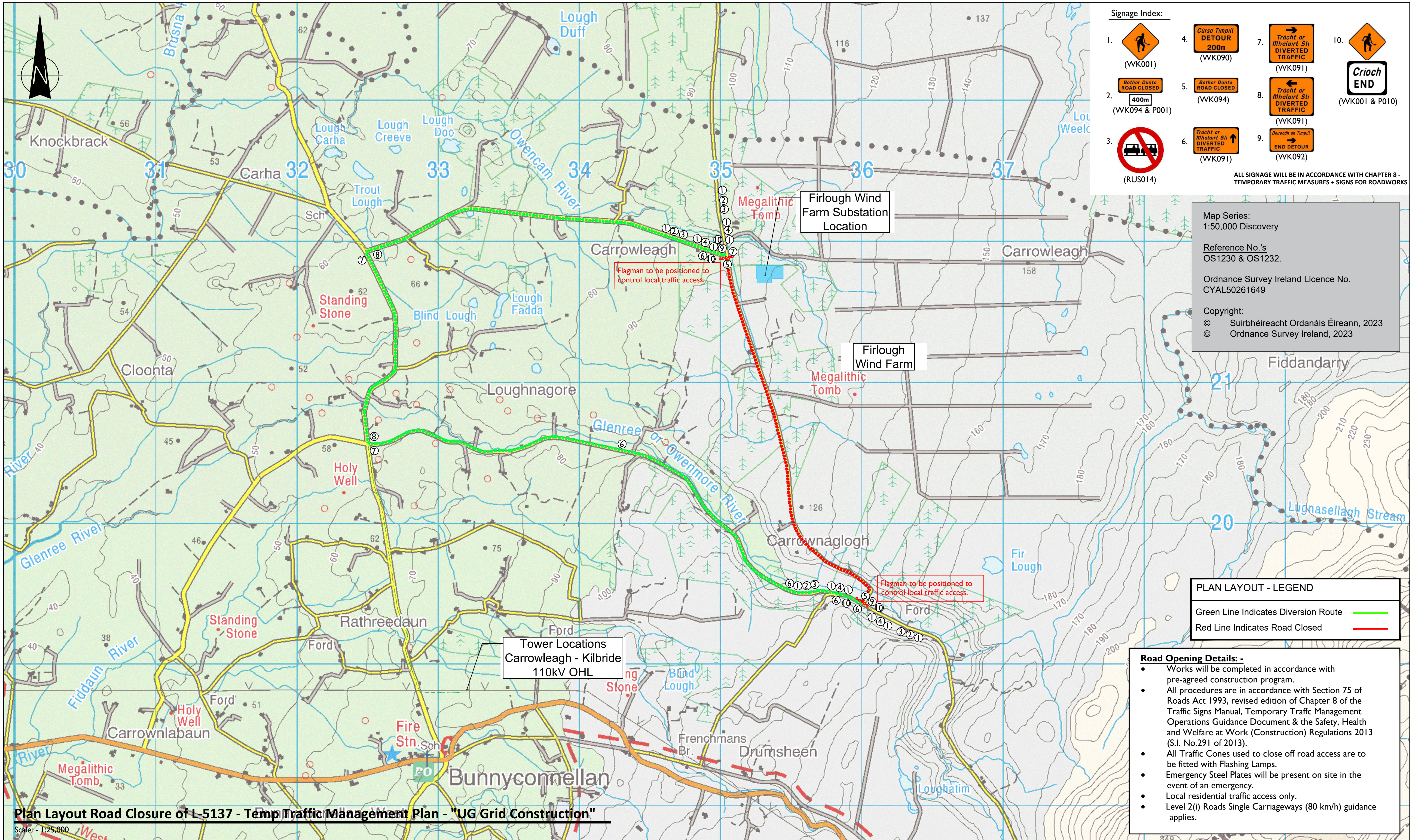
14.0 Waste Management

All waste products (general waste, plastic, timber, etc.) arising during the construction phase will be managed and disposed of in accordance with the provisions of the Waste Management Act 1996 and associated amendments and regulations, and a Waste Management Plan will be prepared by the contractor prior to the commencement of construction. All waste material will be disposed of at a fully licensed facility.

15.0 Construction Hours

Standard working hours for construction will be 8.00am to 8.00pm Monday to Friday and 8.00am to 6.00pm on Saturday (if required), with no works on Sundays or Bank Holidays except in exceptional circumstances or in the event of an emergency. All site personnel will be required to wear project notification labelling on high visibility vests and head protection so that they can be easily identified by all workers on-site.

Project Management Initials: Designer: GD Checked: DB Approved: RG ISO A3 297mm x 420mm



Map Series:
1:50,000 Discovery

Reference No.'s
OS1230 & OS1232.

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PLAN LAYOUT - LEGEND

Green Line Indicates Diversion Route
Red Line Indicates Road Closed

Road Opening Details: -

- Works will be completed in accordance with pre-agreed construction program.
- All procedures are in accordance with Section 75 of Roads Act 1993, revised edition of Chapter 8 of the Traffic Signs Manual, Temporary Traffc Management Operations Guidance Document & the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No.291 of 2013).
- All Traffic Cones used to close off road access are to be fitted with Flashing Lamps.
- Emergency Steel Plates will be present on site in the event of an emergency.
- Local residential traffic access only.
- Level 2(i) Roads Single Carriageways (80 km/h) guidance applies.

