IONIC CONSULTING

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Date: 28th October 2022

RE: Coole Wind Farm 110kV Grid Connection – RFI Responses

To whom it may concern,

Please find enclosed three reports prepared in relation to Coole Wind Farm 110kV Grid Route which were prepared to assist in providing responses to the request for further information from ABP. The reports are:

- COLE r005 RFI: TII Submission, N4 National Road, Co. Westmeath
- COLE r006 110kV Grid Route Connection RFI Response
- COLE r007 Westmeath County Council Submission – Bridge Crossings

Regards,

____
John Shanahan

On behalf of Ionic Consulting Ltd.

Note:
Following the acquisition of Ionic Consulting Limited by AFRY, on 1st July 2022, Ionic Consulting will be rebranding under the AFRY name. Future communication and project documentation you receive from us may come under the AFRY brand. In addition the Irish legal entity (Ionic Consulting Limited) will be renamed to AFRY Ireland Limited.

Coole Wind Farm

110kV Grid Route Connection

RFI: TII Submission, N4 National Road, Co. Westmeath

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1. Introduction

The proposed Coole Wind Farm is located north of the village of Coole, County Westmeath. The wind farm 110kV grid connection is proposed between the wind farm site and the existing ESB 110kV Mullingar Substation. The overall route is approximately 26km in length, with approximately 3.4km routed along the N4 national primary road north of Mullingar and to the east of Lough Owel.

In response to the Coole wind farm and grid route planning application to An Bord Pleanála, TII submitted observations on the proposed development (reference TII 21-112941, dated 14th May 2021). This report sets out to provide technical responses to the TII observations, where required.

2. Planned Windfarm Grid Route Installation

This report is particularly focussed on a 3.4km section of the N4 road corridor located approximately mid-way between Mullingar and Multyfarnham, Co. Westmeath (refer to the map below and Appendix A). This section of grid route along the N4 would include 4 no. proposed joint bays.

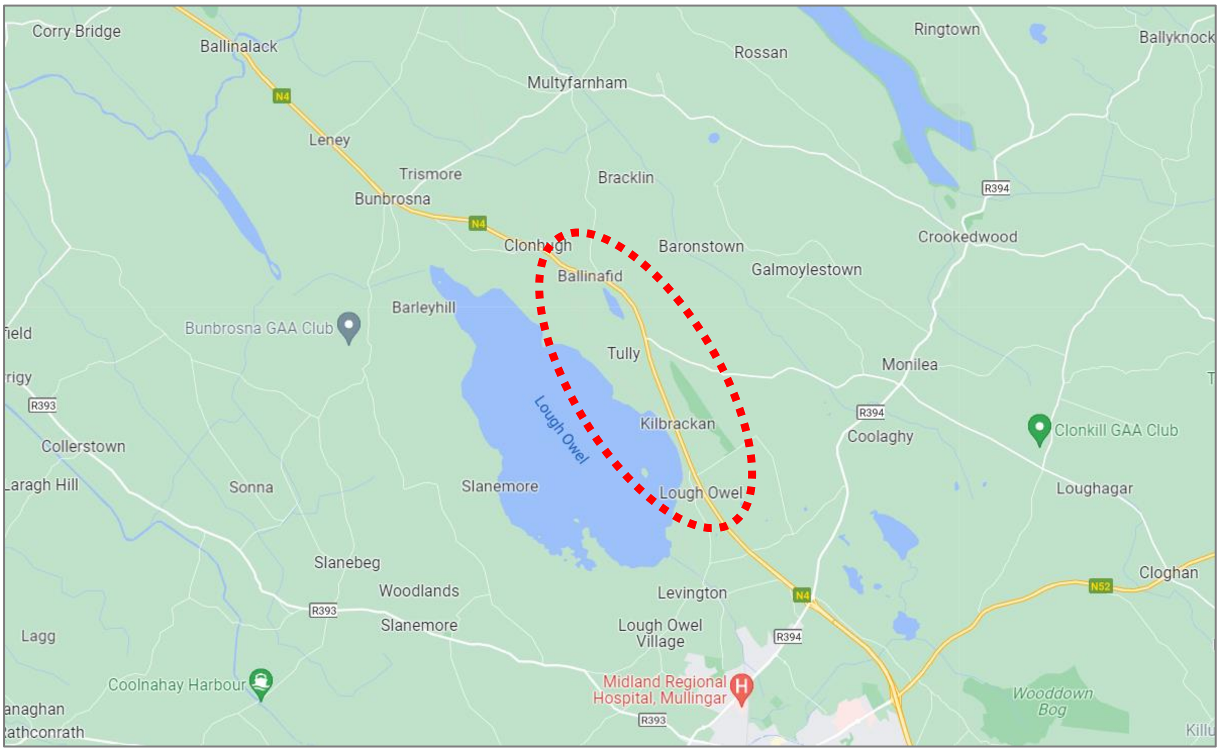


Figure 1 Location Plan

The 110kV grid connection would be installed along the N4 corridor, in the hard shoulder and verge of the N4 roadway. The planned works will be designed and built using the following standards:

- Purple Book "Guidelines for the Opening, Backfilling and Reinstatement of Openings in Public Roads" Rev 1 (April 2017)
- TII Publication CC-PAV-04007 "Requirements for the Reinstatement of Openings in National Roads" (May 2019)
- Any other relevant local authority or TII standard

3. Future National Road (N4) Scheme Planning

High voltage underground grid connections are a common method of constructing grid network infrastructure in Ireland, and for connecting renewable energy power generation and other infrastructure to the power network. It is common practice for underground services and utilities to be laid underground within roads and along public road corridors. It would be common for road engineering projects to have to address technical and programme challenges associated with the presence of underground utilities within a roadway, when planning or carrying out maintenance or upgrade works. Coole Wind Farm Ltd. will be available to engage with TII as required on such matters.

The purpose of this section is to outline potential online road upgrade methodologies for future road upgrades to the N4, considering the presence of the high voltage (HV) cables. Details of a potential upgrade are not currently available, so for the purposes of this exercise, two potential scenarios (A and B) have been considered below. Both scenarios presented consider road upgrade works along the existing road corridor (an online upgrade). If future N4 upgrade works involve constructing a new road within a separate corridor (an offline upgrade), the grid connection could be retained in position without impacting those works. In the case of an online upgrade, it may be necessary to relocate the underground cables to an intermediate temporary location to facilitate the construction sequencing. Without knowing the details of any proposed upgrade it is not possible to predict if this would be required, however the methodology involved would be similar to that presented in scenario B.

For the purposes of this exercise, as outlined in Figure 2, the HV cable is shown located in the hard shoulder of the existing roadway.

3.1 SCENARIO A: Major Road Resurfacing, no road realignment required

In this scenario, if a full or partial resurfacing is required, no movement of the HV cable would be required. For many road upgrade works involving underground HV cables, the works do not involve movement or removal of the cable/ducting. This is partly due to the depth of burial (approximately 1.2m) and partly due to the material used to construct the cable trench (cement bound granular material [CBGM] around the ducting with graded stone [Cl. 804] within the upper section of the trench).

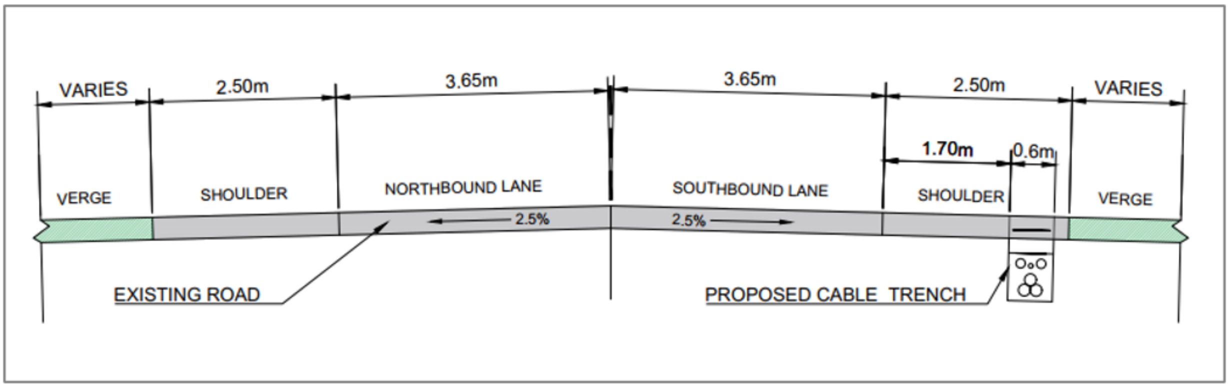


Figure 2 Illustrative road cross-section with proposed grid route within the hard shoulder

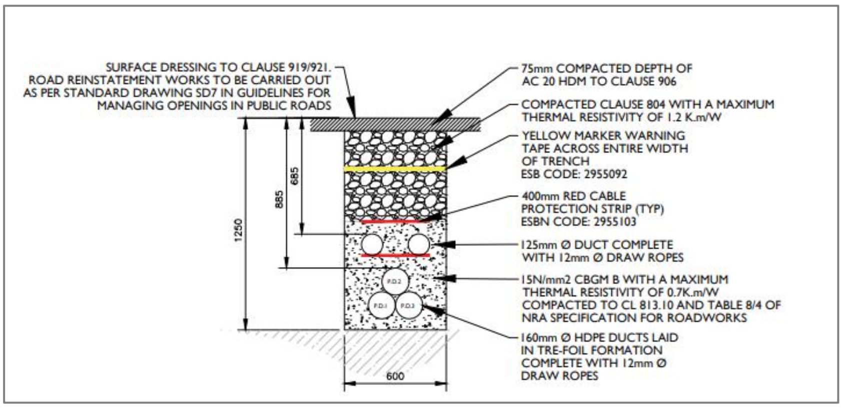


Figure 3 110kV trench detail

3.2 SCENARIO B: Major road upgrade involving both vertical and horizontal re-alignment

In this scenario the HV cable is located in the same position as per Scenario A, however the major road upgrade would require a vertical and horizontal re-alignment of the existing road (an online upgrade), refer to illustrative cross-section in Figure 4.

This scenario imagines that the cable must move location from the southbound lane to the northbound extended lane.

It should also be noted that the road widening depicted in Figure 4 is not the only configuration of a road upgrade. However, Scenario B generally holds true for upgrades as the principal will be the same. The methodology of the upgrade is discussed below.

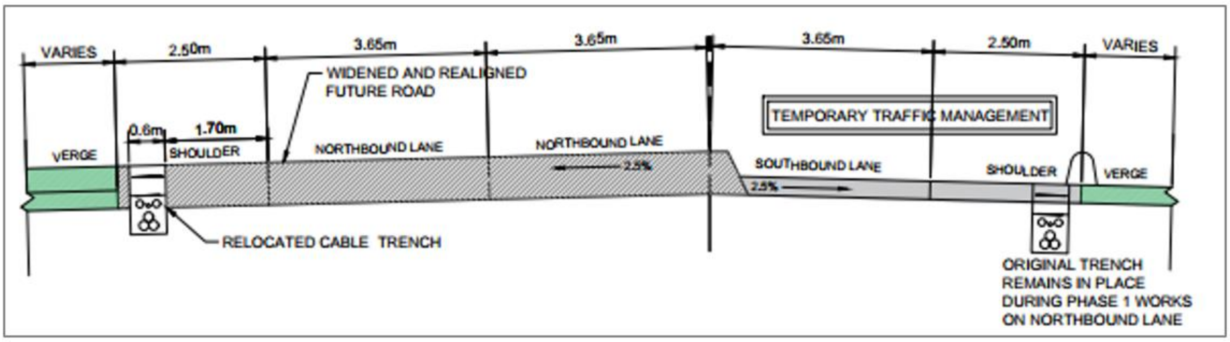


Figure 4 Illustrative Road cross-section for an online upgrade involving both vertical and horizontal alignment

3.2.1 Scenario B Methodology

Phasing of Works:

The works required for moving the HV cable requires 2 phases. Phase 1, as illustrated in Figure 4, is to install the new ducting on the northbound carriage while keeping the southbound carriage open. The southbound carriage will, at that time, contain a live HV cable and this sequence would be chosen to minimise outages on the circuit.

Phase 2 will then require the north bound carriage to be open while the south bound is closed. The original Coole cable will be de-energised, and the removal will take place. The remainder of the road construction will then take place.

It is assumed that the N4 must stay at least partially open to traffic during any major upgrade works by means of appropriate traffic management. Therefore, the phasing of works required for the cable move should not significantly impact staging of the overall road upgrade.

Construction Methodology:

In Phase 1 of the proposed methodology, there are several steps that have been depicted in Figure 5, Figure 6, Figure 7 and Figure 8 below.

- **Step 1**: the road sub-base layers would be constructed to the approved design by the TII contractor. An integrated road/trench design and specification would be provided by the designers and would undergo an approval process with TII, EirGrid and other relevant stakeholders.
- **Step 2**: the cable trench would be excavated as per an integrated design.
- **Step 3:** the cable trench would be installed with the requisite ducts, tape and backfill as per the agreed design and specifications.
- **Step 4:** the road construction would continue, adding the upper layers across the road and compaction of same. As above, this would be completed to the agreed specifications and approved design. The final layers and surfacing would be across the entire road width.

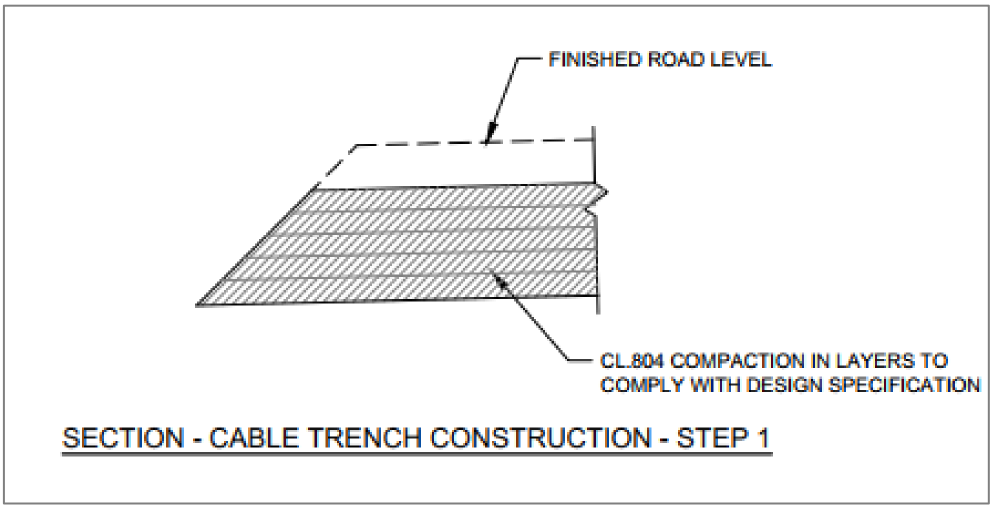


Figure 5 Step 1 of Construction

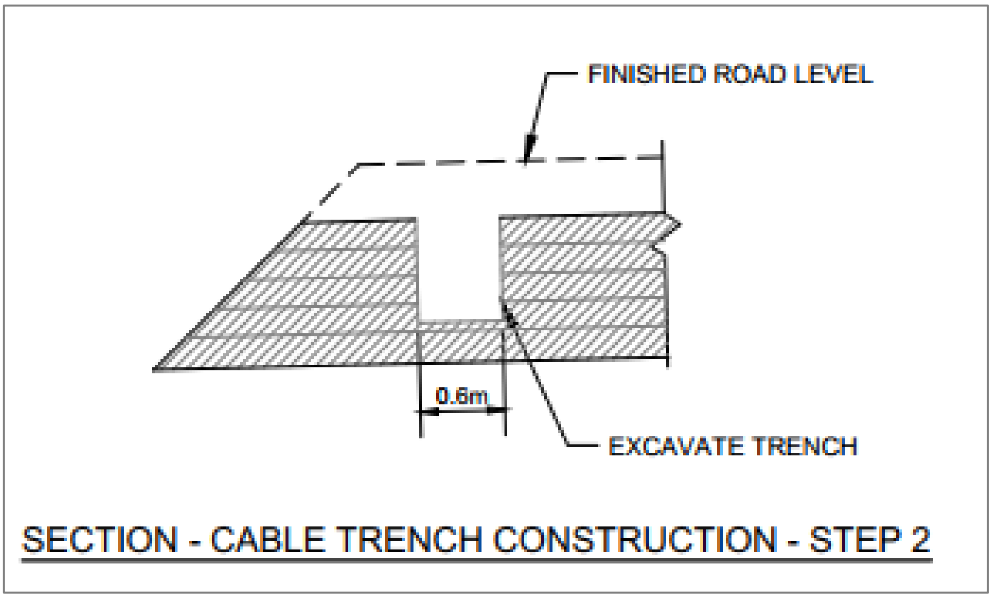


Figure 6 Step 2 of Construction

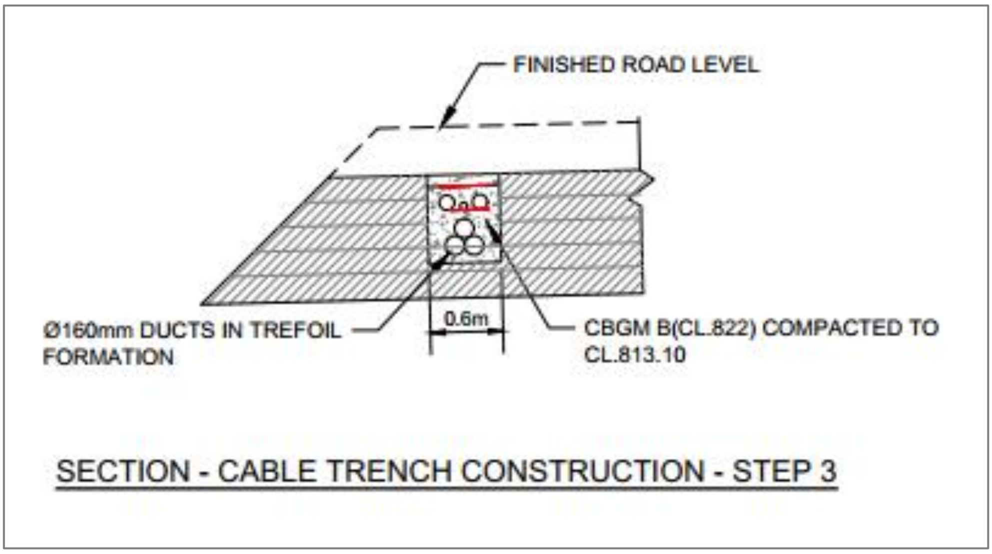


Figure 7 Step 3 of Construction

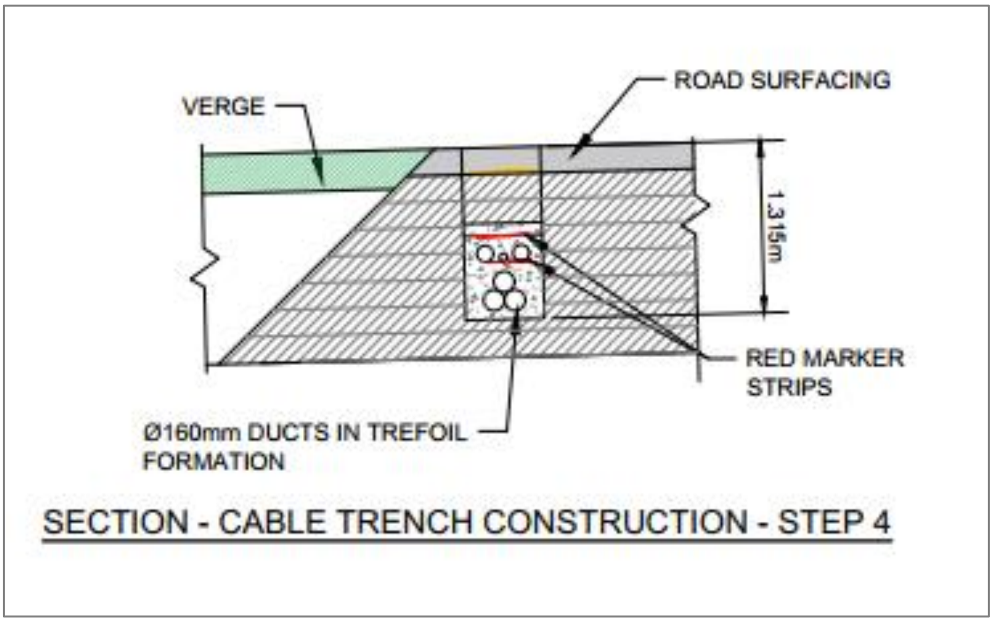


Figure 8 Step 4 of Construction

Once the cable has been moved to the other side of the N4, the new cables will then be jointed to the existing cables at an appropriate location. The sequence of works in this scenario is outlined in the following pages.