Plan Layout Road Closure of L-5137 - Temp Traffic Management Plan - "UG Grid Construction"

Scale: - 1:25,000

Head Office
Beenreigh,
Abbeydorney,
Tralee, Co. Kerry
Ireland
Tel: 00353 66 7135710

CLIENT
JENNINGS O'DONOVAN & PARTNERS LIMITED CONSULTING ENGINEERS

PROJECT
Firlough Wind Farm 110kV Loop-In Grid Connection

PROJECT NUMBER
05-806

SHEET NUMBER
05806-DR-250

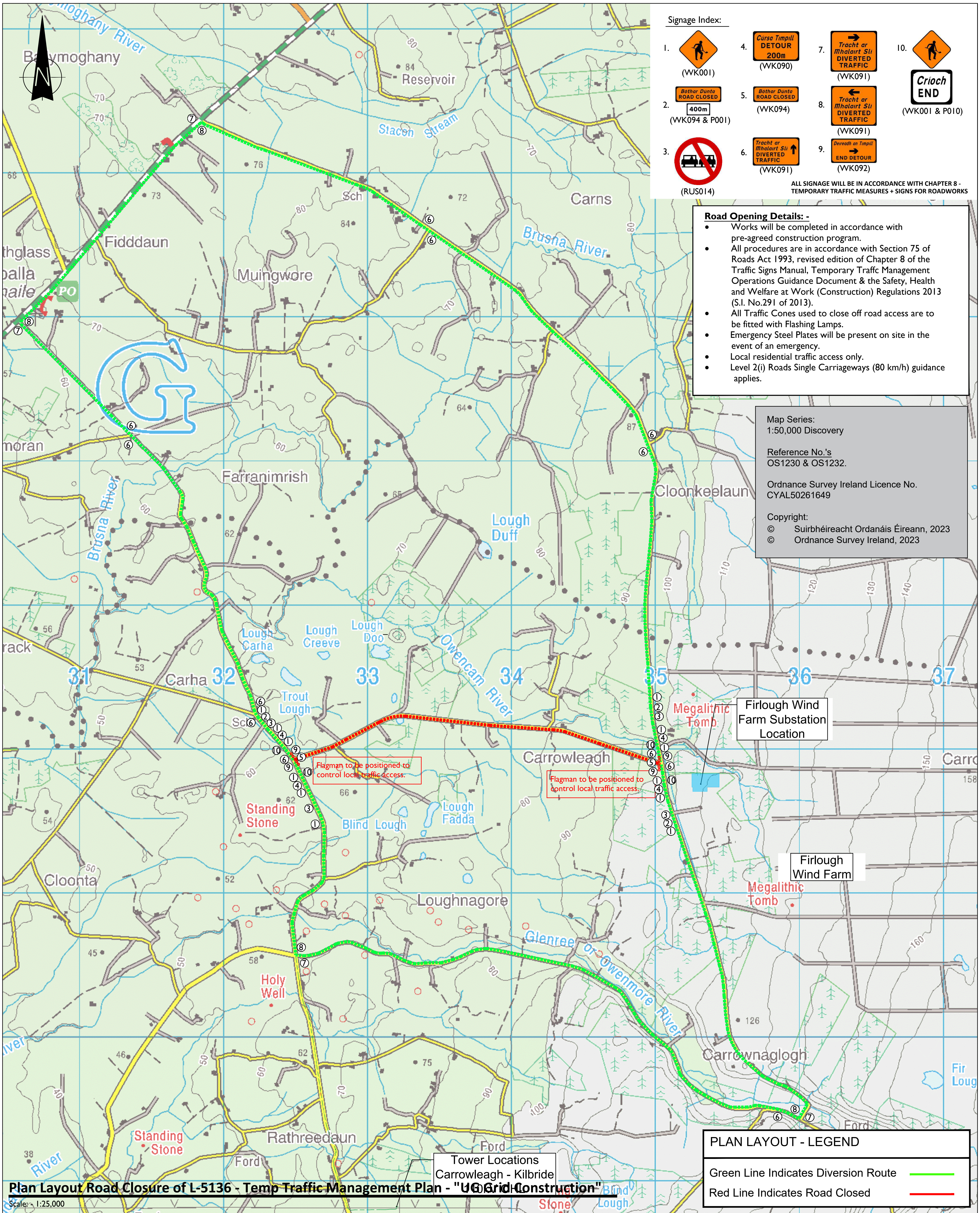
SHEET TITLE
Overall Site Location Map -Temporary Traffic Management -Road Closure of L-5137

DRAWING STATUS
For Planning

ISSUE/REVISION

I/R	DATE	DESCRIPTION
P1	21.06.23	Issued for Planning
P0	24.11.21	Issued for Planning

ISO A3 297mm x 420mm



Plan Layout Road Closure of L-5136 - Temp Traffic Management Plan - "UG Grid Construction"

Scale: - 1:25,000

tli GROUP

Head Office
Beenreigh,
Abbeydorney,
Tralee, Co. Kerry
Ireland
Tel: 00353 66 7135710