Health and Safety

The Health and Safety Authority (HSA) Code of Practice for Avoiding Danger from Underground Services should be referenced when designing or working near to high voltage power cables.

In the case of a major road upgrade as outlined in the previous sections, the following would apply:

1) All designs works will require the identification of underground services through dial before you dig, record retrieval, ground penetrating radar and CAT scanner as required.
2) The first stage of works would be the installation of new ducts away from the existing circuit and therefore outside of zone of any live underground cables.
3) The next stage of works would require the de-energisation of the existing cable to allow any works take place within the zone of the live underground cable.
4) No works would take place near or adjacent to live underground cables.
5) Finally, all energising and de-energising works will be with the supervision of ESB Networks.

In the case that the road is to be resurfaced, a power cable outage would not be required. However, if the road were to be opened at a location containing high voltage cable, as per scenario B outlined above, contact must be made with ESBN, and an outage would be required for such works.

Sequence of Works

The following is the sequence of works required to install the new ducting and cable, de-energise the existing cable and re-energise new cable **in the event of a major road upgrade.**

It should be noted any new designs would be completed in coordination with, or completed by the TII appointed designer.

1. N4 major upgrade works require moving Coole 110kV grid connection
2. A new design would be prepared for the new cable location
3. TII designers would integrate the new cable trench design into road upgrade design
4. Construction commences
5. Ducting (civil works) would be installed in the new location
6. Cable would be pulled into new duct and jointed within the works
7. Existing circuit would be de-energised
8. Existing circuit is cut as it exits the N4 works
9. New cable is connected and jointed to the exisitng cable, and then re-energised
10. Old cable is removed from ducts and road upgrade works continue

4. 110kV joint Bay & Trench Details

4.1 Joint Bay Details

Joint bay details are indicated on drawing COLE d005.4.1 (refer to Appendix B). Joints bays are precast concrete units and comprise a ground slab and surrounding retaining walls. Joint bay locations, details, backfilling, and surface reinstatement design will be agreed with EirGrid, ESBN, Westmeath Co. Co. and TII prior to any works and a detailed design will be developed by the Coole 110kV grid route designer.

From an EirGrid/ESBN perspective, joint bays are located where the terrain and access are suitable for facilitating cable pulling equipment, cable jointing, maintenance, fault finding and future operation of the installation.

An extract from the joint bay drawing is included below, showing a plan and sections of the structure.

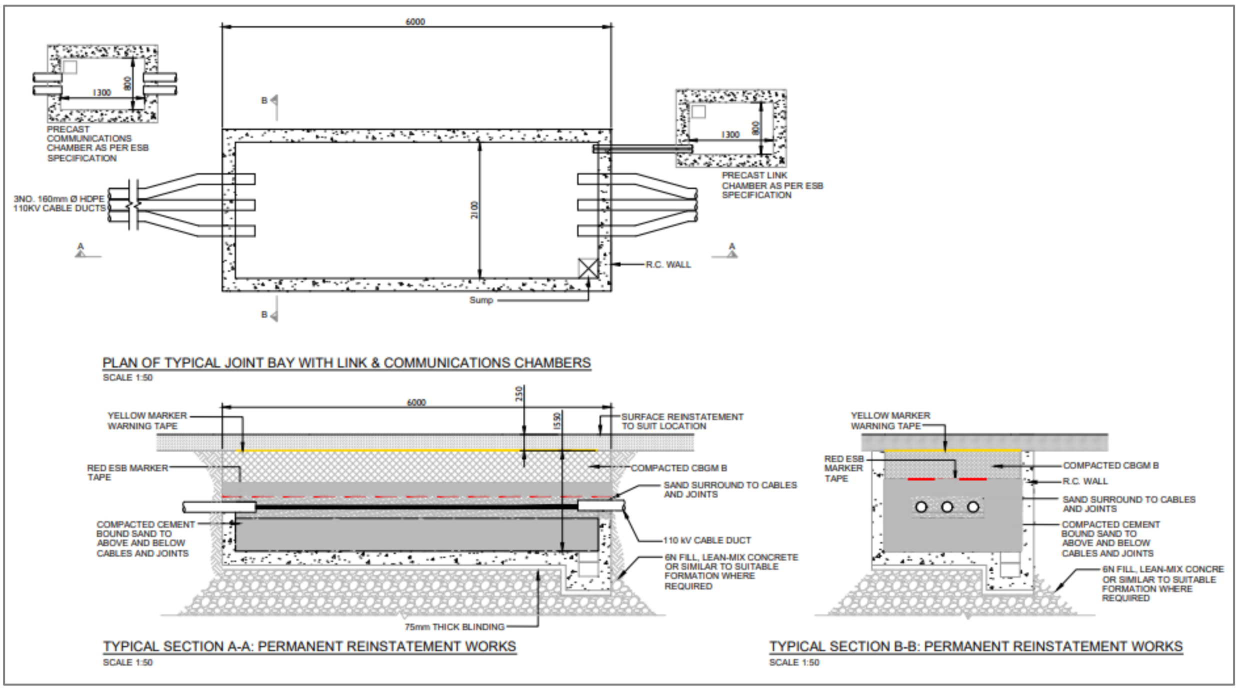


Figure 9 Standard 110kV Joint Bay

4.2 Cable Laying Details

The proposed cable trench details are indicated on drawing COLE d005.4.2 (refer to Appendix B). A standard trench will be 0.6m wide and 1.25m in depth, containing 3 no. power ducts/cables in trefoil formation at the base of the trench, with 1 no. communications ducts/cable and 1 no. earthing duct/cable situated above them.

The trench location within the road cross-section will be agreed with EirGrid, ESBN, TII and Westmeath County Council during a design review process at detailed design stage. Usually, it is proposed to lay the ducting within the road hard shoulder or within the grass verge (where either are available). Details, backfilling, and surface reinstatement design will be agreed with EirGrid, ESBN, Westmeath Co. Co. and TII prior to any works and a detailed design will be developed by the Coole 110kV grid route designer.

An extract from the trench drawing is included below.

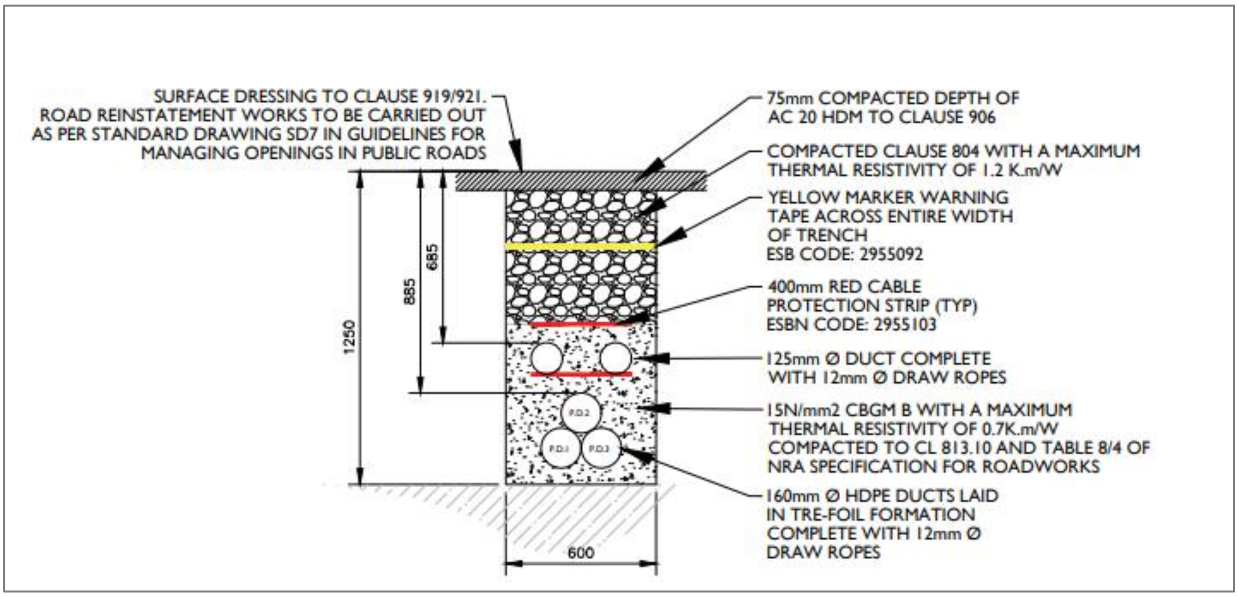


Figure 10 Grid connection trench detail

The reinstatement will be designed to be in accordance with the relevant TII or local authority standards, including TII publication “Requirements for the Reinstatements of Openings in National Roads”.

Where the trench passes through the road pavement, the extent of reinstatement will be confirmed with TII and Westmeath County Council at detailed design stage and confirmed during the road opening licence application.

It is acknowledged that the quality of installation, supervision of installation and materials used during installation of these civil works is a determining factor of any issues that may be encountered along the road surface once works are complete.

The 110kV grid route is proposed to be installed to the EirGrid specification, which requires CBGM material to be installed for the entirety of the circuit. This limits the potential for any settlement issues within the backfill around the ducts themselves. The grid route designers and contractors will be subject to a prequalification process, which can be utilised to ensure that the chosen companies are familiar and experienced with the relevant EirGrid and TII standards and specifications.

5. Road Management & Maintenance

In their response submission, TII outlined what they consider to be a number of significant implications for road authorities in the management and maintenance of the strategic national road network resulting from the laying of high voltage electricity cabling in the national road reservation including:

I. Impacts on embankments, bridges, drainage, road furniture infrastructure leading to future maintenance liabilities
II. Impediments to future routine network improvements such as pavement overlay and strengthening, installation of new verge-side signs and other road furniture
III. Impacts on network traffic flows during installation
IV. Impediment to future on-line upgrades of national roads because of the implications to road authority/TII in having to incur the additional costs of moving underground cables in order to accommodate road improvements

These items are addressed in the table below from a technical perspective.

I. Impacts on embankments, bridges, drainage, road furniture infrastructure leading to future maintenance liabilities	The proposed trench will be positioned so that it will not negatively impact the stability of embankments along the road corridor. It is acknowledged that any negative impacts on a road embankment, which would contain or be adjacent to the proposed grid route, could potentially be detrimental to both the road and grid route itself. The grid route does not cross bridges along the section along the N4. Where the trench would be positioned within the hard shoulder, this should not inhibit the maintenance or replacement of any roadside drains. Where the proposed trench is in proximity to drainage pipes or other infrastructure, a minimum clearance will be maintained in accordance with the EirGrid/ESBN specification. Where the trench would be in the grass verge, then the position of the trench could be agreed with TII/Westmeath CO. Co. to ensure a designated space is retained to allow for drainage maintenance or improvement works. The trench position will be subject to agreement with EirGrid/ESBN as well the road authorities (TII & Westmeath Co. Co.).
II. Impediments to future routine network improvements such as pavement overlay and strengthening, installation of new verge-side signs and other road furniture	With regard to pavement overlay, it is not envisaged that the grid route would inhibit pavement replacement along this section of the N4, refer to Section 3 Scenario A. With regard to strengthening the pavement, given the concrete surround to the ducting, the trench section should provide suitable strength within the lower section of the trench. Where the trench would be positioned within the hard shoulder, this should not inhibit the installation of verge-side road signs and other furniture. Where the trench would be in the grass verge, then the position of the trench could be agreed with TII/Westmeath Co. Co. to ensure a designated space is retained for any anticipated signs or furniture.

III. Impacts on network traffic flows during installation	A traffic management plan and programme of works will be developed with the road authorities in order to ensure any disruption to traffic flows are minimised during installation of the ducting. Given the width of the road corridor it is not envisaged that a road closure would be required to construct the ducting along this section of the N4.
IV. Impediment to future on-line upgrades of national roads because of the implications to road authority/TII in having to incur the additional costs of moving underground cables in order to accommodate road improvements	Refer to Section 3 Scenario B.

6. National Road Network Maintenance & Safety: Haul Route

In their submission, TII stipulated a number of requirements of the developer with regards to the haul route:

Any works to the N4/L1927 junction shall comply with TII publications and shall be subject to a Road Safety Audit as appropriate. Subject to the RSA, works should ensure ongoing safety of all road users.	Noted. The road widening works will be designed to comply with the relevant TII publications and subject to a RSA as appropriate. Works and designs will be progressed to ensure ongoing safety of all road users.
All proposals are requested to be referred to TII.	Noted. Proposals will be referred to TII.
Any damage caused to the road pavement "due to the turning movement of abnormal length loads" shall be rectified in accordance with TII Standards and details shall be agreed with the Road Authority prior to the commencement of any development on site.	Noted. However, we suggest that prior to commencement of deliveries a road condition survey be completed to record the condition of the road in advance of deliveries. If damage is noted a further road condition survey can be completed after deliveries and compared against the before condition in order to determine the extent and type of repairs required.
The developer shall consult with all PPP Companies, MMaRC Contractors and road authorities over which the haul route traverses to ascertain any operational requirements such as delivery timetabling, etc. and to ensure that the strategic function of the national road network is safeguarded.	Noted.

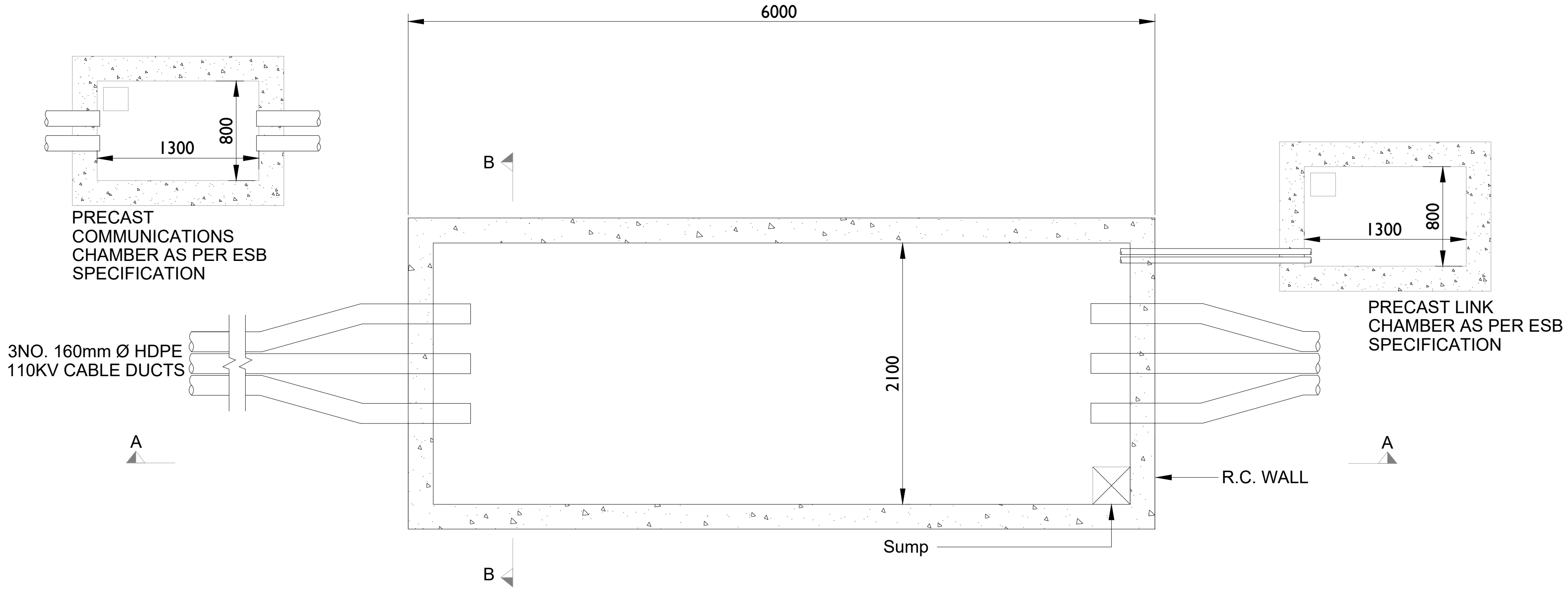
APPENDIX A

Site Overview – N4 Grid Connection Route

MULLINGAR

APPENDIX B

Coole – Cable Trench Cross-Section & Joint Bay



PLAN OF TYPICAL JOINT BAY WITH LINK & COMMUNICATIONS CHAMBERS

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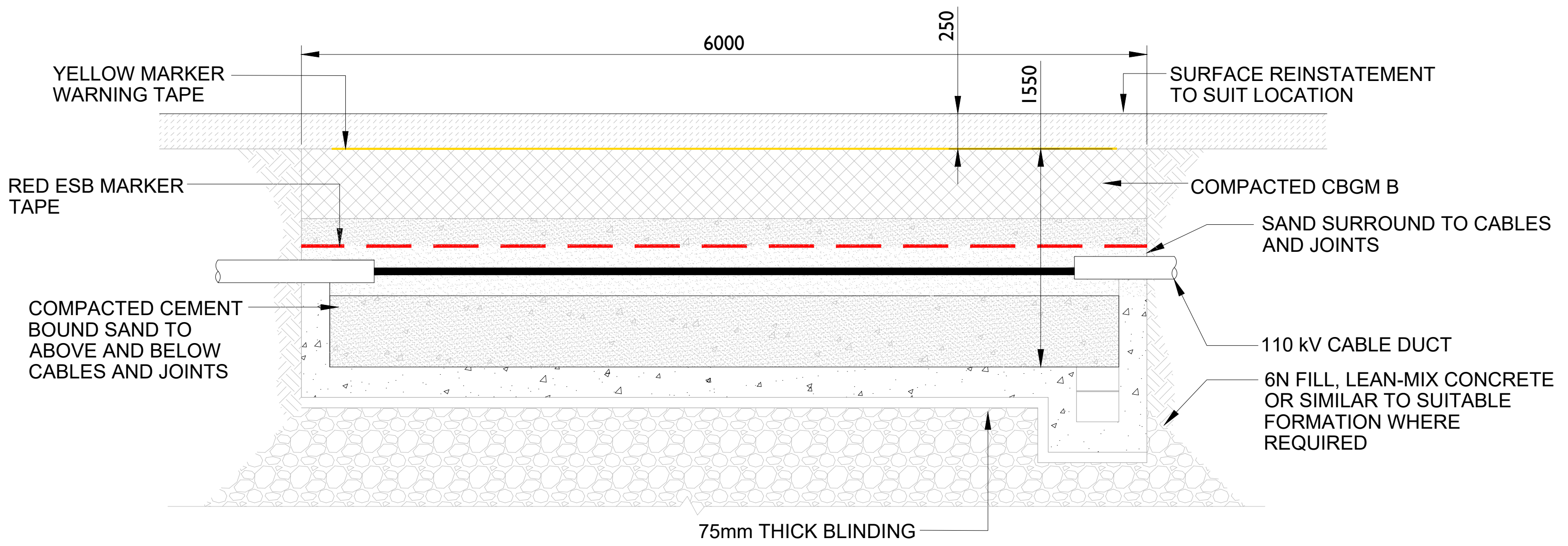