CLIENT

JENNINGS O'DONOVAN & PARTNERS LIMITED CONSULTING ENGINEERS

SHEET TITLE

Overall Site Location Map -Temporary Traffic Management -Road Closure of L-5136

DRAWING STATUS

For Planning

LEGEND/NOTES: -

PROJECT

Firlough Wind Farm 110kV Loop-In Grid Connection

PROJECT NUMBER

05-806

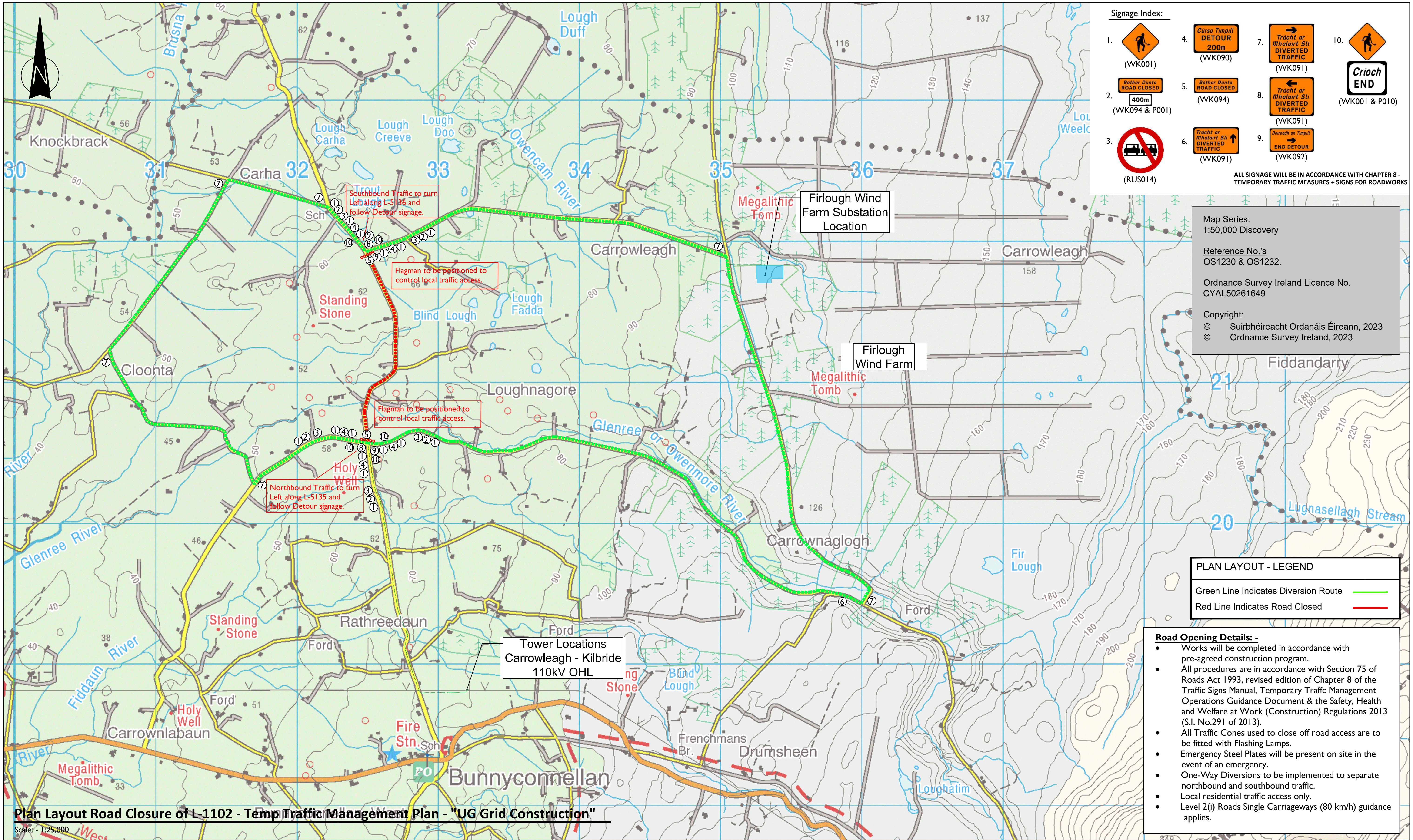
SHEET NUMBER

05806-DR-251

ISSUE/REVISION

I/R	DATE	DESCRIPTION
P0	24.11.21	Issued for Planning

Project Management Initials: Designer: GD Checked: DB Approved: RG ISO A3 297mm x 420mm



Signage Index:

1. (WK001)
2. Bóthar Dúnta ROAD CLOSED 400m (WK094 & P001)
3. (RUS014)
4. Cúrsa Timpill DETOUR 200m (WK090)
5. Bóthar Dúnta ROAD CLOSED (WK094)
6. Trácht ar Mhalairt Slí DIVERTED TRAFFIC (WK091)
7. Trácht ar Mhalairt Slí DIVERTED TRAFFIC (WK091)
8. Trácht ar Mhalairt Slí DIVERTED TRAFFIC (WK091)
9. Deireadh an Timpill END DETOUR (WK092)
10. Críoch END (WK001 & P010)

ALL SIGNAGE WILL BE IN ACCORDANCE WITH CHAPTER 8 - TEMPORARY TRAFFIC MEASURES + SIGNS FOR ROADWORKS

Map Series:
1:50,000 Discovery

Reference No.'s
OS1230 & OS1232.

Ordnance Survey Ireland Licence No.
CYAL50261649

PLAN LAYOUT - LEGEND

Green Line Indicates Diversion Route

Red Line Indicates Road Closed

Road Opening Details: -

- Works will be completed in accordance with pre-agreed construction program.
- All procedures are in accordance with Section 75 of Roads Act 1993, revised edition of Chapter 8 of the Traffic Signs Manual, Temporary Traffc Management Operations Guidance Document & the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No.291 of 2013).
- All Traffic Cones used to close off road access are to be fitted with Flashing Lamps.
- Emergency Steel Plates will be present on site in the event of an emergency.
- One-Way Diversions to be implemented to separate northbound and southbound traffic.
- Local residential traffic access only.
- Level 2(i) Roads Single Carriageways (80 km/h) guidance applies.