TYPICAL SECTION A-A: PERMANENT REINSTATEMENT WORKS

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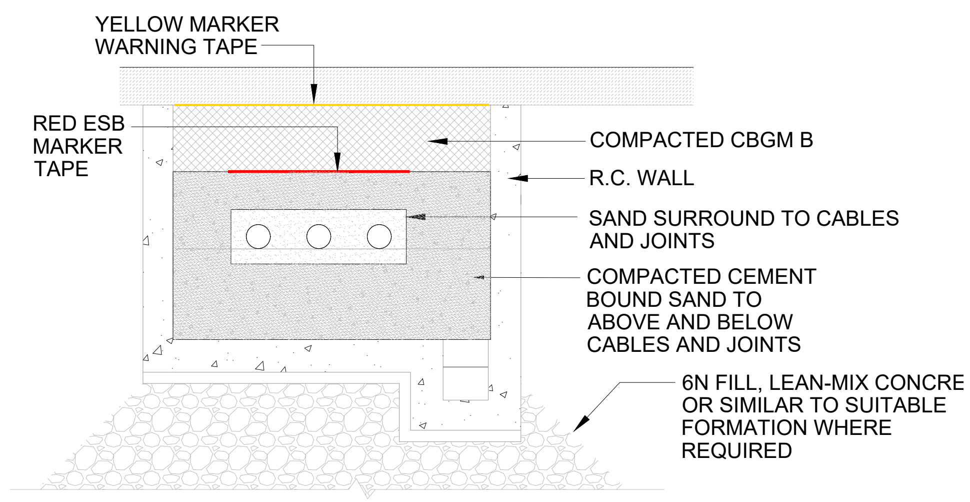

TYPICAL SECTION B-B: PERMANENT REINSTATEMENT WORKS

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NOTES

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PROJECT
COOLE WIND FARM
GRID ROUTE

TITLE
JOINT BAY
TYPICAL DETAILS

REVISION
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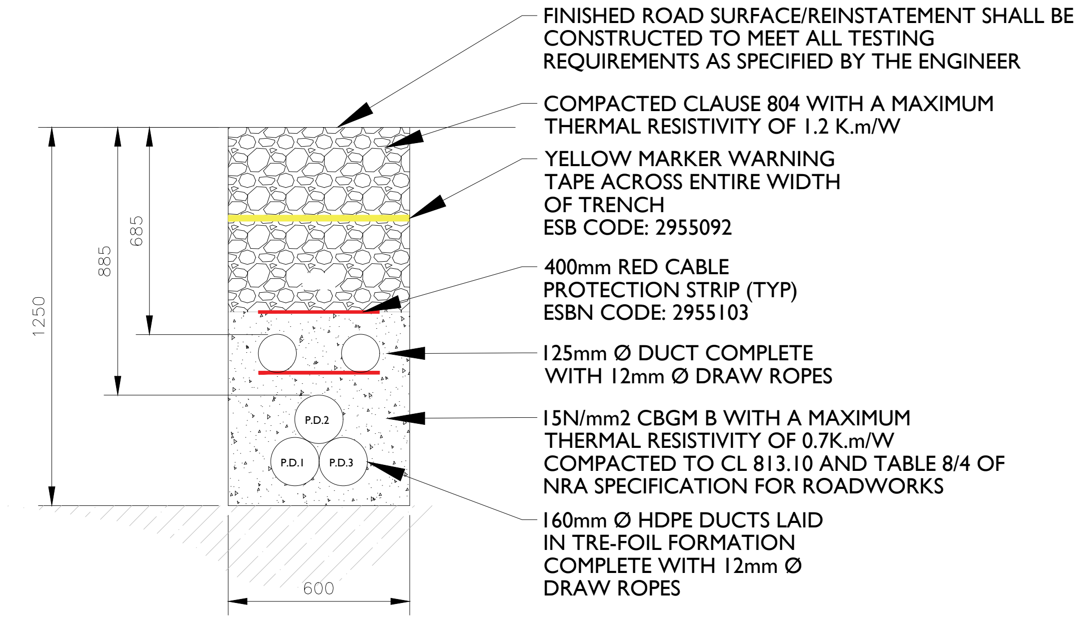
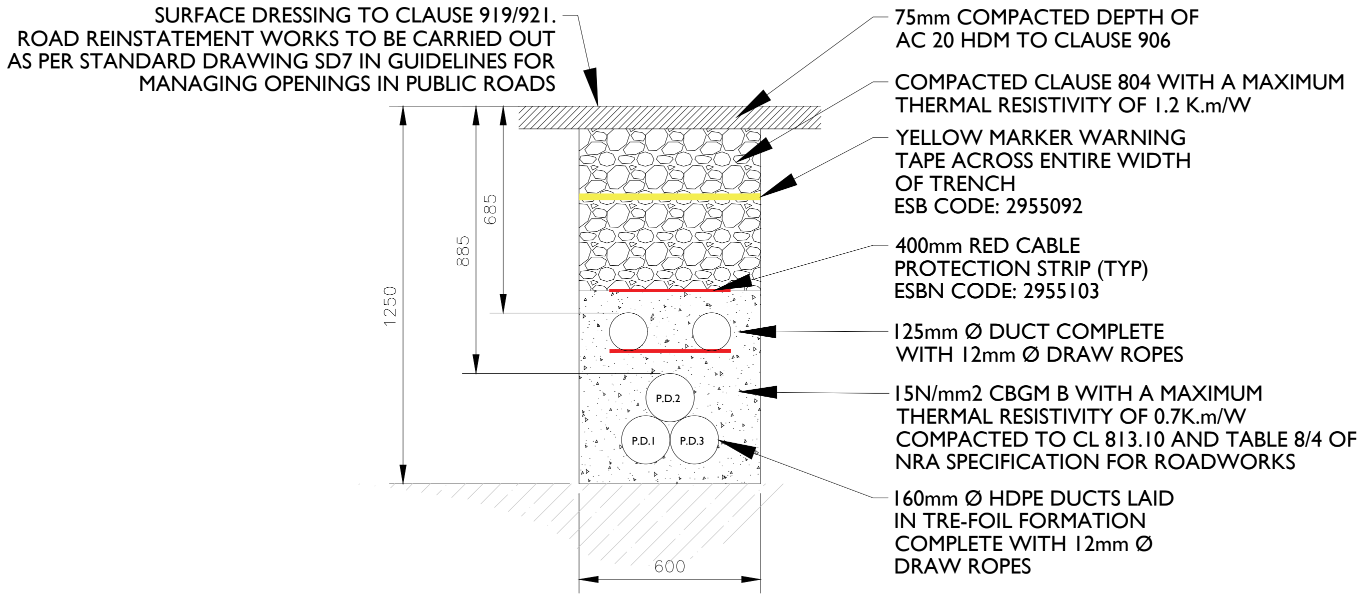


TYPICAL TRENCH DETAIL - PRIVATE ROAD



TYPICAL TRENCH DETAIL - PUBLIC ROAD

NOTES

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PROJECT: COOLE WIND FARM GRID ROUTE

TITLE: GRID ROUTE TRENCH TYPICAL DETAILS

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Coole Wind Farm

110kV Grid Route Connection

RFI Response

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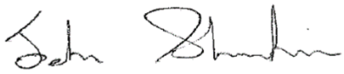

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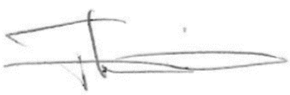

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1. Introduction

The proposed Coole Wind Farm is located north of the village of Coole, County Westmeath. The wind farm 110kV grid connection is proposed between the wind farm site and the existing ESB 110kV Mullingar Substation. The overall route is approximately 26km in length.

This report aims to provide clarification to the questions raised in third party submissions in relation to electric and magnetic fields and duct crossings.

2. Electric & Magnetic Fields

One of the submissions raised questions in relation to electric and magnetic fields (EMF) and underground grid connections. The questions raised related to:

- Maximum levels of magnetic field associated with the underground cables at distances from the cables
- Forecasted range of magnetic fields throughout the day and how forecasted values are calculated
- Confirmation if forecasted magnetic fields are within acceptable limits

EirGrid are the state owned company that manages and operates the transmission grid across the island of Ireland, and the proposed Coole Wind Farm 110kV grid connection will be designed and constructed to their specifications. Following construction the grid route will be handed over to transmission system asset owner (TAO) ESBN and will be operated by transmission system operator (TSO) EirGrid.

The following resources relating to EMF are included here to provide further information and provide answers, where available:

- https://www.eirgridgroup.com/about/health-and-safety/
- EMF & You, Information about Electric & Magnetic Fields and the electricity transmission system in Ireland, July 2014 – EirGrid (refer to Appendix A)
- The Electricity Grid and Your Health, Answering Your Questions – EirGrid (refer to Appendix A)
- Literature Review of Electromagnetic Fields (EMF) and Human Health, and an Evidence Base of EMF Measurements from the Irish Transmission System, RPS for EirGrid 2014 https://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-Evidence-Based-Environmental-Study-1-EMF.pdf

Some extracts are presented below, to assist in answering the questions raised in the consultation.

- Maximum levels of magnetic field associated with the underground cables at distances from the cables

Figure 1 indicates anticipated magnetic field levels at an alternating current underground grid connection. The figure indicates levels of 2.32 microteslas directly above the underground cables and 0.15 microteslas at a distance 10m away. Figure 2 illustrates the range of magnetic field from overhead and underground alternating current grid connections operating in Ireland. The forecasted range for a 110kV underground cable route is 0 to <4 microteslas (µT), with the field level reducing with distance from the cables.

Measurements, commissioned by EirGrid, were taken on the Irish transmission system in 2014. The results are included in the RPS reference above and are in line with anticipated magnetic field levels.

These fields are far below the 1998 ICNIRP Guidelines for exposure to AC magnetic fields (100µT). It should be noted that in 2010 ICNIRP updated its ELF-EMF guidelines, which included the recommendation for a 200µT reference level for exposure for the general public, but these have not yet been adopted by the European Union (page 13 EMF & You, EirGrid).

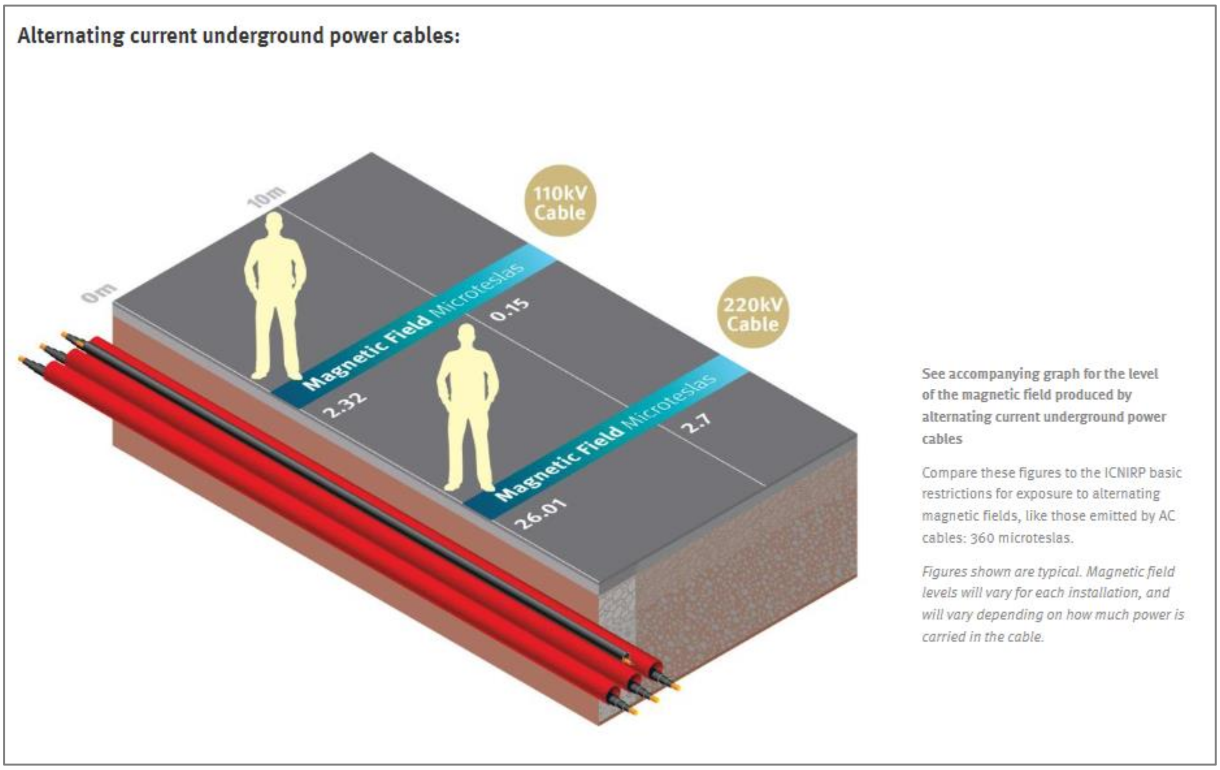


Figure 1 Extract from EirGrid's information website https://www.eirgridgroup.com/about/health-and-safety/

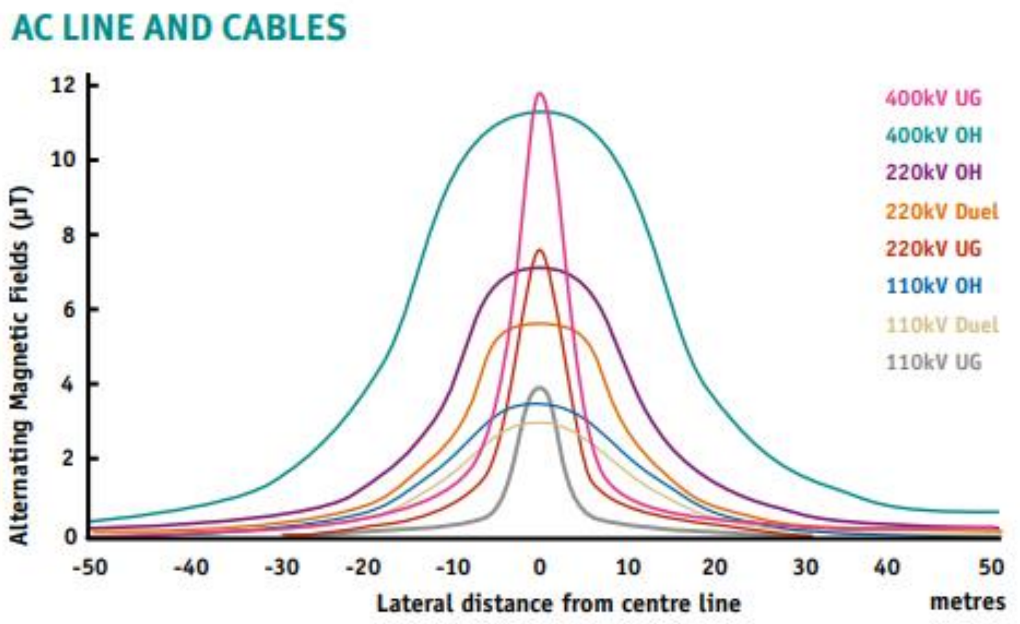


Figure C illustrates the magnetic field from overhead AC lines operating in Ireland. The fields strength decreases with distance. The fields from these AC lines are far below the 1998 ICNIRP Guidelines for exposure to AC magnetic fields (100µT).
In 2010 ICNIRP updated its ELF-EMF guidelines, which included the recommendation for a 200µT reference level for exposure for the general public, but these have not yet been adopted by the European Union.

Figure 2 Extract from EirGrid document EMF & You (refer Appendix A) showing 110kV underground cables with an alternating magnetic field <4 µT directly over the cable trench

- Forecasted range of magnetic fields throughout the day and how forecasted values are calculated

Magnetic field levels will vary for each installation and will vary depending on how much current is carried in the cable (EirGrid, refer to Figure 1 above), which is dependant on the output from the wind farm, which in turn is dependant on wind speeds throughout a given day. The forecasted range for a 110kV underground cable route is 0 to <4 µT, but given the variable nature of the generation it is not feasible to provide a forecast throughout a given day. Refer to the ICNIRP https://www.icnirp.org/ for further information regarding EMF forecasted values, the RPS reference above for measured values, and the further reading provided by EirGrid, in Figure 5 below.

THE MAGNETIC FIELD

The magnetic field is produced by moving electric charges and so the strength of the magnetic field varies directly with the current flows in lines or cables. As a result, the magnetic field can vary at different times during the day. You can imagine this as being like the flow rate of water in a water pipe. Magnetic fields are measured in units of microtesla (µT).

Figure 3 Extract from EMF & You (pg. 7), EirGrid

Want to know more?

This leaflet is EirGrid's summary on this topic. If you want to investigate further, here are some useful links to information on EMFs from national and international agencies.

International Commission on Non-Ionizing Radiation Protection: EMFs
http://bit.ly/ICNIRP_LF

International Commission on Non-Ionizing Radiation Protection: Power Lines
http://bit.ly/ICNIRP_Lines

World Health Organization
http://bit.ly/WHO_EMF

European Commission
http://bit.ly/EC_EMF

Irish Government
http://bit.ly/Ireland_EMF

UK Public Health England
http://bit.ly/UK_EMF

US National Institute of Environmental Health Services
http://bit.ly/NIEHS_EMF

Figure 4 Extract from The Electricity Grid and Your Health, EirGrid

- Confirm if forecasted magnetic fields are within acceptable limits

EirGrid have confirmed that forecasted magnetic fields are within acceptable limits. Please refer to Figure 6 below.

What are the recommendations on exposure to EMFs?

EirGrid operates the transmission grid to stringent safety recommendations. National and international agencies make these recommendations. They do this independently of any grid operator.

Several of these recommendations come from the International Commission for Non-Ionizing Radiation Protection (ICNIRP).

This is an independent body, funded by public health authorities around the world.

ICNIRP has investigated the safety of EMFs for decades, and provides guidance on safe levels of exposure. The HSE recommends that ICNIRP guidelines are followed to protect the health of the public.

As you can see from the diagrams above, we design the electricity network to make sure that public exposure to EMFs complies with these guidelines.

Figure 5 Extract from EirGrid's information website https://www.eirgridgroup.com/about/health-and-safety/

3. Crossing Existing Ducts

One of the submissions raised questions in relation to crossing existing ducts along the grid connection route. Questions raised related to:

- Steps that can be taken to avoid damage to existing ducts or services during installation of the 110kV grid connection.
- Steps that can be taken to ensure safety of the existing cable and ensure no damage to health or infrastructure.
- Demonstration of a methodology to avoid damage to existing utilises and services and preventing the occurrence of electric accidents during construction and thereafter.

Trenching workings for the 110kV underground grid connection will be completed following the guidelines and recommendations of the following documents:

- Code of Practice For Avoiding Danger From Underground Services, Health & Safety Authority
- How You Can Avoid Hitting Electrical Cables When Digging and Drilling, ESB Networks

Both documents are included in Appendix B for reference. Generally safe excavation practices will involve the following steps which will help to avoid any damage to existing services:

a) Use records/plans to correctly locate underground services. Local knowledge of existing buried ducts and services can also be particularly useful.
b) Utilise ground investigation techniques to identify the location of underground services along the route. This can involve intrusive ground investigations like slit trenches, or unintrusive methods such as ground penetrating radar.
c) Use cable locating devices on site.
d) Use safe excavation practices, e.g. hand digging in the vicinity of existing ducting and utilities.