Plan Layout Road Closure of L-1102 - Temp Traffic Management Plan - "UG Grid Construction"

Scale: - 1:25,000

tli GROUP
Head Office
Beenreigh,
Abbeydorney,
Tralee, Co. Kerry
Ireland
Tel: 00353 66 7135710

CLIENT
JENNINGS O'DONOVAN & PARTNERS LIMITED CONSULTING ENGINEERS

PROJECT
Firlough Wind Farm 110kV Loop-In Grid Connection

PROJECT NUMBER
05-806

SHEET NUMBER
05806-DR-252

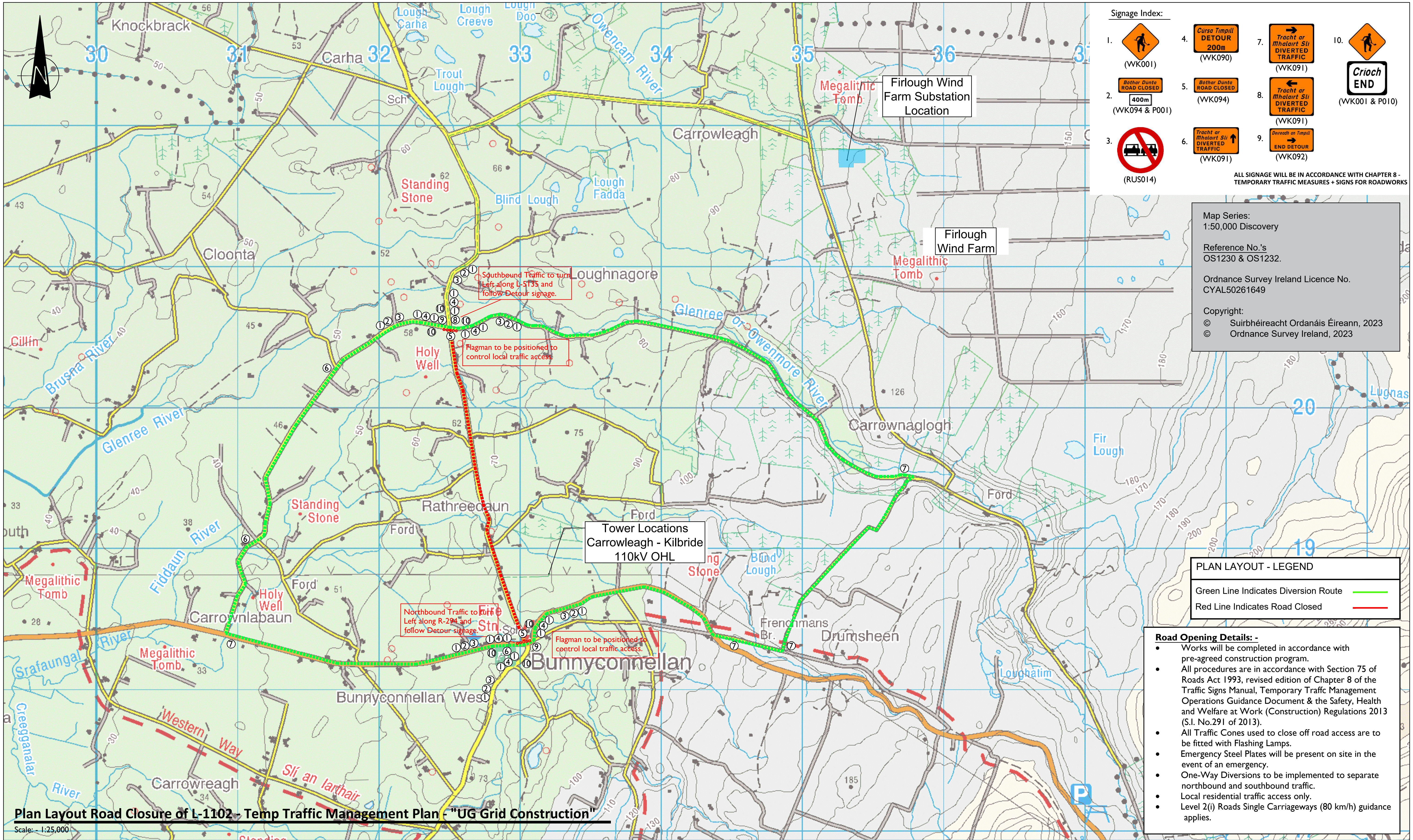
SHEET TITLE
Overall Site Location Map -Temporary Traffic Management -Road Closure of L-1102

DRAWING STATUS
For Planning

ISSUE/REVISION

I/R	DATE	DESCRIPTION
P1	21.06.23	Issued for Planning
P0	24.11.21	Issued for Planning

Project Management Initials: Designer: GD Checked: DB Approved: RG ISO A3 297mm x 420mm



Plan Layout Road Closure of L-1102 - Temp Traffic Management Plan - "UG Grid Construction"

Scale: - 1:25,000

Head Office
Beenreigh,
Abbeydorney,
Tralee, Co. Kerry
Ireland
Tel: 00353 66 7135710

CLIENT
JENNINGS O'DONOVAN & PARTNERS LIMITED CONSULTING ENGINEERS

PROJECT
Firlough Wind Farm 110kV Loop-In Grid Connection

PROJECT NUMBER
05-806

SHEET NUMBER
05806-DR-253

SHEET TITLE
Overall Site Location Map -Temporary Traffic Management -Road Closure of L-1102