The crossing of the existing low voltage/communications cable will be designed and constructed in accordance with the EirGrid Specification and associated standard details. A detailed design will be completed for the entire route and all crossings, and will be subject to a detailed review and approval process with EirGrid and other stakeholders, including utility owners. This will help to ensure the safety and integrity of existing infrastructure and the proposed grid route.

At a duct crossing, the minimum clearance between the ducts (proposed 110kV ducts and existing utility duct) will be in accordance with the EirGrid specification (Section 4.2), which requires a minimum clearance of 300mm between ducts in any direction. The 110kV cables route will cross existing utilities either above or below, and the standard EirGrid drawings are included in Appendix C. The 110kV ducts will be surrounded in concrete at crossing locations, and ESBN warning tape and steel plates will be included within the trench, refer to Figure 6 below. These measures provide warmings during any future excavations and provide protection to the power cables.

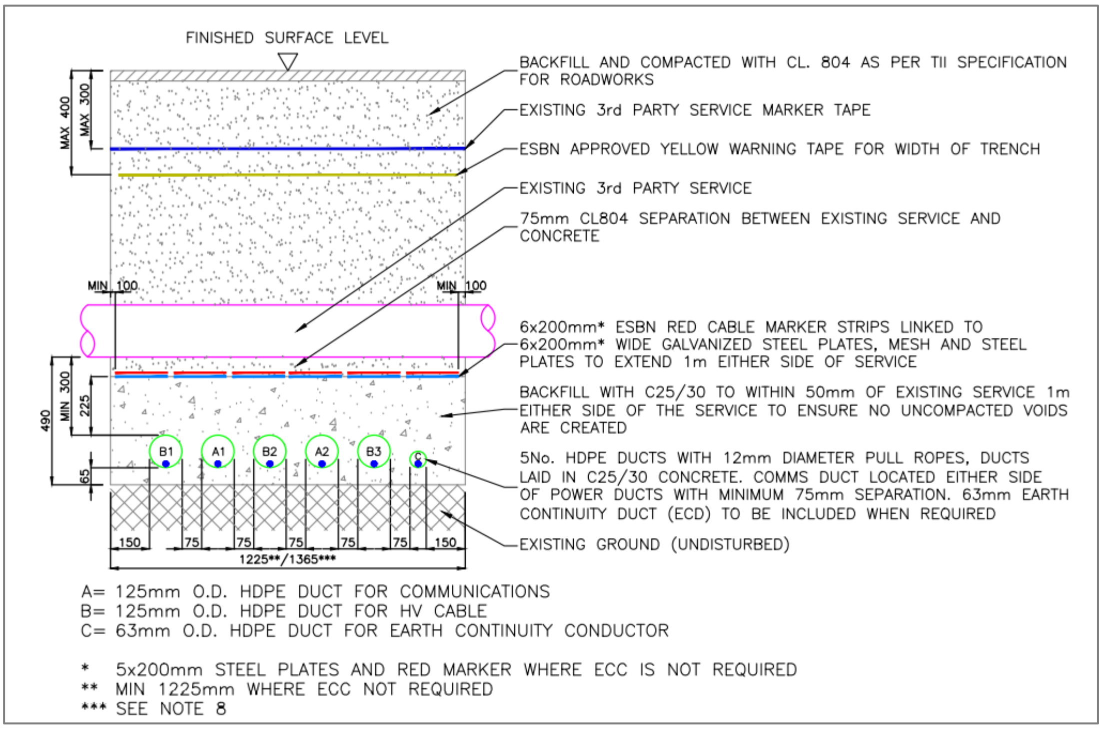


Figure 6 Extract from EirGrid standard details for crossing a 3rd party duct (Drawing XDC-CBL-STND-H-003, refer Appendix C)

APPENDIX A

- EMF & You, Information about Electric & Magnetic Fields and the electricity transmission system in Ireland, July 2014 – EirGrid
- The Electricity Grid and Your Health, Answering Your Questions – EirGrid

EIRGRID

EMF & YOU

Information about Electric & Magnetic Fields and the electricity transmission system in Ireland

Revised July 2014

GRID25

www.eirgridprojects.com

PUBLIC INFORMATION GUIDE

ABOUT EIRGRID

EirGrid, a state-owned company, is the operator of the national electricity grid in Ireland.

The national grid is an interconnected network of high-voltage power lines and cables, comparable to the motorways, dual-carriageways and main roads of the national road network.

EirGrid operates power lines at three voltage levels (400 kilo Volts (kV), 220kV and 110kV) and is approximately 6,400km in overall length.

WELCOME

The national grid is vital to ensuring that all customers, – industrial, commercial and residential – have a safe, secure, reliable, economic and efficient electricity supply.

In developing the grid we look to international and national best-practice guidelines regarding public health and safety, ensuring that the system complies with them at all times.

We know that some people have questions and concerns when there is a grid development proposed in their area.

This publication was developed to give an overview of the electricity transmission system in Ireland and the Electric and Magnetic Fields (EMF) associated with it.

We aim to provide you with factual information on EMF, in relation to both underground and overhead technologies.

For more information, including evidence-based studies that include detailed EMF readings from Irish transmission lines, we recommend you review reports published on our website at www.eirgridprojects.com along with links to other sources of information.

EirGrid remains committed to designing and operating the transmission system to the highest standards.

We will not compromise on the health and safety of the public and our staff in designing or operating the national grid.

We welcome your feedback and recommendations for the inclusion of further information on our website.

Fintan Slye
CHIEF EXECUTIVE

WHAT ARE ELECTRIC AND MAGNETIC FIELDS?

The existence of electric and magnetic (EMF) fields has been recognised since electricity was discovered and these have been the subject of thousands of scientific studies around the world. Research conducted over the past 30 years has significantly enhanced our knowledge of EMF.

EirGrid understands that some people may have concerns about the potential effects of EMF from power lines on health. There has been considerable public debate surrounding EMF and this has generated many questions. For example:

- What are EMF?
- What studies have been carried out?
- Are there risks to human health?
- What is the national and international guidance on EMF exposure?
- Do power lines affect animals?
- Should people take any special precautions against EMF?
- What is EirGrid's position on EMF exposure?

This publication provides information about the current scientific, regulatory, and company perspectives and sources of additional information on EMF to answer these questions.

Electric and Magnetic Fields occur both naturally and from man-made sources.

All electricity, both natural and man-made, produces two types of fields: electric fields and magnetic fields. EMF are produced by natural phenomena which have been a constant part of the environment throughout human evolution. For instance, the Earth has a natural electric field and a magnetic field.

The most common source of man-made EMF that we encounter is electricity.

The man-made sources include all electrical systems including house wiring, electrical appliances and overhead and underground power lines. In Ireland the voltage in homes is 230V. Electricity in Ireland is transmitted at voltages of up to 400,000V (400kV).

THE ELECTRIC FIELD

The electric field depends on voltage. The higher the voltage, the stronger the electric field. You can imagine it as being like pressure in a water pipe. A 400kV power line produces a higher electric field than a 110kV power line. The magnitude of an electric field is expressed in volts or kilovolts (thousands of volts) per metre. This is written as V/m or kV/m.

Electric fields are strongest closest to a power line and their level reduces quickly with distance. Electric fields are blocked by buildings, trees etc.

Therefore, inside a typical house the dominant sources of electric fields are typical household appliances such as microwave ovens, hair-dryers and electric blankets.

There are no external electric fields associated with underground cables. This is because the electric field produced is contained within the cable.

THE MAGNETIC FIELD

The magnetic field is produced by moving electric charges and so the strength of the magnetic field varies directly with the current flows in lines or cables. As a result, the magnetic field can vary at different times during the day. You can imagine this as being like the flow rate of water in a water pipe. Magnetic fields are measured in units of microtesla (μT).

Unlike electric fields, magnetic fields are not blocked by buildings, trees etc. Like electric fields, magnetic fields are highest closest to an electricity line or cable and their level reduces quickly with distance from the line or cable.

Appliances that use a lot of power, such as electric heaters or cookers, generate higher levels of magnetic fields than lower powered appliances.

Q WHY DOES A FLUORESCENT LIGHT GLOW UNDER A HIGH VOLTAGE POWER LINE?

There is a well-known phenomenon whereby a fluorescent light will glow dimly if placed below a high-voltage power line. This effect is caused by the electric field. The electric field causes a tiny current (measured in millionths of an ampere) to flow through the mercury vapour inside the tube which casts a weak glow.

The moment you move the fluorescent light away from the line, the electric field weakens and the light goes out. This phenomenon has no impact on people or other organisms.

WHAT IS THE ELECTROMAGNETIC SPECTRUM?

Electromagnetic energy travels in waves. These waves span a broad range of frequencies from static frequency (fields that do not change direction with time) at one end of the spectrum, to very high frequency (fields that change billions of times per second) at the other end of the spectrum.

The electromagnetic spectrum shown in *Figure A* identifies the various types of electromagnetic energy based on their frequency. The earth's magnetic field is largely constant and therefore is described as a static field. Its frequency is very low or zero. The earth's static magnetic field (which acts like a giant bar magnet) causes a compass to align north-south.

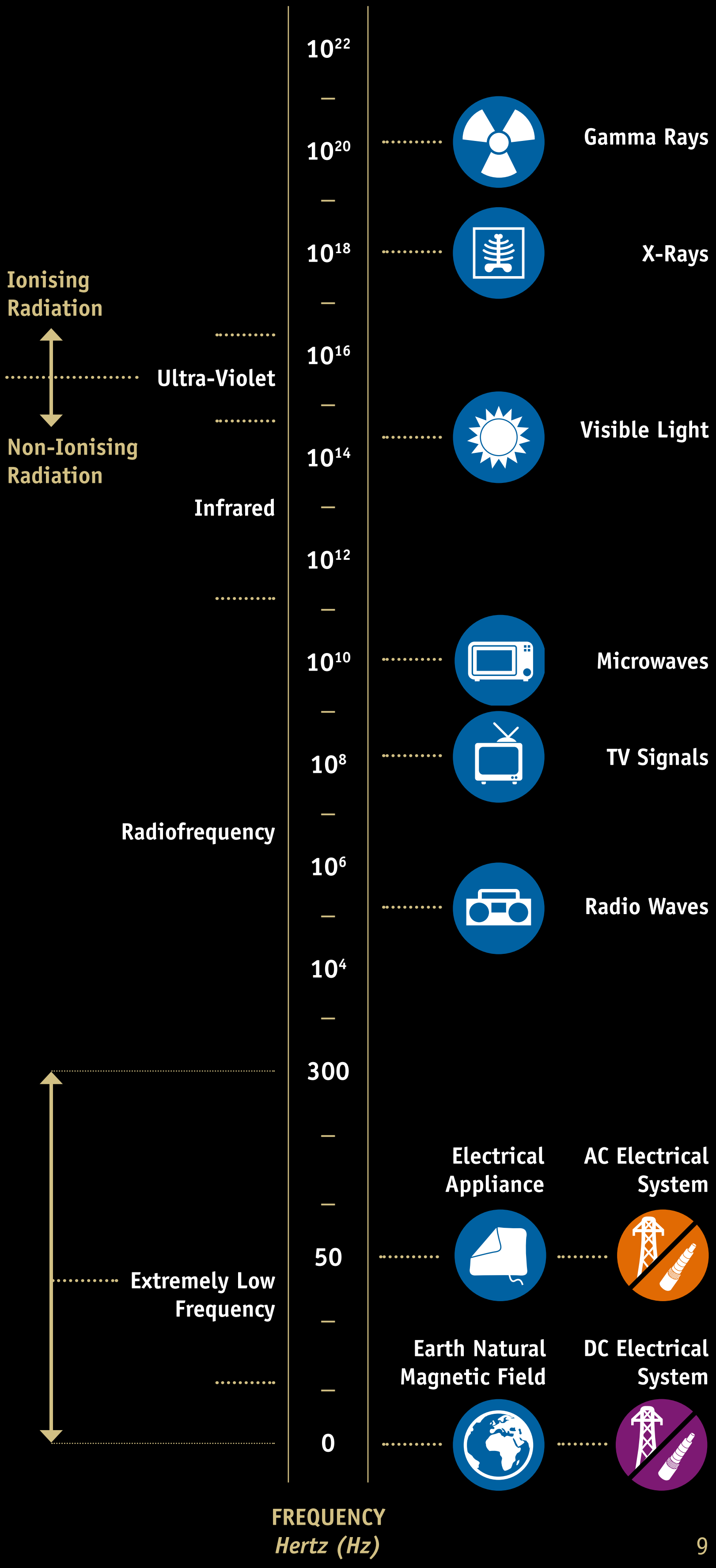
Most man-made sources of electric and magnetic fields fluctuate in direction and intensity. They are called time-varying or alternating current fields (AC). Time-varying or AC fields come from anything that runs on electricity, from electrical installations to household appliances.

Their frequency is expressed in hertz (Hz). Hertz is the rate at which the field alternates back and forth per second. The electric power system operates at 50Hz in Ireland and Europe and 60Hz in some other places such as North America and thus is a source of EMF at these frequencies. Such frequencies are in the extremely low frequency (ELF) range, 0-300Hz. The ELF-EMF from all electrical equipment are time-varying fields with a dominant frequency of 50Hz in Ireland/Europe.

The strength of the EMF or field depends on how close you are to the equipment. Hence the EMF a person can experience from a household appliance can be similar or higher than that from transmission lines because you can be much closer to the household appliance than an overhead transmission line, which is usually several metres or more away from you.

THE ELECTROMAGNETIC SPECTRUM

FIGURE A



ARE EMF ASSOCIATED WITH ELECTRICITY THE SAME AS RADIATION?

No. The fields resulting from electricity are fundamentally different from x-ray and gamma ray radiation.

Whilst these are all forms of electromagnetic energy there are important fundamental differences.

The term radiation is usually used to refer to ionising energy. Ionising means that, if the radiation is sufficiently strong, it can break bonds in molecules and therefore damage biological molecules including the DNA of cells. Only the high-frequency portion of the electromagnetic spectrum is ionising. This includes, x-rays, gamma rays and ultraviolet light.

The energy in visible light, radio frequency and fields in the static and 50Hz ranges, including electricity, are all classified as non-ionising.

It is very important to realise that 50Hz fields, i.e. electricity, are non-ionising. They have insufficient energy to ionise molecules.

Examples of non-ionising energy include EMF from the earth and electric power sources, radio waves and TV waves, microwaves, and most frequencies of visible light. See *Figure A*, page 9.

WHAT SCIENTIFIC STUDIES ON THE HEALTH IMPACT OF EMF HAVE BEEN CARRIED OUT?

Since 1979 many scientific studies have been carried out on the possible effects of EMF on people.

To determine if something is harmful to health, scientists evaluate the results from three different types of studies.

1. EPIDEMIOLOGICAL STUDIES

Epidemiology is the study of patterns of disease in populations. It searches for statistical links or associations between exposures, such as EMF, and disease in human populations. Epidemiological studies are usually observational, meaning that researchers investigate, but do not try to change, what happens as people go about their daily lives. As a result, epidemiological studies are susceptible to certain kinds of errors that lead an exposure and a disease to be associated even when one does not cause the other. For example, the positive association between number of doctors per capita and mortality rates arises not because doctors increase mortality, but rather because of social and economic factors such as industrialisation and job opportunities. Likewise, just because persons with a certain health condition live near electric power sources does not mean that the fields from these power sources caused the condition. Other environmental and behavioural causes would have to be ruled out, as would the possibility that some people moved to the area after already developing the health condition.

2. EXPERIMENTAL STUDIES – PEOPLE AND ANIMALS

These studies involve exposing people or animals to EMF in controlled laboratory conditions and looking for biological changes. For practical reasons, human experimental studies of EMF are usually short-term. Experimental studies generally study effects of short-term exposures.

3. EXPERIMENTAL STUDIES – CELLS AND TISSUES

These studies involve exposing isolated tissues and cells to EMF in controlled laboratory conditions to investigate potential mechanisms of interaction.

TWO TYPES OF TECHNOLOGY

Transmission systems worldwide are typically constructed as overhead lines and in some cases underground cables are used.

Two types of technology can be used to transmit electricity. Both AC and DC power lines produce electric and magnetic fields. AC lines produce AC electric and magnetic fields and DC lines produce static electric and magnetic fields.

When electricity transmission cables are placed underground, the metallic shielding of the cables block the electric field from the cables above the ground, but this shielding does not block the magnetic field from the cables.

EirGrid operates approximately 6,400 km of high-voltage transmission lines that carry AC electricity at voltages of 110kV, 220kV and 400kV. EirGrid also owns and operates the East-West Interconnector which is a 260km high voltage direct current (HVDC) Interconnector. This carries DC electricity from a converter station in County Meath, on underground and subsea cables to a converter station in North Wales (or in the reverse direction). More information about this project can be found at www.eirgridprojects.com

The transmission grid is constructed and operated to rigorous safety standards. Among the standards to which it adheres are those as set out by the International Commission on Non-Ionising Radiation Protection (ICNIRP) – the independent standard-setting body for EMF which is recognised by the World Health Organisation and the European Union. Established in 1992, it provides science-based guidance and recommendations, including recommended limits of exposure.

ALTERNATING MAGNETIC FIELDS

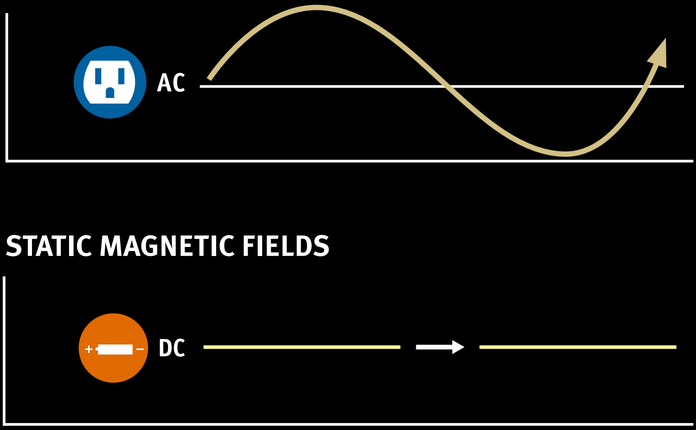


Figure B. Schematic comparison of AC and DC current flow and the resulting magnetic fields.

THE EFFECT OF DISTANCE ON MAGNETIC FIELDS

Both AC and DC technologies produce magnetic fields and both decrease with distance as you move away from the line or cable. See graphs below:

AC LINE AND CABLES

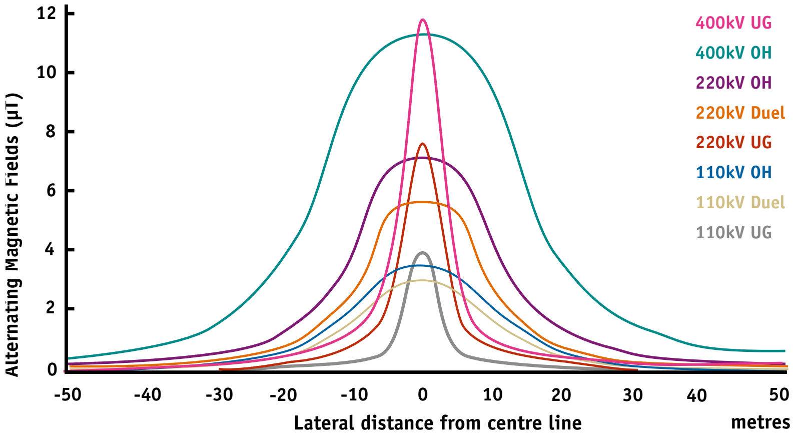


Figure C illustrates the magnetic field from overhead AC lines operating in Ireland. The fields strength decreases with distance. The fields from these AC lines are far below the 1998 ICNIRP Guidelines for exposure to AC magnetic fields (100μT).
In 2010 ICNIRP updated its ELF-EMF guidelines, which included the recommendation for a 200μT reference level for exposure for the general public, but these have not yet been adopted by the European Union.

UNDERGROUND DC CABLE

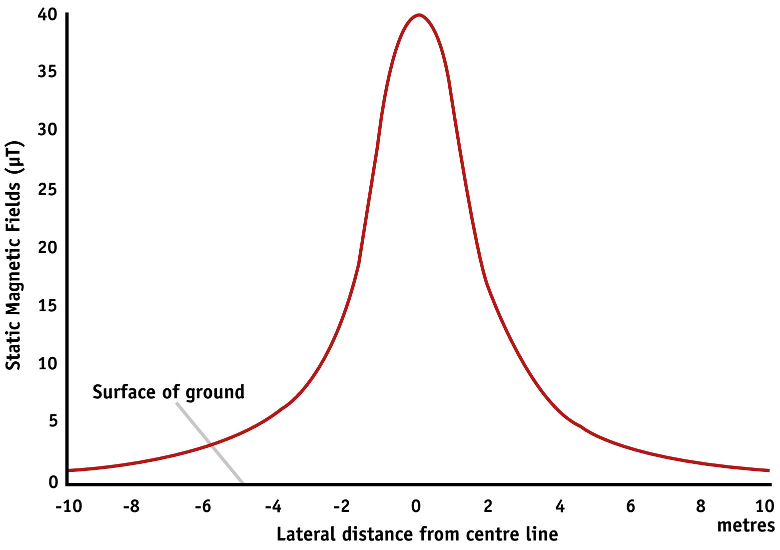


Figure D illustrates that the DC magnetic field decreases rapidly as you move away from the cable centre line. At a distance of 10 metres, the static magnetic field from the cable diminishes to 0.6μT. The DC magnetic field from this cable is far below the ICNIRP guideline (400,000μT).

DIRECT CURRENT CABLES

The fields associated with DC cables like those of the East-West Interconnector are predominately static fields and have no frequency i.e. the direction of the field does not change or oscillate (0Hz). This is different than AC lines or cables which have alternating fields which change or oscillate at 50 times a second (50Hz).

The magnetic fields associated with the East-West Interconnector have similar characteristics to the magnetic field that occurs naturally in the earth, e.g., earth's own magnetic field. Naturally occurring magnetic fields, such as that of the earth, are relatively weak. The earth's magnetic field varies between 30μT at the equator and 60μT at the north and south poles. In Ireland, the intensity of the earth's magnetic field is approximately 49μT.

Underground DC cables are normally buried to a depth of approximately 1 metre and the strongest static magnetic field produced along the route of the East-West Interconnector in Ireland is on the ground directly above the buried cable. For the East-West Interconnector this is approximately 43μT. This value is similar to or lower than the Earth's natural magnetic field.

Figure D, page 13 illustrates that the magnetic field from the East-West Interconnector decreases rapidly as you move away from the cable centre line. At a distance of 10 metres, the static magnetic field from the cable diminishes to 0.6μT.

Sources of static magnetic fields, besides the earth and the East-West Interconnector, include those generated by suburban transportation systems, permanent magnets, MRI scanners and some industrial processes.

Graph 3 on page 30 illustrates the range of static magnetic field levels measured near electric trains and magnets in common devices compared to calculated static magnetic field levels from the East-West Interconnector cables when the cables are carrying maximum current.

WHAT DO HEALTH AND SCIENTIFIC AGENCIES SAY ABOUT RESEARCH ON DC MAGNETIC FIELDS AND HEALTH?

Research has been conducted over many decades on the potential biological or health effects of exposure to DC magnetic fields.

Independent review panels of scientific experts assembled by authoritative national and international scientific agencies have reviewed this research. None has concluded that static magnetic fields found in normal living and working environments cause adverse health effects.

These agencies include the World Health Organisation (2006), the National Radiological Protection Board of Great Britain (2004), and the International Agency for Research on Cancer (IARC) (2002). In 2009 the International Commission on Non-Ionising Radiation Protection (ICNIRP) issued guidelines for exposure for members of the public to DC magnetic fields. Other more recent reviews have been performed for the UK's Health Protection Agency (2008) and the European Union's Scientific Committee on Emerging and Newly Identified Health Risks (2007, 2009).

These agencies concluded that exposure to only very strong DC magnetic fields can cause biological effects. The exposures required to produce such effects, however, are extraordinarily high relative to levels of DC magnetic fields produced by common sources.

The International Commission on Non-Ionising Radiation Protection (ICNIRP) developed its guidelines for exposure limits to the public and workers after reviewing evidence from cell and tissue studies, experimental studies of humans and laboratory animals, and epidemiologic studies.

The ICNIRP limits for occupational exposure to static magnetic fields is *2T for the head and trunk, and 8T for limbs.

The ICNIRP limits for general public exposure to static magnetic fields is ** 0.4T.

The ICNIRP published additional guidance on exposures to DC magnetic fields in 2014, but stated: “The guidelines are not expected to be relevant for the general public because all exposures to intense magnetic fields below 1Hz are currently found at workplaces.”

The ICNIRP noted that cardiac pacemakers may be affected by very strong magnetic fields, but the levels where this might occur are more than ten times higher than the highest magnetic field produced by DC cables such as those of the East-West Interconnector.

* 2T = 2,000,000μT
** 0.4T = 400,000μT

Installation of East-West interconnector in a public road in Ireland

WHAT IS THE VIEW OF THE IRISH GOVERNMENT ON DC FIELDS?

In Ireland, the Government published a report of the Expert Group on the Health Effects of Electromagnetic Fields on 22 March, 2007 (DCMNR, 2007).

A panel of eight scientists examined a wide range of issues in relation to the potential health effects of EMF, including those produced by the electricity system.

The panel's conclusions regarding static magnetic fields were similar to those of the World Health Organisation and other scientific agencies.

During the planning and construction of the East-West Interconnector, concerns were raised about the magnetic fields produced by currents flowing through its DC cables.

The Irish Government appointed an Independent Expert Panel to measure and assess the fields from the cables. The panel was satisfied from the measurements provided that the magnetic field at all frequencies was well below levels recommended by the ICNIRP guidelines.

The measurements and reports from this independent study can be found at www.dcenr.gov.ie/energy.

In response to public concerns about magnetic fields from the East-West Interconnector, in 2011, the Irish Government commissioned a Dutch health scientist to investigate the situation.

In 2012, the Government commissioned a report* from the Chief Medical Officer which concluded that the East-West Interconnector does not pose a risk to public health.

*www.dcenr.gov.ie/energy/

Where can I find more information on DC magnetic fields?

The following are sources EirGrid recommends you visit should you require more detailed information on DC magnetic fields.

- Expert Group on Health Effects of Electromagnetic Fields. Department of Communications, Energy and Natural Resources (DCENR) 2007. www.dcenr.gov.ie/energy/
- Department of Communications, Energy and Natural Resources (DCENR). Data and Report of the Expert Monitoring Panel on Electro Magnetic Fields (EMF) Emissions in relation to the East-West Interconnector (EWIC) www.dcenr.gov.ie/energy/
- International Commission on Non-ionising Radiation Protection (ICNIRP). Fact Sheet – On the guidelines on limits of exposure to static magnetic fields published in Health Phys 96(4);504-514; 2009. www.icnirp.de/PubEMF.htm
- World Health Organisation (WHO). Static electric and magnetic fields – Fact Sheet N°299 (March 2006). www.who.int/peh-emf/publications/facts/fs299/en/

ARE THERE ANY PRECAUTIONS THAT NEED TO BE TAKEN?

The assessments by the national and international health and scientific agencies of health and biological research on DC magnetic fields do not support the idea that fields generated by the underground cable system would have any health impacts on humans or animals.

All exposures are far, far below limits on public exposure recommended in health guidelines.

WHAT DO HEALTH AND SCIENTIFIC AGENCIES SAY ABOUT RESEARCH ON AC MAGNETIC FIELDS AND HEALTH?

National and international health and scientific agencies have reviewed more than 30 years of research including thousands of studies.

None of these agencies has concluded that exposure to ELF-EMF from power lines or other electrical sources is a cause of any long-term adverse effects on human, plant, or animal health. Agencies have recognised a statistical association between estimated higher long-term exposures to magnetic fields and childhood leukaemia in some epidemiological studies. However they have not been able to rule out the contribution of chance, selection bias and other factors to explain this association with reasonable confidence. Neither long-term studies of animals, nor studies of cellular mechanisms, have confirmed a biological basis for such an association. This explains why no health agency has concluded that there is a causal relationship between magnetic fields and health effects.

SCENIHR is the European Union's Scientific Committee on Emerging and Newly Identified Health Risks. The committee provides opinions

on emerging or newly-identified health and environmental risks. On 4 February 2014, SCENIHR published its "Preliminary opinion on Potential health effects of exposure to electromagnetic fields (EMF)". This is an update to its 2009 opinion.

The committee reported that new epidemiology studies do not shed light on a previously reported association with childhood leukaemia. Shortcomings in these studies, and a lack of experimental support from animal studies or cellular evidence prevent a causal interpretation of this statistical association.

Several recent epidemiology studies examined residential proximity to power lines and childhood leukaemia risk, but overall provided no new evidence for an association. In the largest study to date, Bunch et al. (2014) provided an extension and update to the 2005 study in the United Kingdom by Draper et al. The authors extended the study period by 13 years (1962-2008), included lower voltage lines (132kV) in addition to 275/400kV lines, and included Scotland in addition to England and Wales in their analyses. Bunch et al. (2014) included over 53,000 childhood cancer cases and over 66,000 healthy control children and reported no overall association with residential proximity to 132kV, 275kV, and 400kV power lines for leukaemia or any other cancer among children. The statistical association with distance that was reported in the earlier Draper et al. (2005) study was not apparent in this extended analysis.

No health agency has concluded that exposure to EMF from power lines and other electrical sources is a cause of any long-term adverse effects on human, plant, or animal health.

In 2007, the World Health Organisation updated the International Agency for Research on Cancer (IARC) report with the publication of its comprehensive review of ELF-EMF health research.[1]

THE CONCLUSIONS OF THE WORLD HEALTH ORGANISATION REPORT CAN BE SUMMARISED AS FOLLOWS:

- The research does not establish that exposure to EMF of the nature associated with power lines causes or contributes to any disease or illness.
- There are no substantive health issues related to electric fields at levels generally encountered by members of the public.
- While epidemiology studies have reported a weak statistical association between childhood leukaemia and long-term exposures to magnetic fields greater than 0.3-0.4μT, this association is not supported by the laboratory studies and has not been considered a causal relationship.
- The animal studies as a whole do not show adverse effects, including cancer, among animals exposed to high levels of magnetic fields.
- The laboratory studies on cells and tissues have not confirmed any explanation as to how weak magnetic fields could cause disease.
- Because the epidemiology studies have limitations and the experimental studies provide little or no support for an association with cancer or mechanisms to cause cancer, the World Health Organisation did not conclude that magnetic fields cause childhood leukaemia. Thus, considering all of the research together, the reviewers for the World Health Organisation did not conclude that magnetic fields cause any long-term, adverse health effects.
- The view of the World Health Organisation on ELF-EMF and health issues provided on its website is "based on a recent in-depth review of scientific literature, [we conclude] that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields".[2]

[1] http://www.who.int/peh-emf/publications/elf_ehc/en/index.html
[2] http://www.who.int/peh-emf/about/whatisemf/en/index.html

To date, the whole body of scientific research has not confirmed any adverse effect to human health from EMF.

The independent international health and scientific agencies are continuing to review and monitor the possibility of health effects from exposure to EMF. They are doing this not because they have identified a problem but to ensure that even the smallest possibility of a health risk has not been overlooked, given that everyone in the developed world is exposed to EMF. The findings of these agencies carry considerable weight, as they reflect the judgements of groups of multiple scientists rather than the views of individuals.

The World Health Organisation stated that the scope of any actions we may take to reduce EMF exposure, either personally or as a society, should be proportional to the strength of the science. The actions to reduce exposure should be very low in cost and should not compromise the health, social and economic benefits of electricity to our society.

WHAT IS THE VIEW OF THE IRISH GOVERNMENT?

In March 2007, Ireland's Department of Communications, Marine and Natural Resources (DCMNR) assembled a panel of independent scientists to review EMF and radio frequency research. The conclusions are summarised in the document entitled "Health Effects of Electromagnetic Fields". The conclusions of this report were consistent with those of The International Agency for Research on Cancer (IARC), the World Health Organisation and other national and international agencies. In relation to EMF, the report states:

'No adverse health effects have been established below the limits suggested by international guidelines.'

In January 2014, the Department of the Environment announced it was conducting a review of the latest research on EMF and EirGrid is committed to addressing any recommendations in this report.

WHAT IS THE VIEW OF THE EUROPEAN UNION?

In 1999, the Council of the European Union adopted a recommendation in relation to public and occupational exposure to EMF. This recommendation applies the exposure guidelines advocated in 1998 by the ICNIRP, to locations where people spend significant time.

The 1998 ICNIRP guidelines specify limits on exposure to EMF, which are called 'basic restrictions'. To make sure that these basic restriction limits are not exceeded, 'reference levels' for both electric and magnetic field exposure are provided. For the general public these reference levels at 50Hz are 500kV/M and 100μT.[3] If the EMF exposure level is less than the reference level, compliance with the basic restriction is assured. If exposure exceeds the reference level, the circumstances of the exposure need to be examined more closely to confirm compliance.

[3] In 2010 ICNIRP updated its ELF-EMF guidelines, which included the recommendation for a 200μT reference level for exposure for the general public, but these have not yet been adopted by the European Union.

ARE THERE ANY PRECAUTIONS THAT NEED TO BE TAKEN?

A 2007 Government report stated that, while there is limited scientific evidence of an association between ELF-EMF and childhood leukemia, considerable research carried out in laboratories does not support this possibility.

Nevertheless, the report recommended that the evidence should not be discounted and suggested no-cost, or low-cost, precautionary measures to lower people's exposure to ELF fields.

As a precautionary measure, it recommended that future power lines and power installations should be sited away from heavily populated areas. The report also noted that lowering international guideline limits as a precautionary measure is not recommended by the World Health Organisation.

These precautionary goals are achieved by EirGrid by routing lines as far from existing residences as is reasonably possible, optimising the phasing of adjacent lines, and incorporating stakeholder input during the consultation process carried out in the development of new electricity infrastructure.

Source: Report from Expert Group on the Health Effects of Electromagnetic Fields for Department of Communications, Marine and Natural Resources, 2007.

DO POWER LINES AFFECT ANIMALS?

As with human health, some have expressed concern about the potential effects of EMF from high-voltage transmission lines on animal health, welfare, behaviour and productivity.

The potential effects from EMF on both economically important domesticated animal species and wildlife have been investigated since the 1970s. This has led to a good understanding of the potential means by which EMF could affect organisms in the vicinity of power lines.

Overall, the research does not show that EMF have adverse effects on the health, behaviour or productivity of animals, including livestock.

The substantial body of research on wild and domestic animals is informative for all large mammals and does not indicate any risk.

Thus, there is no scientific basis in the research literature to conclude that the presence of a transmission line would create conditions that would impair the health of animals or would precipitate abnormal behaviour.

Studies on dairy cows, for example, failed to find any consistent variation in fertility, hormone levels, milk fat content or dry matter intake beyond what would be expected due to normal variation even when exposed to ELF-EMF far stronger than would occur from the Irish transmission system.

Other research on sheep has examined the effect of ELF-EMF on weight gain, wool production, behaviour, onset of puberty and immune function. None of the studies showed consistent or replicated evidence of adverse effects.

CROPS, PLANTS AND TREES

As scientific literature has accumulated, both from laboratory and field studies, on the potential effect of EMF from transmission lines on plants, including agricultural crops and trees, and forest and woodland vegetation, no adverse effects on plants have been reported from electric and magnetic field exposures at levels comparable to those near high-voltage transmission lines.

Where can I find more information on ELF fields?

The following are sources EirGrid recommends you visit should you require more detailed information on AC fields.

- **THE WORLD HEALTH ORGANISATION – INTERNATIONAL EMF PROJECT (2007)**

  www.who.int/mediacentre/factsheets/fs322/en/index.html

- **THE EUROPEAN HEALTH RISK ASSESSMENT NETWORK ON ELECTROMAGNETIC FIELDS EXPOSURE (2010)**

  http://efhran.polimi.it/docs/EFHRAN_D2_final.pdf

- **HEALTH PROTECTION AGENCY**

  www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/ElectromagneticFields/ElectricAndMagneticFields/HealthEffectsOfElectricAndMagneticFields/

- **DEPARTMENT OF COMMUNICATIONS ENERGY AND NATURAL RESOURCES**

  www.dcenr.gov.ie

- **EUROPEAN COMMISSION**

  http://ec.europa.eu/enterprise/sectors/electrical/documents/lvd/electromagnetic-fields/

- **INTERNATIONAL AGENCY FOR RESEARCH ON CANCER**
  www.iarc.fr/en

- **INTERNATIONAL COMMISSION ON NON-IONISING RADIATION PROTECTION**
  www.icnirp.de

- **SCIENTIFIC COMMITTEE OF THE EUROPEAN COMMISSIONS**

  http://ec.europa.eu/health/scientific_committees/consultations/public_consultations/scenihr_consultation_19_en.htm

- **EIRGRID PROJECTS**
  www.eirgridprojects.com

WHAT IS EIRGRID'S POSITION AND COMMITMENT?

EirGrid's position on EMF and health is based on the authoritative conclusions and recommendations of established national and international health and scientific agencies which have reviewed the body of scientific research.