DRAWING STATUS
For Planning

ISSUE/REVISION

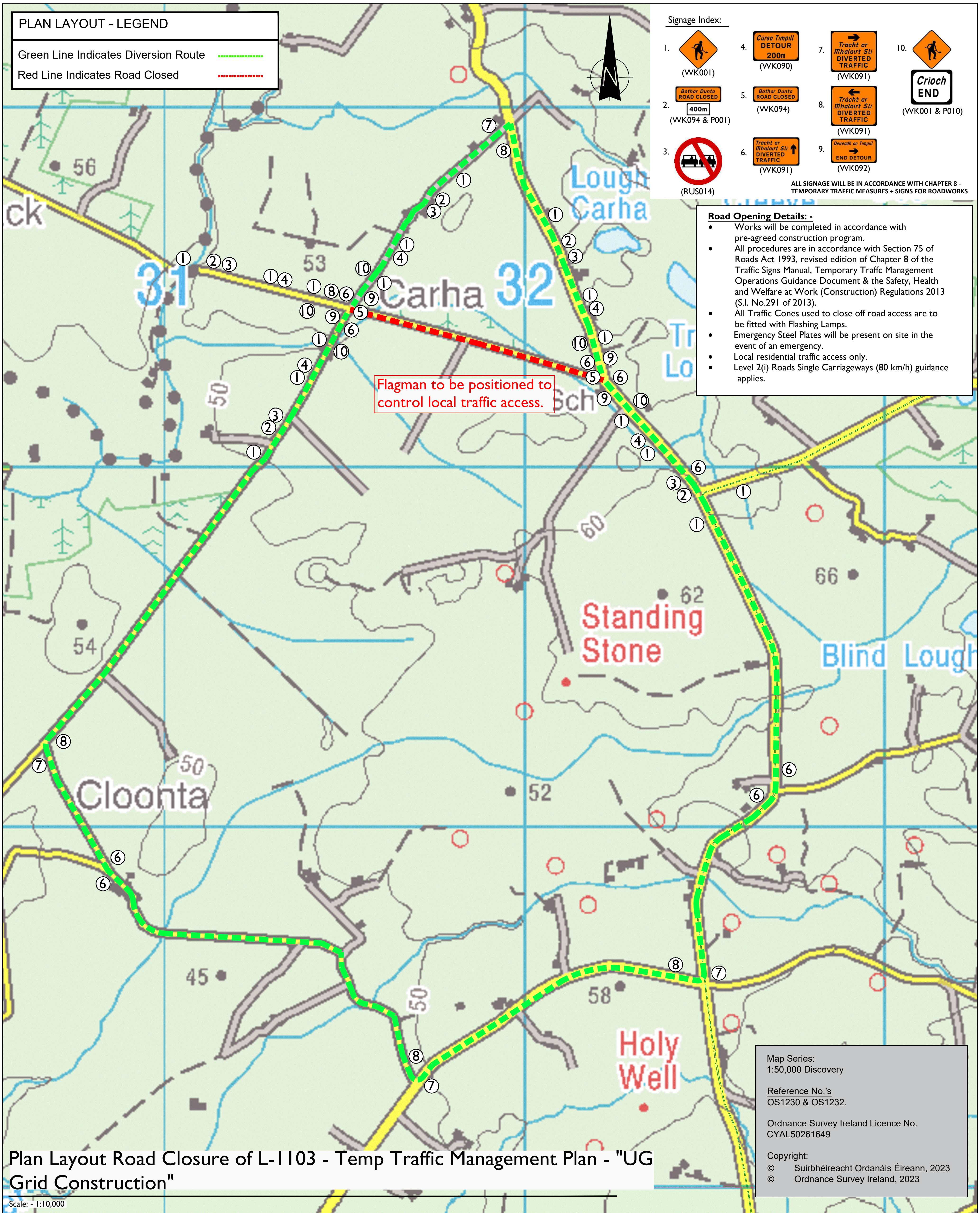
I/R	DATE	DESCRIPTION
P1	21.06.23	Issued for Planning
P0	24.11.21	Issued for Planning

ISO A3 297mm x 420mm

PLAN LAYOUT - LEGEND

Green Line Indicates Diversion Route

Red Line Indicates Road Closed



Signage Index:

1. (WK001)
2. Bóthar Dúnta ROAD CLOSED 400m (WK094 & P001)
3. (RUS014)
4. Cúrsa Timpill DETOUR 200m (WK090)
5. Bóthar Dúnta ROAD CLOSED (WK094)
6. Tracht ar Mhalairt Slí DIVERTED TRAFFIC (WK091)
7. Tracht ar Mhalairt Slí DIVERTED TRAFFIC (WK091)
8. Tracht ar Mhalairt Slí DIVERTED TRAFFIC (WK091)
9. Deireadh an Timpill END DETOUR (WK092)
10. Críoch END (WK001 & P010)

ALL SIGNAGE WILL BE IN ACCORDANCE WITH CHAPTER 8 - TEMPORARY TRAFFIC MEASURES + SIGNS FOR ROADWORKS

Road Opening Details: -

- Works will be completed in accordance with pre-agreed construction program.
- All procedures are in accordance with Section 75 of Roads Act 1993, revised edition of Chapter 8 of the Traffic Signs Manual, Temporary Traffc Management Operations Guidance Document & the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No.291 of 2013).
- All Traffic Cones used to close off road access are to be fitted with Flashing Lamps.
- Emergency Steel Plates will be present on site in the event of an emergency.
- Local residential traffic access only.
- Level 2(i) Roads Single Carriageways (80 km/h) guidance applies.

Map Series:
1:50,000 Discovery

Reference No.'s
OS1230 & OS1232.