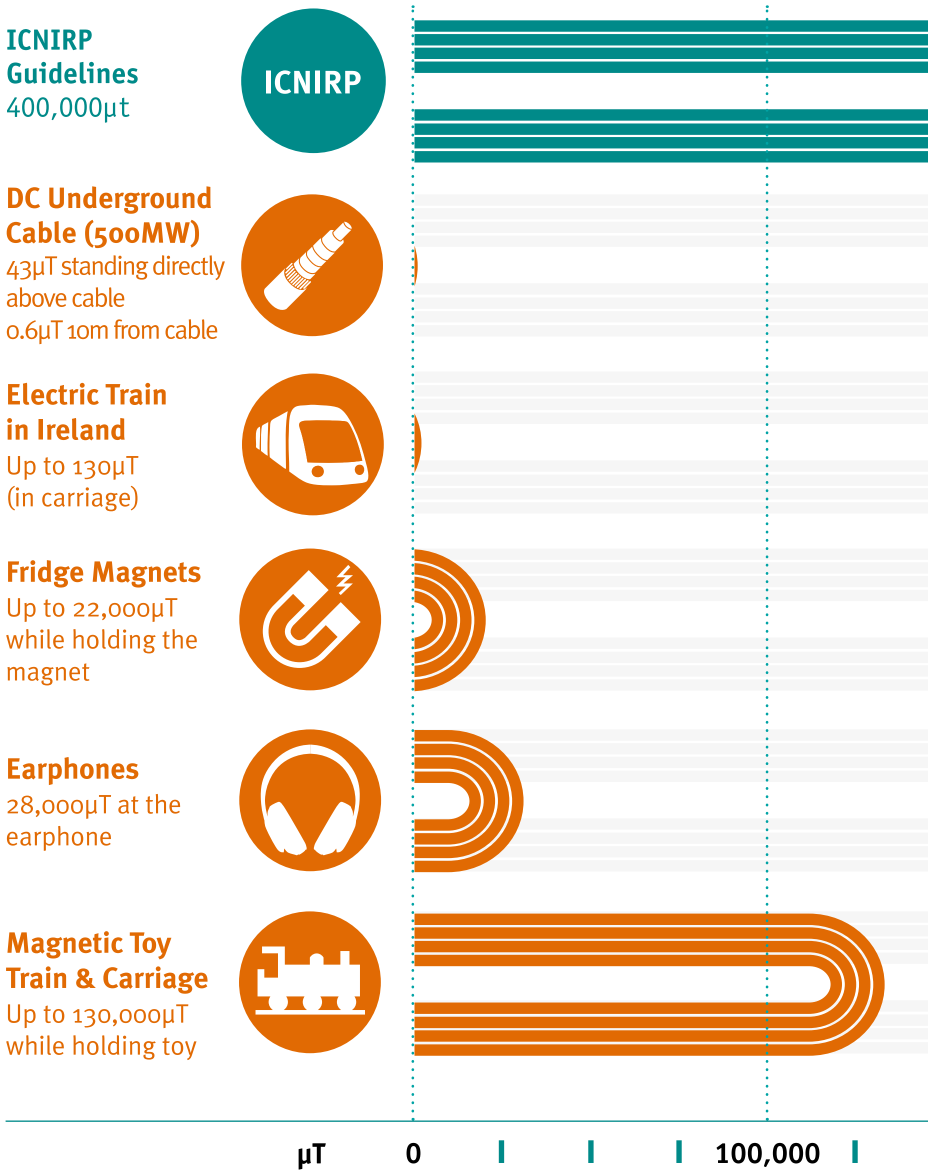
These agencies have consistently concluded that the research does not indicate that EMF cause any adverse health effects at the levels encountered in our everyday environment and that compliance with the existing ICNIRP standards provides sufficient public health protection.

EirGrid recognises that some individuals are concerned about issues regarding EMF and health. EirGrid is committed to addressing these concerns by continuing to:

- Design and operate the transmission system in accordance with current international guidelines on EMF (ICNIRP), as reviewed by the World Health Organisation and endorsed by the EU and the Irish Government.
- Closely monitor engineering and scientific research in this area.
- Provide information to the general public and to staff on this issue.

COMPARISON OF DC MAGNETIC FIELDS FROM COMMON SOURCES

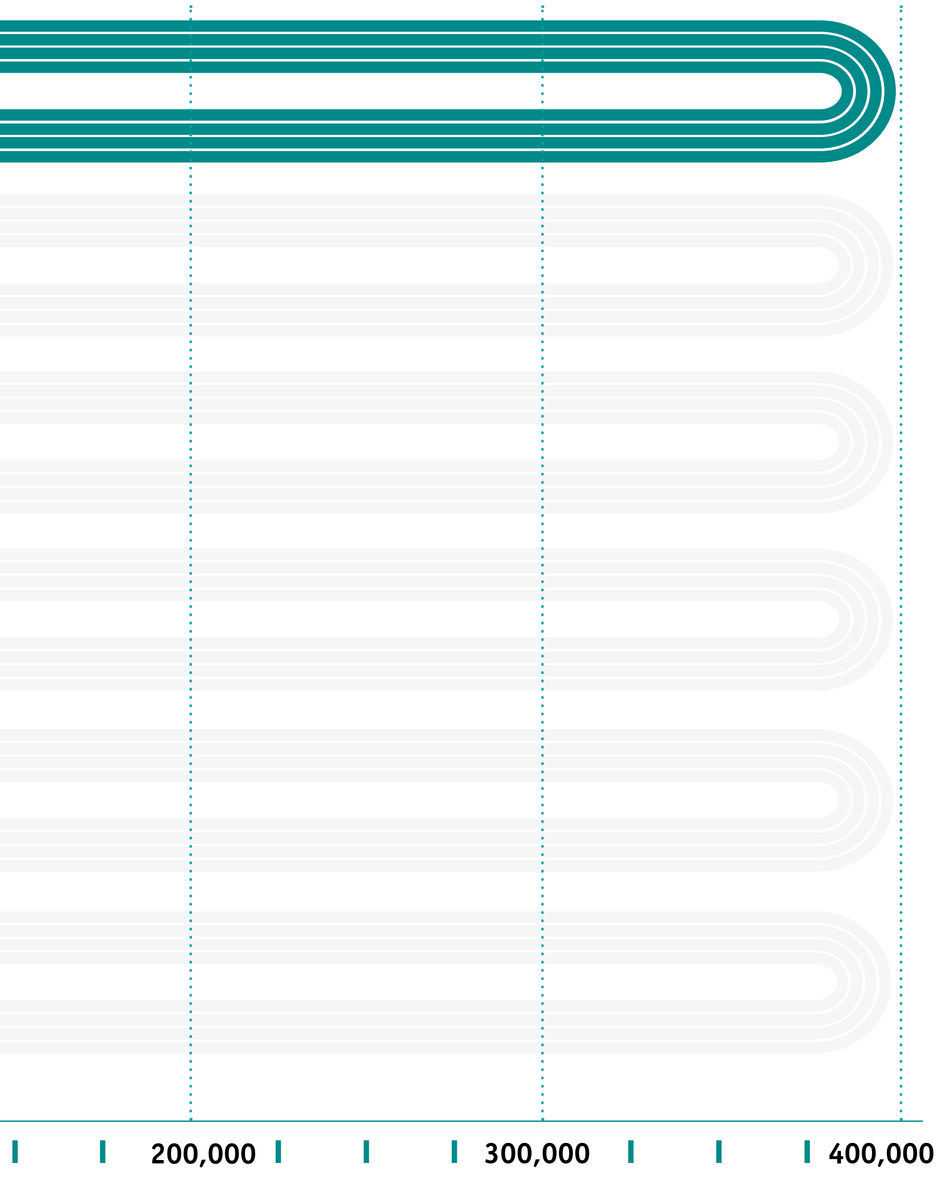
Graph 1. DC magnetic fields from common sources compared to calculated magnetic fields from a 500MW DC cable.



THE INTERNATIONAL COMMISSION ON NON-IONISING RADIATION PROTECTION (ICNIRP) WAS ESTABLISHED IN 1992.

This independent scientific commission was established to advance non-ionising radiation protection for the benefit of people and the environment. It provides science-based guidance and recommendations including independent international guidelines and recommended limits of exposure. ICNIRP is formally recognised by the World Health Organisation and the European Union as the non-governmental standard setting body for EMF.

This graphic provides an indication of approximate fields from lines and appliances. For actual measurements from DC cables already built in Ireland see www.dcenr.gov.ie/energy/



Source of data: Compliance Engineering Ireland (CEI).

AC ELECTRIC FIELDS

Graph 2. The graphic opposite shows some examples of different sources of electric fields and how they compare to typical electric fields associated with overhead electricity lines that make up part of the electricity grid in Ireland.

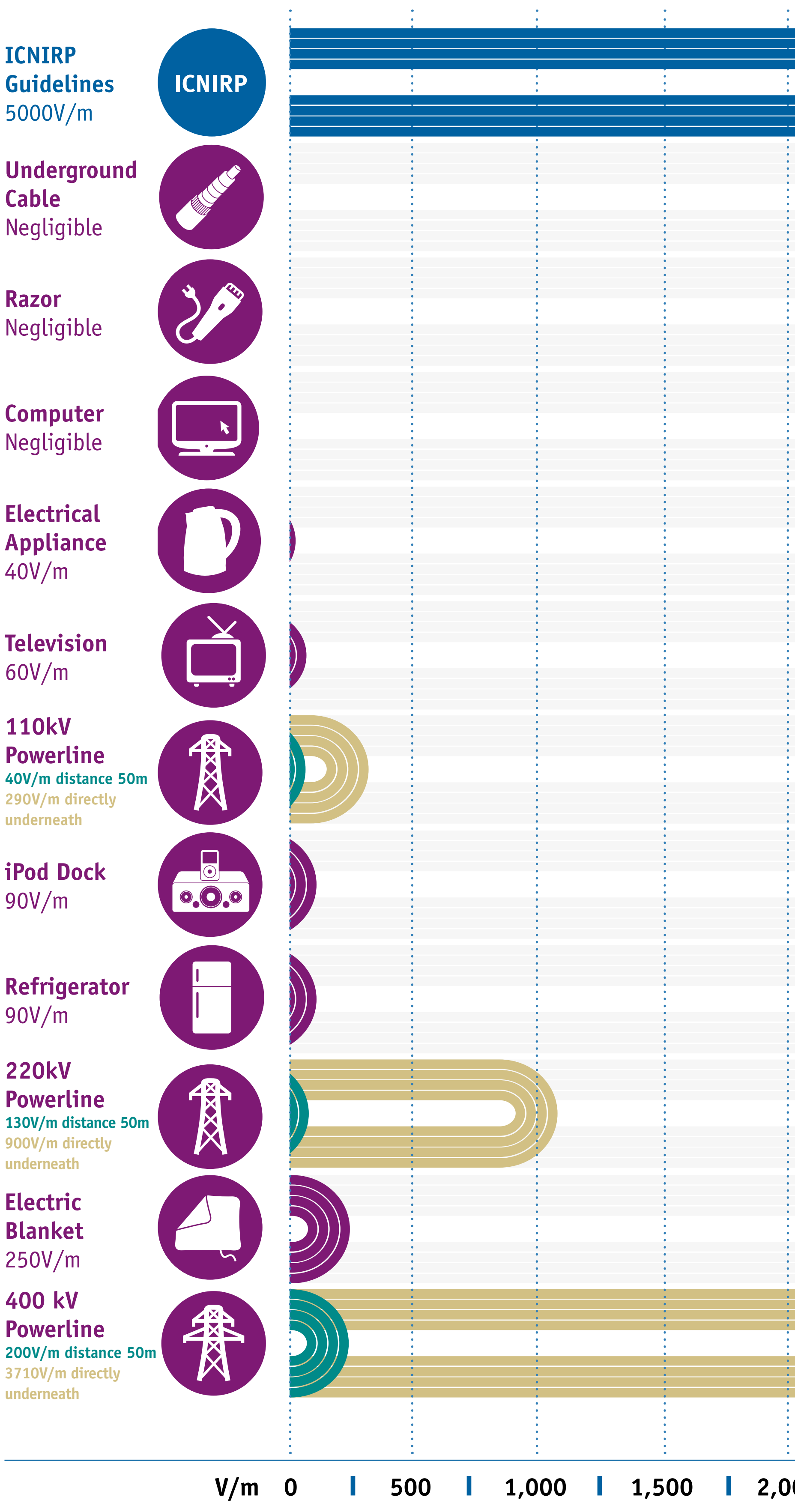
The graph also references the ICNIRP guidelines for exposure to electric fields set to ensure public health and safety.

THE INTERNATIONAL COMMISSION ON NON-IONISING RADIATION PROTECTION (ICNIRP) WAS ESTABLISHED IN 1992.

This independent scientific commission was established to advance non-ionising radiation protection for the benefit of people and the environment. It provides science-based guidance and recommendations including independent international guidelines and recommended limits of exposure. ICNIRP is formally recognised by the World Health Organisation and the European Union as the non-governmental standard setting body for EMF.

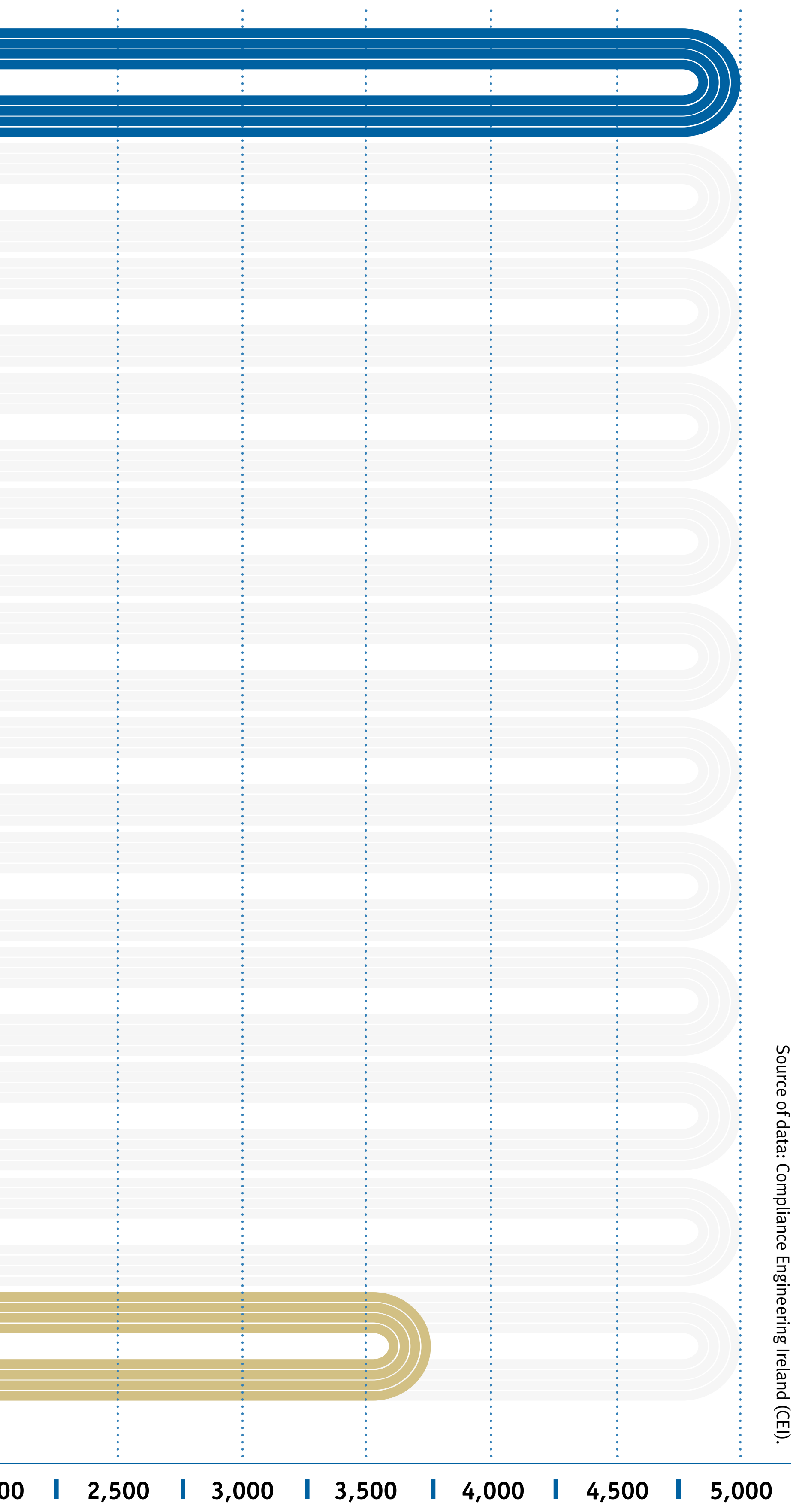
This provides an indication of approximate fields from lines and appliances. For actual measurements from transmission lines already built in Ireland see eirgridprojects.com

COMPARISON OF AC ELECTRIC FIELDS



5kV/m is a reference value, 9.2KV/m is maximum allowable electric field as per the ICNIRP recommendati

S FROM COMMON SOURCES



ons (using the Dimbylow calculations).

Source of data: Compliance Engineering Ireland (CEI).

AC MAGNETIC FIELDS

Graph 3. The graphic opposite shows some examples of different sources of magnetic fields and how magnetic field levels from these sources compare to typical magnetic field levels from electricity lines or cables that make up part of the electricity grid in Ireland.

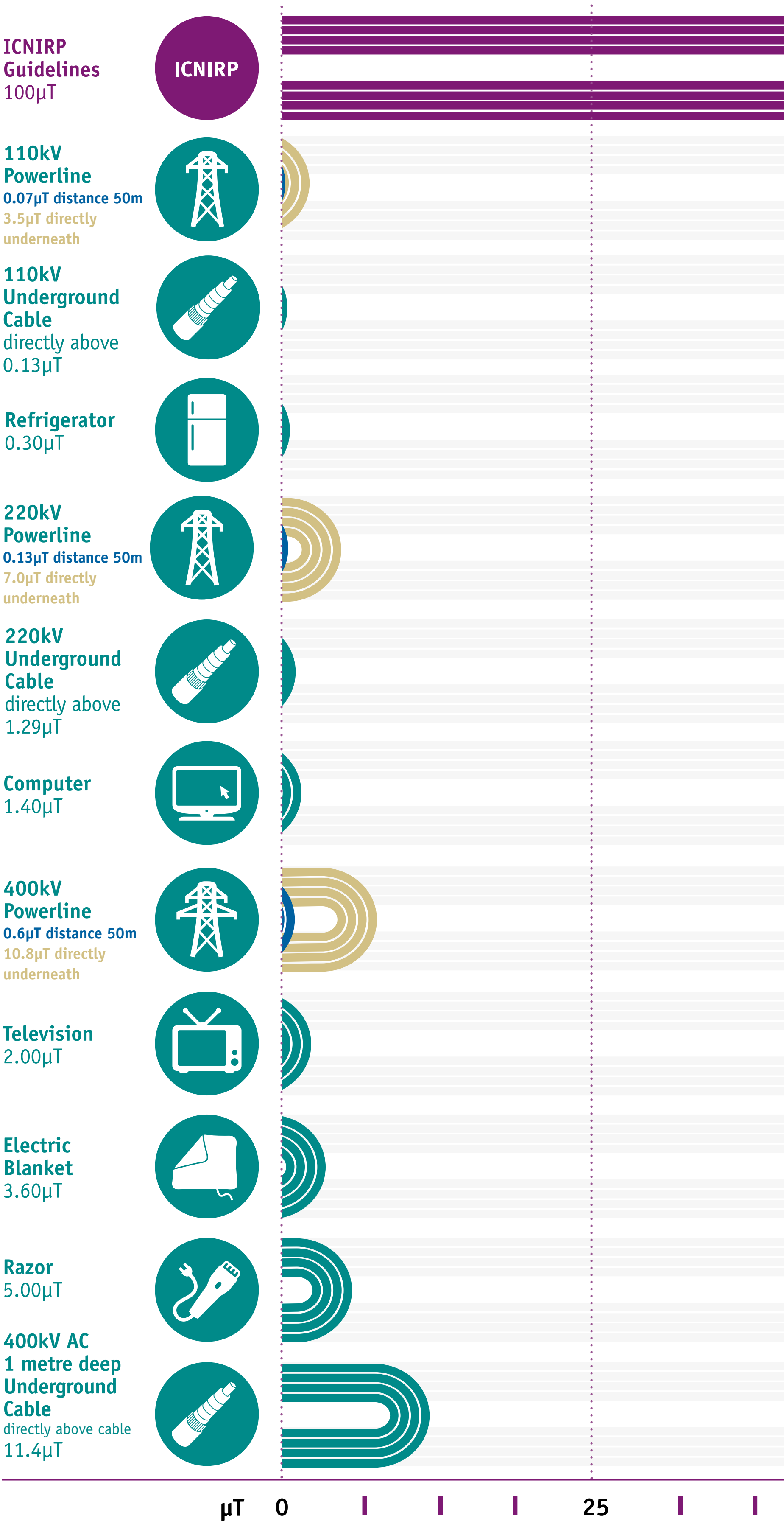
The graph also references the ICNIRP guidelines for exposure to magnetic fields set to ensure public health and safety.