Ordnance Survey Ireland Licence No.
CYAL50261649

Plan Layout Road Closure of L-1103 - Temp Traffic Management Plan - "UG Grid Construction"

Scale: - 1:10,000

tli GROUP

Head Office
Beenreigh,
Abbeydorney,
Tralee, Co. Kerry
Ireland
Tel: 00353 66 7135710

CLIENT
JENNINGS O'DONOVAN & PARTNERS LIMITED CONSULTING ENGINEERS

SHEET TITLE
Overall Site Location Map -Temporary Traffic Management -Road Closure of L-5136

DRAWING STATUS
For Planning

LEGEND/NOTES: -

PROJECT
Firlough Wind Farm 110kV Loop-In Grid Connection

PROJECT NUMBER
05-806

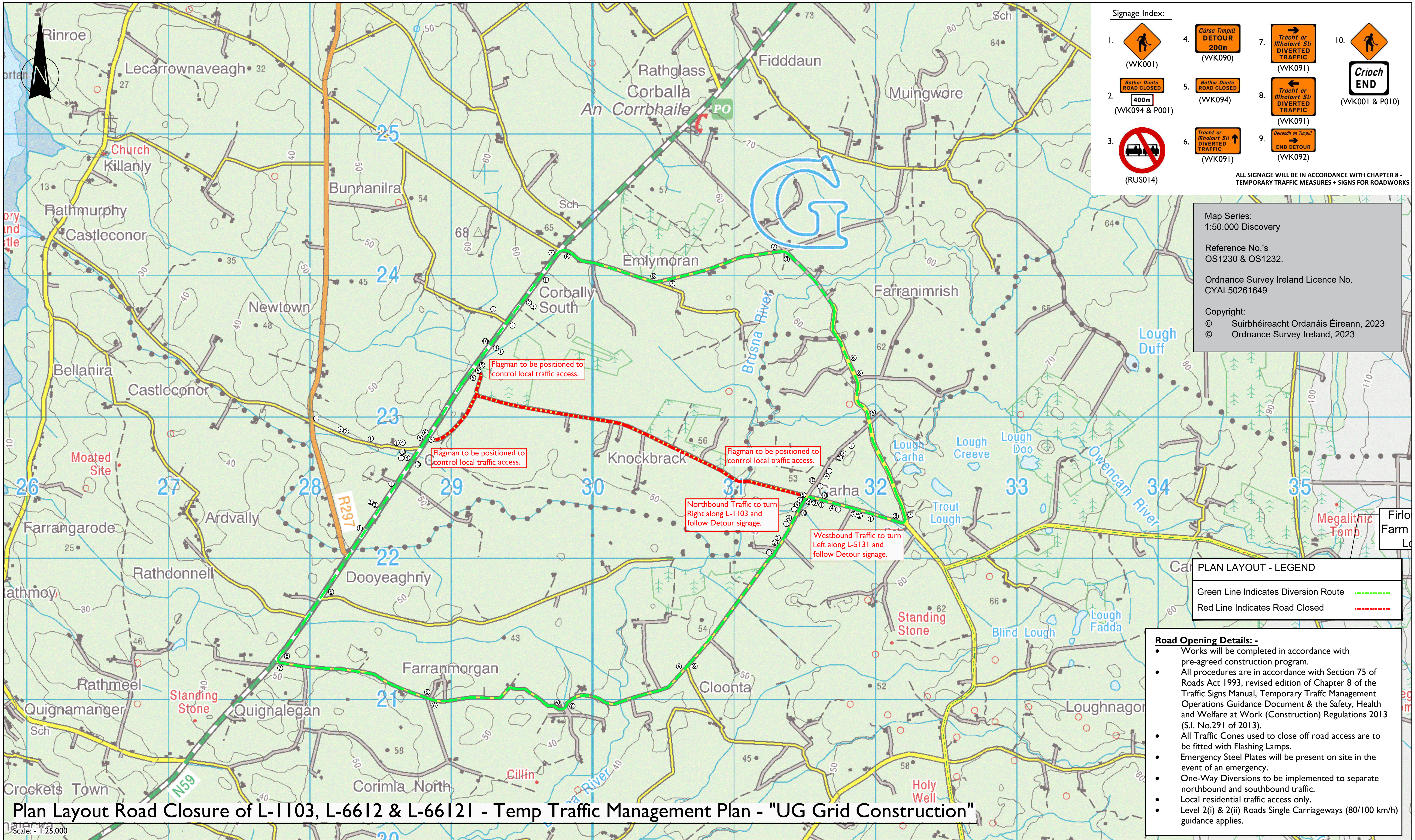
SHEET NUMBER
05806-DR-281

FOR PLANNING APPLICATION
NOT FOR CONSTRUCTION

ISSUE/REVISION

P1	21.06.23	Issued for Planning
P0	17.02.23	Issued for Planning
I/R	DATE	DESCRIPTION

Project Management Initials: Designer: GD Checked: DB Approved: RG ISO A3 297mm x 420mm



Plan Layout Road Closure of L-1103, L-6612 & L-66121 - Temp Traffic Management Plan - "UG Grid Construction"

Scale: - 1:25,000

Road Opening Details: -

- Works will be completed in accordance with pre-agreed construction program.
- All procedures are in accordance with Section 75 of Roads Act 1993, revised edition of Chapter 8 of the Traffic Signs Manual, Temporary Traffc Management Operations Guidance Document & the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No.291 of 2013).
- All Traffic Cones used to close off road access are to be fitted with Flashing Lamps.
- Emergency Steel Plates will be present on site in the event of an emergency.
- One-Way Diversions to be implemented to separate northbound and southbound traffic.
- Local residential traffic access only.
- Level 2(i) & 2(ii) Roads Single Carriageways (80/100 km/h) guidance applies.

tli GROUP

Head Office
Beenreigh,
Abbeydorney,
Tralee, Co. Kerry
Ireland
Tel: 00353 66 7135710