THE INTERNATIONAL COMMISSION ON NON-IONISING RADIATION PROTECTION (ICNIRP) WAS ESTABLISHED IN 1992.

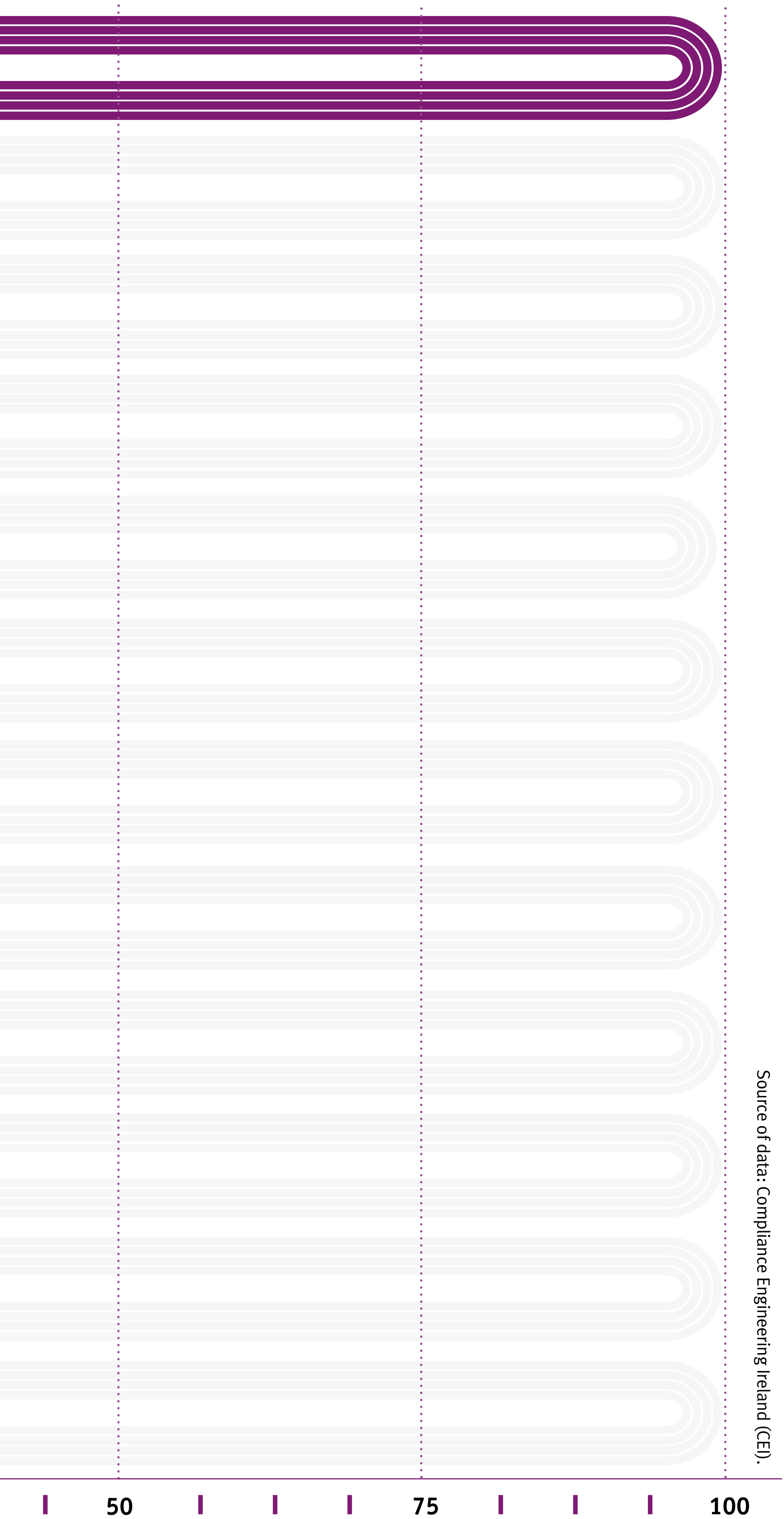
This independent scientific commission was established to advance non-ionising radiation protection for the benefit of people and the environment. It provides science-based guidance and recommendations including independent international guidelines and recommended limits of exposure. ICNIRP is formally recognised by the World Health Organisation and the European Union as the non-governmental standard setting body for EMF.

This graphic provides an indication of approximate fields from lines and appliances. For actual measurements from transmission lines already built in Ireland see eirgidprojects.com

COMPARISON OF DIFFERENT SOURCE



S OF AC MAGNETIC FIELDS (µT)



Source of data: Compliance Engineering Ireland (CEI).

GLOSSARY

AC (ALTERNATING CURRENT)
Electricity that changes direction at regular intervals is described as AC electricity. AC is the form in which electricity is delivered to our homes and businesses. This is the type of electricity used mainly on the Irish transmission system and in every other system in the world.

CARCINOGENIC
Any substance or agent, including ionising radiation, that causes cancer.

CONDUCTOR
An object or material that can carry electricity, like the power cables used in an overhead line.

CURRENT
The movement of an electrical charge similar to the rate of fluid flow in a pipeline.

DC (DIRECT CURRENT)
Electricity that flows in one direction only, like the battery in your car.

ELECTRIC FIELD
An electric field is created by the difference in electric potential (voltage) between the conductors in power cables. The strength of an electric field is expressed in units of volts per meter (V/m). Higher voltage sources produce higher electric fields.

ELECTROMAGNETIC FIELD
The term electromagnetic field is frequently used to refer to electromagnetic energy across a wide frequency spectrum ranging from the earth's natural fields to cosmic radiation. Sometimes it refers to frequencies above about 100 kHz where electric and magnetic fields are coupled and radiate away from sources.

ELF (EXTREMELY LOW FREQUENCY)
Frequencies found at the end of the electromagnetic spectrum that contain very little energy and cannot directly break molecules apart, ie., non-ionising. 50Hz electric power operates at ELF levels.

FREQUENCY
AC Electricity is transmitted in waves. The number of times the wave repeats itself in a second is the frequency and is measured in Hertz. On the Irish transmission system, AC electricity is transmitted at 50Hz.

INDUCED CURRENT
A flow of electric current in an object created by the proximity to an AC power source.

IONISING RADIATION
Radiation, such as X-rays, which has sufficient energy to break molecular chemical and electrical bonds.

MAGNETIC FIELD
Created by the movement of electric charges.

Magnetic fields surround magnetic materials and electric currents. In magnetic materials and permanent magnets, the field is created by the coordinated spins of electrons and nuclei within iron atoms. The magnitude of the magnetic field is expressed as magnetic flux density, also referred to as magnetic field strength. Measured in Tesla (for large fields) or μT (for small fields).

MOLECULE
The smallest particle of a substance that retains the properties of that substance.

NON-IONISING RADIATION
Electromagnetic fields at frequencies that do not have enough energy to disrupt atoms or molecules.

RADIATION
Any of a variety of forms of energy propagated through space.

VOLTAGE
Voltage is the difference in electric potential between any two conductors of a circuit. It is the electric ‘pressure’ that exists between two points and is capable of producing the flow of current through an electrical conductor. Voltage in a power line is comparable to pressure on a pipeline. Voltage is measured in units of kilovolts/m.

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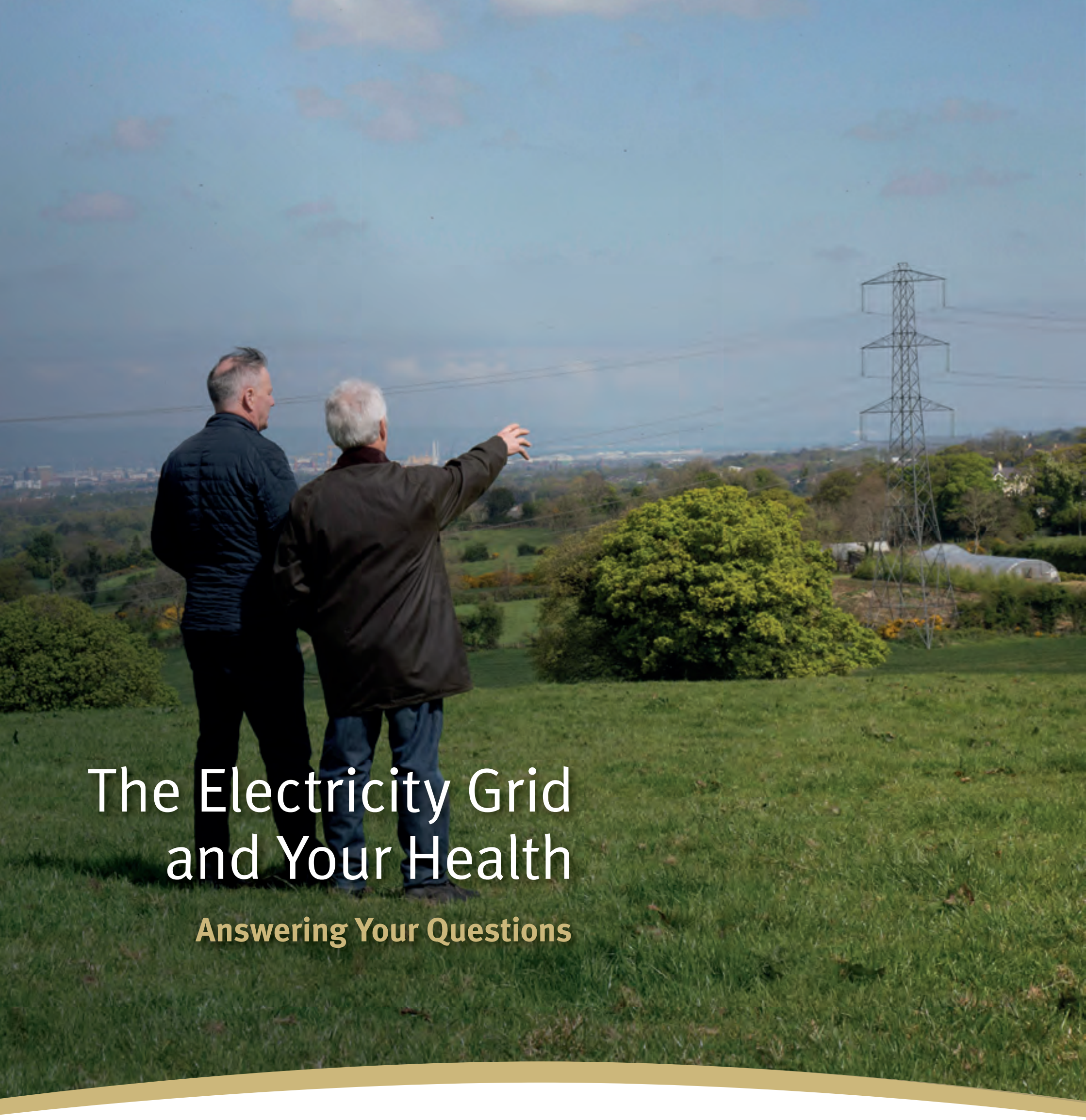
07/14

EG/CW/EMF/V2



The Electricity Grid and Your Health

Answering Your Questions

EIRGRID

The current. The future.

EirGrid is responsible for a safe, secure and reliable supply of electricity – now and in the future.

We develop, manage and operate the electricity transmission grid. This brings power from where it is generated to where it is needed – throughout Ireland.

We use our grid to supply power to industry and businesses that use large amounts of electricity. Our grid also powers the distribution network. This supplies the electricity you use every day in your homes, businesses, schools, hospitals, and farms.

We develop new electricity infrastructure only when it is needed. EirGrid answers to Government and to regulators.

Our safety promise

We obey all laws, and meet all applicable health and safety standards. We work for the benefit and safety of every citizen in Ireland.

Electricity is a very safe way to provide energy to homes and businesses, and we use a lot of it in our daily lives. This requires EirGrid to transmit large amounts of electricity.

The main safety risk this creates is accidental electrocution – and this is a very low risk.

To protect against this risk, we send this energy on wires carried by poles and pylons, or buried underground in cables.

However, some people worry about the electric and magnetic fields (EMFs) that are found near electricity lines and cables.

What are EMFs?

When electric current flows, both electric and magnetic fields are produced. The EMFs from electricity are in the extremely low frequency end of the electro-magnetic spectrum. (See flap.) They occur in the home, in the workplace, or anywhere we use electricity.

However, people everywhere are exposed to EMFs wherever they live, not just from electricity lines. Natural sources of EMFs include the earth's geomagnetic field, and electric fields from storm clouds.

EMFs occur anywhere that electricity is generated, transmitted or used. Apart from power lines, this includes electrical appliances and wiring in our homes and businesses.

Like other issues related to man-made technologies, extremely low-frequency EMFs have been measured, researched and closely monitored.

The consensus from health and regulatory authorities is that extremely low frequency EMFs do not present a health risk.

We know that some people have genuine concerns about EMFs and health. This leaflet aims to simply explain the facts about EMFs, based on current information from health and scientific agencies.

Are EMFs the same as radiation?

No. The fields resulting from electricity are fundamentally different from x-ray and gamma ray radiation. Although they are all forms of electromagnetic energy, there are important and fundamental differences.

The term radiation usually refers to electromagnetic energy that falls at the ionising end of the spectrum. This kind of energy is capable of breaking bonds in molecules. This damages our basic biological building blocks – the DNA of our cells.

Only the high-frequency portion of the electromagnetic spectrum is ionising. This includes x-rays and gamma rays.

EMFs from the electricity grid are non-ionising. This term means that they do not have enough energy to cause damage to human or animal cells in the same way ionising radiation does.

Another source of non-ionising energy are EMFs from the earth itself. The non-ionising end of the spectrum also includes radio waves, TV signals, and visible light.

Some people fear that EMFs could cause cancer in the same way that ionising radiation does. However, the scientific consensus is that there is no credible way to explain how this could happen.

Why are there recommendations on exposure to EMFs?

We can't easily avoid EMFs, as western society has become dependent on technologies that produce them.

But too much of anything can affect human health. This applies to every aspect of our lives; from the food we eat, to how sedentary we are. It also applies to EMFs: at high levels of exposure there are harmful effects.

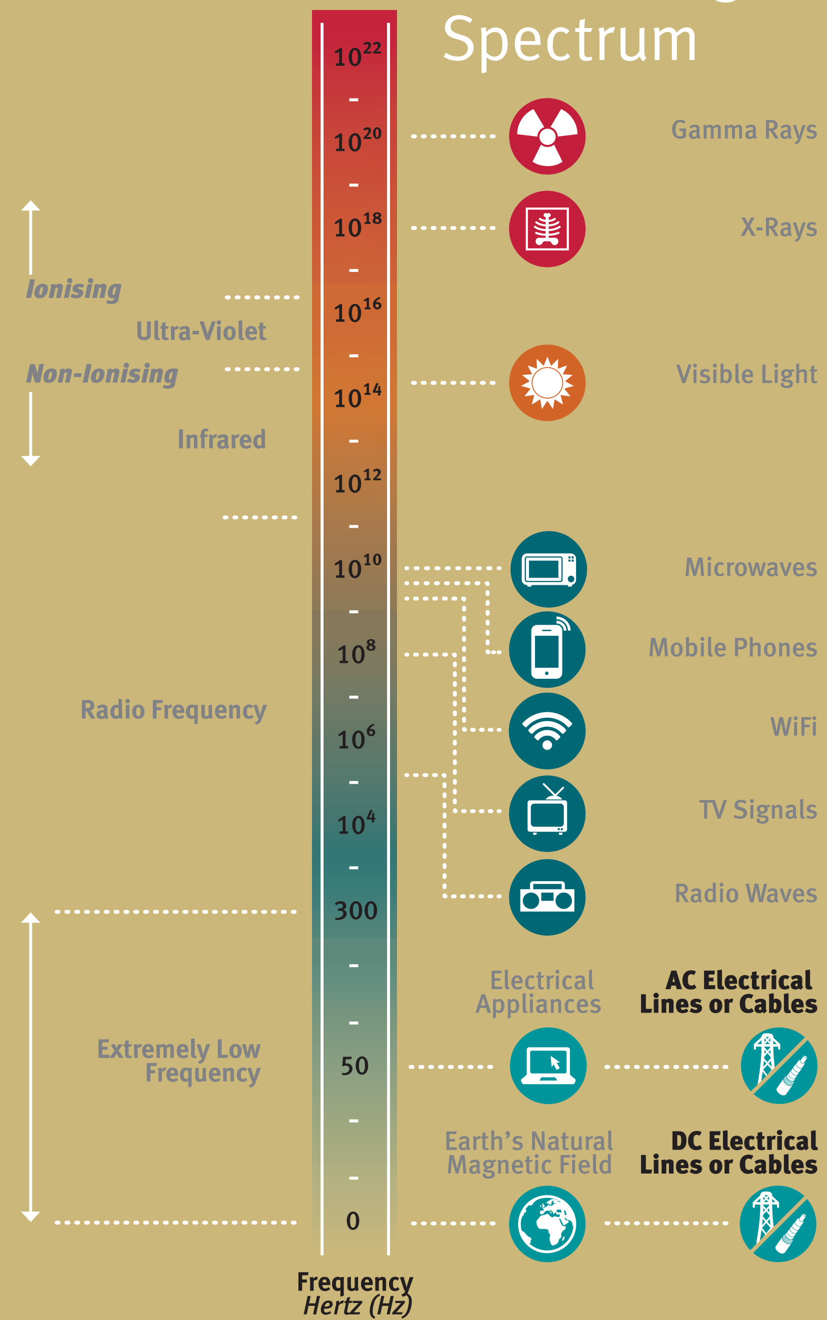
Because of this, health and regulatory authorities recommend exposure limits for extremely low-frequency EMFs.

However, forty years of research has found no hazardous effects from long-term exposure to low levels of EMFs.

This includes the small amounts of extremely low frequency EMFs produced by electricity.

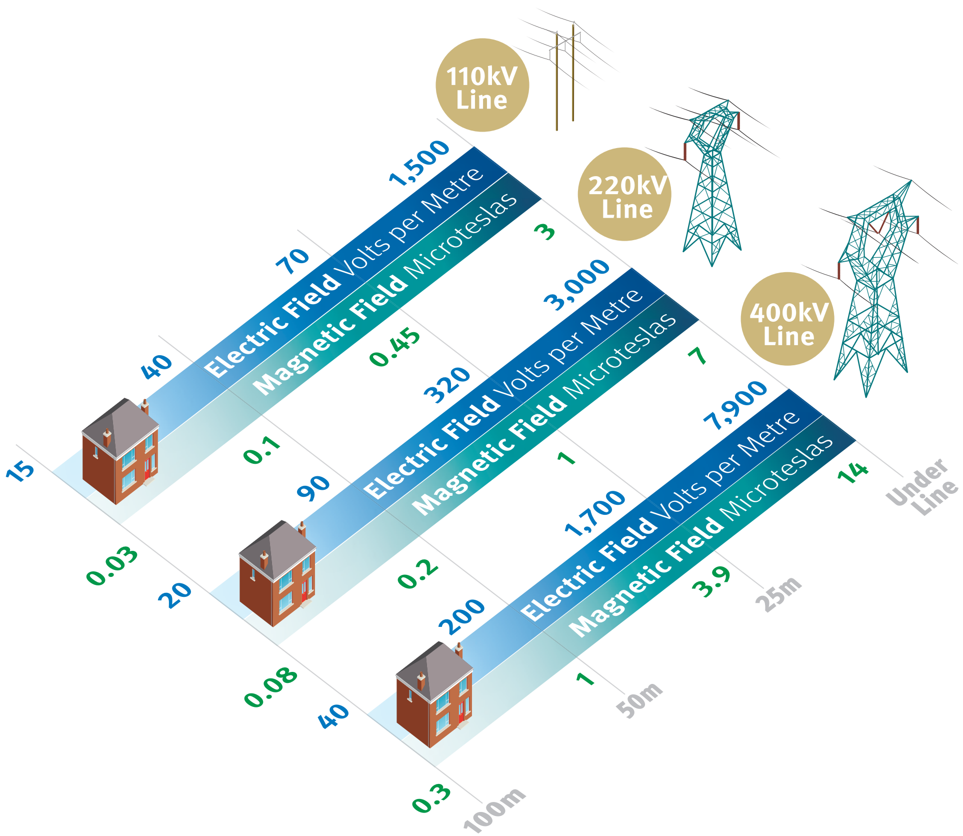
This occurs in home appliances and domestic wiring as well as overhead lines, underground cables, and substations.