CLIENT
JENNINGS O'DONOVAN CONSULTING ENGINEERS

PROJECT
Firlough Wind Farm 110kV Loop-In Grid Connection

PROJECT NUMBER 05-806

SHEET NUMBER 05806-DR-282

SHEET TITLE
Overall Site Location Map -TTM - Road Closure of L-1103, L-6612 & L-66121

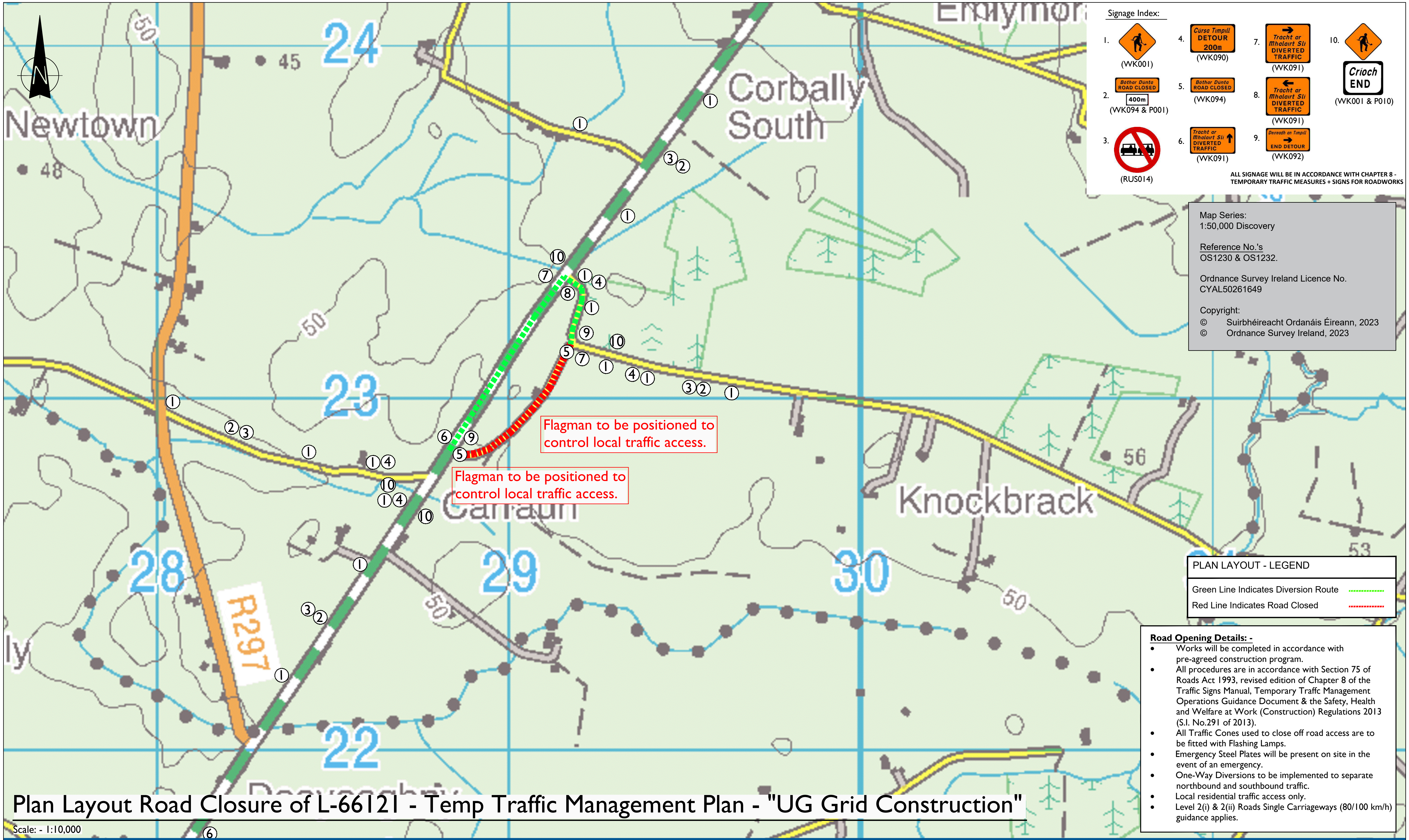
DRAWING STATUS For Planning

FOR PLANNING APPLICATION NOT FOR CONSTRUCTION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
P1	21.06.23	Issued for Planning
P0	17.02.23	Issued for Planning

Project Management Initials: Designer: GD Checked: DB Approved: RG ISO A3 297mm x 420mm



Signage Index:

1. (WK001)
2. (WK094 & P001)
3. (RUS014)
4. (WK090)
5. (WK094)
6. (WK091)
7. (WK091)
8. (WK091)
9. (WK092)
10. (WK001 & P010)

ALL SIGNAGE WILL BE IN ACCORDANCE WITH CHAPTER 8 - TEMPORARY TRAFFIC MEASURES + SIGNS FOR ROADWORKS

Map Series:
1:50,000 Discovery

Reference No.'s
OS1230 & OS1232.

Ordnance Survey Ireland Licence No.
CYAL50261649

PLAN LAYOUT - LEGEND

Green Line Indicates Diversion Route
Red Line Indicates Road Closed

Road Opening Details: -

- Works will be completed in accordance with pre-agreed construction program.
- All procedures are in accordance with Section 75 of Roads Act 1993, revised edition of Chapter 8 of the Traffic Signs Manual, Temporary Traffc Management Operations Guidance Document & the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No.291 of 2013).
- All Traffic Cones used to close off road access are to be fitted with Flashing Lamps.
- Emergency Steel Plates will be present on site in the event of an emergency.
- One-Way Diversions to be implemented to separate northbound and southbound traffic.
- Local residential traffic access only.
- Level 2(i) & 2(ii) Roads Single Carriageways (80/100 km/h) guidance applies.

Plan Layout Road Closure of L-66121 - Temp Traffic Management Plan - "UG Grid Construction"

Scale: - 1:10,000

tli GROUP

Head Office
Beenreigh,
Abbeydorney,
Tralee, Co. Kerry
Ireland
Tel: 00353 66 7135710

CLIENT
JENNINGS O'DONOVAN & PARTNERS LIMITED CONSULTING ENGINEERS

PROJECT
Firlough Wind Farm 110kV Loop-In Grid Connection

PROJECT NUMBER
05-806

SHEET NUMBER
05806-DR-283

SHEET TITLE
Overall Site Location Map -Temporary Traffic Management - Road Closure of L-66121

DRAWING STATUS
For Planning

FOR PLANNING APPLICATION NOT FOR CONSTRUCTION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
P1	21.06.23	Issued for Planning
P0	17.02.23	Issued for Planning

Firlough WF - 110kV Grid Connection

Route Summary & Joint Bay Locations - UGC A

Rev1 (09.12.22)

Section From	Section To	Section Length	Bonding Arrangement	No. of Watercourses	Watercourses	No. of Culverts	No. of Services	No. of Bridges	Bridges	Comments
Tie In Tower (15B)	JB-01A	500.8	Single Point Bonded	-	-	-	4	-	-	-
JB-01A	JB-02A	725.5	Single Point Bonded	1	Srafaungal River	1	7	1	B1	*HDD Bridge Crossing*
JB-02A	JB-03A	762.3	Cross Bonded	1	Fiddaun Stream	-	3	1	B2	*HDD Bridge Crossing*
JB-03A	JB-04A	763.4	Cross Bonded	1	Glenree Stream	-	2	1	B3	*HDD Bridge Crossing*
JB-04A	JB-05A	764.2	Cross Bonded	1	Loughnagore Stream	-	1	-	B4	*HDD Bridge Crossing*
JB-05A	JB-06A	715.5	Single Point Bonded	-	-	1	1	-	-	
JB-06A	JB-07A	644.5	Cross Bonded	-	-	-	1	-	-	-
JB-07A	JB-08A	643.8	Cross Bonded	-	-	1	2	1	-	*Planning Application Planning Ref No.21905*
JB-08A	JB-09A	643.9	Cross Bonded	-	-	-	2	-	-	
JB-09A	Firlough Windfarm	485.0	Single Point Bonded		-	1	4	-	-	*Black Lough Windfarm MV Cable Undercrossing*
	Total:	**6,648.8**		**4**		**4**	**27**	**4**		

Firlough WF - 110kV Grid Connection

Route Summary & Joint Bay Locations - UGC B

Rev1 (09.12.22)

Section From	Section To	Section Length	Bonding Arrangement	No. of Watercourses	Watercourses	No. of Culverts	No. of Services	No. of Bridges	Bridges	Comments
Tie In Tower (15A)	JB-01B	579.9	Single Point Bonded	-	-	-	4	-	-	-
JB-01B	JB-02B	624.9	Single Point Bonded	1	Srafaungal River	1	7	1	B1	*HDD Bridge Crossing*
JB-02B	JB-03B	777.5	Cross Bonded	1	Fiddaun Stream	-	3	1	B2	*HDD Bridge Crossing*
JB-03B	JB-04B	781.8	Cross Bonded	1	Glenree Stream	-	2	1	B3	*HDD Bridge Crossing*
JB-04B	JB-05B	782.2	Cross Bonded	1	Loughnagore Stream	-	1	-	B4	*HDD Bridge Crossing*
JB-05B	JB-06B	615.4	Single Point Bonded	-	-	1	2	-	-	
JB-06B	JB-07B	717.2	Cross Bonded	-	-	-	1	-	-	-
JB-07B	JB-08B	713.7	Cross Bonded	-	-	1	2	1	-	*Planning Application Planning Ref No.21905*
JB-08B	JB-09B	714.8	Cross Bonded	-	-	-	2	-	-	
JB-09B	Firlough Windfarm	383.4	Single Point Bonded		-	1	4	-	-	*Black Lough Windfarm MV Cable Undercrossing*
	Total:	**6,690.9**		**4**		**4**	**28**	**4**		

2764

Hydrogen Plant - 110kV Grid Connection

Route Summary & Joint Bay Locations - UGC C

Rev1 (09.12.22)

Section From	*Section To*	*Section Length*	*Bonding Arrangement*	*No. of Watercourses*	*Watercourses*	*No. of Culverts*	*No. of Services*	*No. of Bridges*	*Bridges*	*Comments*
Firlough Windfarm	JB-01C	736.6	Cross Bonded	-	-					
JB-01C	JB-02C	736.7	Cross Bonded							
JB-02C	JB-03C	736.5	Cross Bonded							
JB-03C	JB-04C	435.9	Single Point Bonded							
JB-04C	JB-05C	820.3	Cross Bonded							
JB-05C	JB-06C	820.0	Cross Bonded	-	-					
JB-06C	JB-07C	820.2	Cross Bonded	-	-					
JB-07C	JB-08C	845.0	Cross Bonded	-	-					
JB-08C	JB-09C	846.9	Cross Bonded	-	-					
JB-09C	JB-10C	846.7	Cross Bonded							
JB-10C	Hydrogen Plant Sub	526.1	Single Point Bonded		-					
	Total:	**8,171.0**		**0**		**0**	**0**	**0**		