Electromagnetic Spectrum



What EMFs do overhead AC power lines produce?

Compare the EMF levels below to ICNIRP basic restrictions for exposure to 50 Hz fields.
Electric field: 9,000 volts per metre. Magnetic field: 360 microteslas.



What are the recommendations on exposure to EMFs?

EirGrid operates the transmission grid to stringent safety recommendations. National and international agencies make these recommendations. They do this independently of any grid operator.

Several of these recommendations come from the International Commission for Non-Ionizing Radiation Protection (ICNIRP).

This is an independent body, funded by public health authorities around the world.

ICNIRP has investigated the safety of EMFs for decades, and provides guidance on safe levels of exposure.

The HSE recommends that ICNIRP guidelines are followed to protect the health of the public.

We design the electricity network to make sure that public exposure to EMFs complies with these guidelines.

The diagram on this page shows the levels of EMFs measured near power lines at various distances.

As you can see, levels of EMFs near electricity infrastructure drop considerably as you move away from the lines.

The levels of the electric field depend upon the line voltage, while the magnetic field depends on how much power is being transmitted.

The figures shown are based on the overhead line structures we use operating at typical line loads.

Figures shown are typical. Electric fields will vary with the voltage of each installation, and magnetic fields will vary depending on how much power is carried on each type of line.

Alternating current and direct current

Alternating current (AC) is used to generate and transmit electricity across the grid.

It allows us to quickly respond to the changing needs for electricity.

This is important because large amounts of energy cannot be stored. Electricity must be produced as soon as it is needed, and instantly sent to where it is needed.

Alternating current allows for this. This is why the vast majority of the grid is made up of overhead lines carrying high voltage alternating current.

AC electricity is then sent from the grid to the local electricity distribution network. This network uses the familiar wooden poles and lines that supply power to your home. This network carries lower amounts of power, to meet the typical needs of electricity used in homes, farms and small businesses.

Direct current (DC) is an alternative way to transmit electricity. It is generally used to transfer large amounts of power from one point to another. DC electricity levels cannot be increased or decreased in the same way as AC electricity.

DC Electricity is generally used for the following purposes;

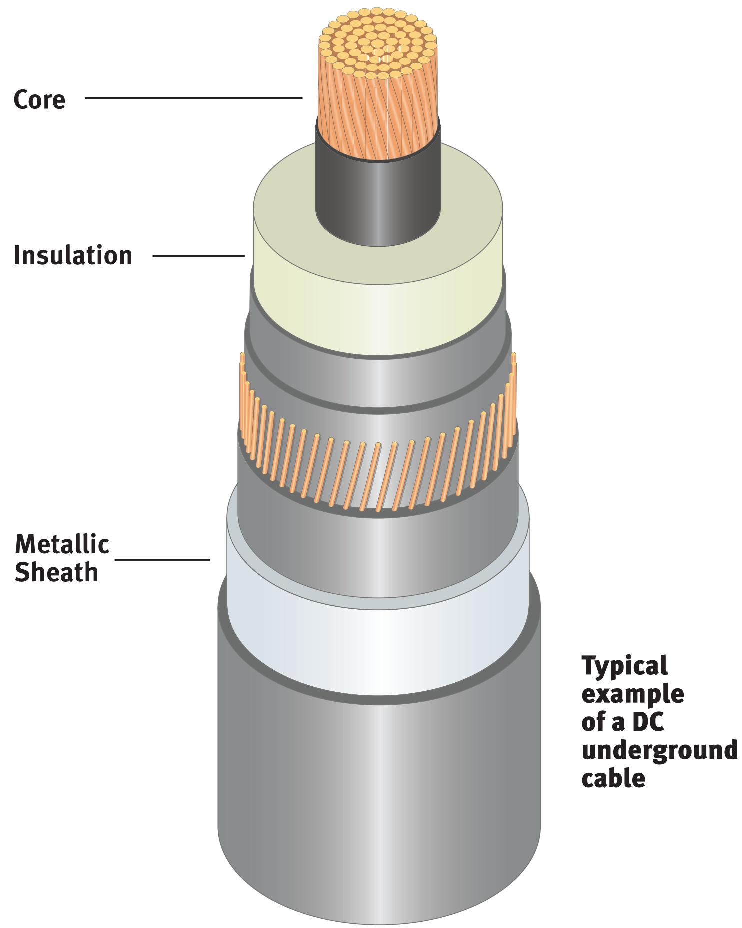
- Transmitting large amounts of power over very long distances – like the East West Interconnector or the proposed Celtic Interconnector.
- Connecting two separate transmission grids of different strength, or that operate at different system frequencies.

In these circumstances, a converter station is needed to change the AC electricity – as used on the grid – to DC electricity.

At the destination, another converter station then changes the DC electricity back to AC, so it can be put back on the grid.

How do underground or undersea power cables work?

To safeguard the power they carry, high voltage cables are insulated and covered in protective sheaths. The cable's metallic sheath also blocks the electric field.

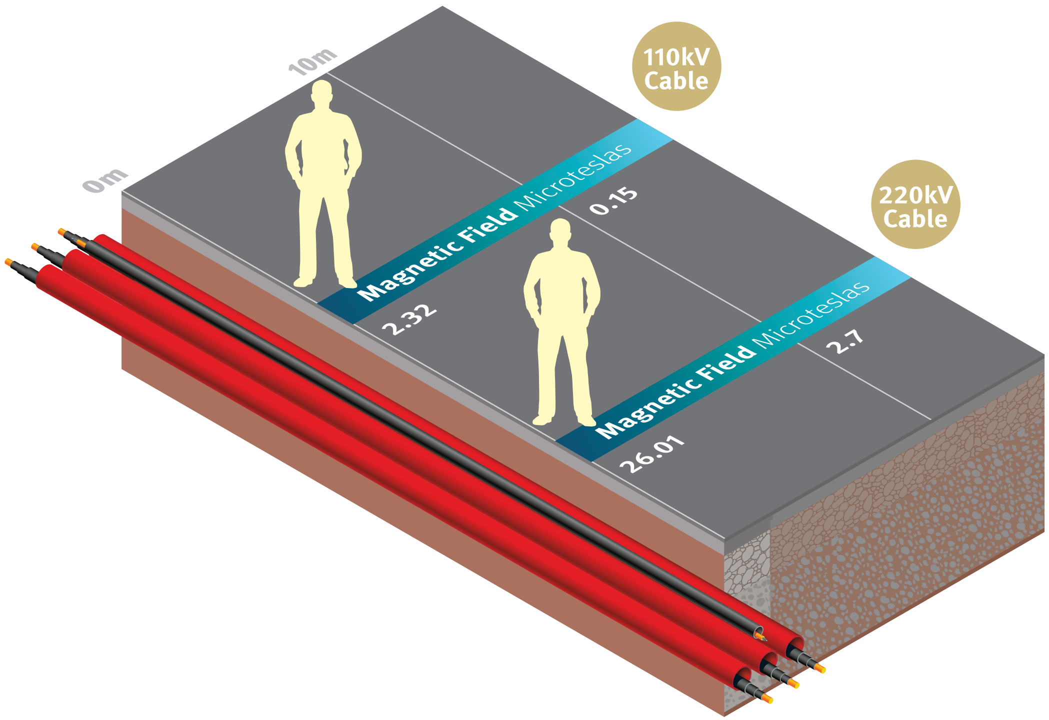


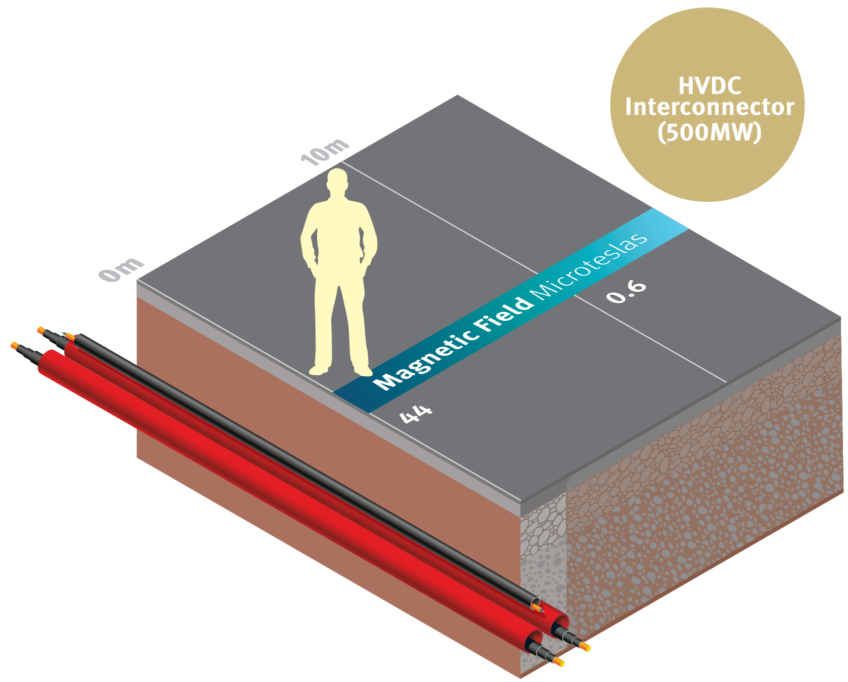
What magnetic field levels do alternating current underground power cables produce?

Compare these figures to the ICNIRP basic restrictions for exposure to alternating magnetic fields, like those emitted by AC cables: **360 microteslas.**

What magnetic field levels do direct current underground power cables produce?

Compare these figures to the ICNIRP basic restrictions for exposure to static magnetic fields, like those emitted by DC cables: **400,000 microteslas.**





Figures shown are typical. Magnetic field levels will vary for each installation, and will vary depending on how much power is carried in the cable.

Why do some people say EMFs are harmful?

The most common concern about EMFs from power lines is a fear that magnetic fields could be associated with childhood leukaemia.

This was first suggested in a 1979 epidemiological study. These kinds of studies look at patterns of disease in populations. While they cannot prove a cause of disease, they can suggest statistical associations that need further investigation.

Because of the 1979 study, power lines and childhood cancers have been comprehensively investigated. These investigations included more epidemiological research, as well as laboratory studies.

There have been mixed results from subsequent epidemiological studies. Some have reported associations with magnetic fields; others have not. Recent studies conducted in the UK, France, Denmark and the US have not established associations between a home near transmission lines and childhood leukaemia.

Crucially, laboratory studies have found no connection and no explanation of how power lines could have this effect.

Based on this history and its own review of research, the World Health Organization states there is no evidence to conclude that exposure to low-level EMFs is harmful to human health.

This issue has become emotive and controversial for some, as none of us can see EMFs or easily control our exposure to them.

There are campaigners who believe any possibility of risk – even unproven – needs action.

There are also some people with health problems that they believe are caused by power lines.

However, anybody who lives in the modern world has widespread exposure to extremely low-frequency EMFs. This is the case whether or not they live near power lines.

Will EMFs be declared hazardous in future?

Those who have fears about EMFs worry that, in future, science will eventually discover they are hazardous.

They look at known carcinogens like tobacco and point out that it was once viewed as safe.

It is helpful to explore this comparison to provide further reassurance.

When there are concerns about a potential health hazard, scientists look for evidence across a variety of studies.

The link between cigarettes and lung cancer was first proposed in 1930s. This was when population studies first showed the clear parallel rise in cigarette consumption and lung cancer.

It took just 20 years to prove this cause and effect, using animal testing, cellular pathology and chemical analysis.

By the 1950s, the scientific case was proven. Over the following decade, health and government authorities started to act on this proof.

In comparison, electricity has been transmitted over lines since the start of the 1900s. Particularly in the UK and the USA, the high-voltage grid expanded hugely in the second half of that century.

There have been more than 100 years of power line use. There has also been over forty years of scientific research into low-level exposure to low frequency EMFs from all electrical sources, including power lines.

The WHO states: "Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals."

There has been a very significant amount of historic exposure, and a very lengthy period of on-going and rigorous investigation.

Yet, there is no conclusive proof that EMFs from power lines are hazardous, nor to explain how they could cause harm.

Want to know more?

This leaflet is EirGrid's summary on this topic. If you want to investigate further, here are some useful links to information on EMFs from national and international agencies.

International Commission on Non-Ionizing Radiation Protection: EMFs
http://bit.ly/ICNIRP_LF

International Commission on Non-Ionizing Radiation Protection: Power Lines
http://bit.ly/ICNIRP_Lines

World Health Organization
http://bit.ly/WHO_EMF

European Commission
http://bit.ly/EC_EMF

Irish Government
http://bit.ly/Ireland_EMF

UK Public Health England
http://bit.ly/UK_EMF

US National Institute of Environmental Health Services
http://bit.ly/NIEHS_EMF

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APPENDIX B

- Code of Practice For Avoiding Danger From Underground Services, Health & Safety Authority
- How You Can Avoid Hitting Electrical Cables When Digging and Drilling, ESB Networks

ESB NETWORKS

HOW YOU CAN AVOID HITTING ELECTRICAL CABLES WHEN DIGGING AND DRILLING

Plain English
Approved by NALA

9800101

How you can avoid hitting electrical cables when digging and drilling

ESB Networks 2017

Revised 2021

Document Reference: DOC-190505-AJV

CONTENTS

ESB NETWORKS

Serving all electricity customers

DO YOU KNOW WHAT LIES BELOW?

Always dial before you dig

Avoid the dangers of underground electricity cables.
Contact us to get maps which show the locations of ESB Networks' underground cables.

PHONE: **1800 928 960**

EMAIL: **dig@esb.ie**

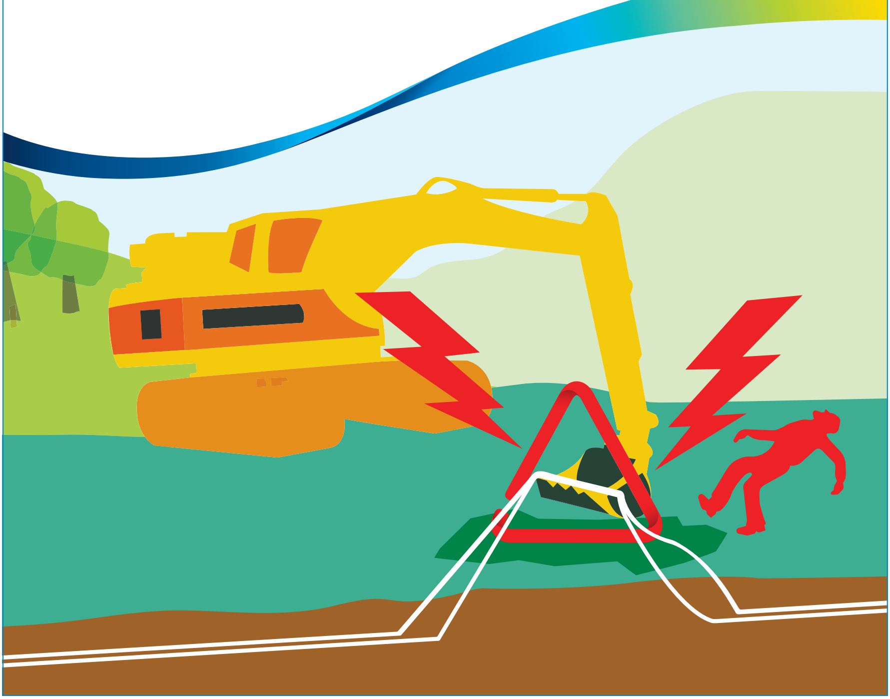
FAX: **01 6388169**

In case of emergency phone
1800 372 999 (24 HOUR/7 DAY SERVICE)

www.esbnetworks.ie

HEALTH AND SAFETY AUTHORITY

IMPORTANT: Please refer to the HSA "Code of Practice For Avoiding Danger From Underground Services" on how to safely carry out excavation work in the vicinity of underground cables. Available at www.hsa.ie



1. What type of work does this booklet apply to?

This booklet provides guidelines that apply to all work that involves penetrating the ground at or below surface level where there may be:

- buried ESB Networks cables; or
- privately owned cables like street lighting cables.

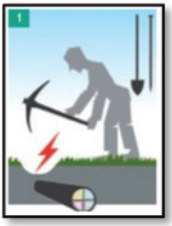
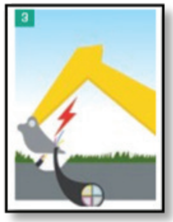
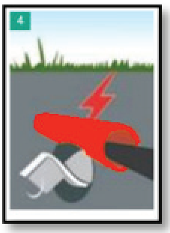
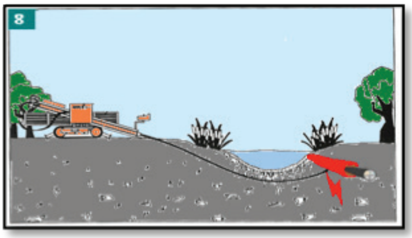
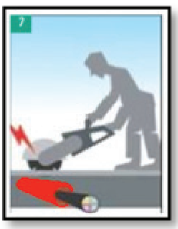
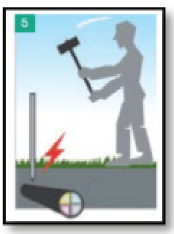
This includes:

- digging trenches to lay pipes or cables; and
- excavation (removing earth to change ground levels or dig a foundation for a house or other structure to be built).

It also includes trenchless techniques like:

- moling (where a machine (mole) forces its way through the soil along the desired path of the pipe),
- pipe ramming (where pipe soil can enter the open pipe when it is being installed),
- horizontal directional drilling (drilling that is precisely directed over a long path using different methods), and
- sheet piling (a wall of connected steel sheets that are driven into the ground to provide support to structures, prevent flooding and so on).

2. Examples of work

Digging trenches and excavation		
Using hand tools	Using a jackhammer	Mechanical excavator
		
Moling	Horizontal directional drilling; moling or pipe ramming	
		
Using a concrete saw	Driving earth-rods	Cutting into service ducts
		

3. What are the hazards of doing work near cables?

Underground cables

When digging or drilling, one of the main dangers is damaging underground electricity cables. You can get an electric shock or be electrocuted if you come in contact with live cables of any voltage including low voltage.

Low voltage cables can be fatal

Contact with cables of any voltage, even low voltage, can cause fatal injuries such as damage to the heart.

Explosion, fire or flames

If a cable is pierced or crushed causing the outer cable sheath and the inner conductors of the cable to connect, this can cause explosion, fire or flames. You could end up with severe and potentially fatal burns to your hands, face and body.

Catastrophic electrical fires

High voltage power cables can be oil filled and oil can ignite. Electrical fires can be catastrophic if damage spreads to other nearby services such as gas pipes. If a gas pipe ignites it can further fuel the fire.

4. Where can I find the legal requirements?

The legal requirements to ensure a safe place of work are set out in the:

- Safety Health and Welfare at Work Act;
- Safety Health and Welfare at Work Construction Regulations;
- Safety, Health and Welfare at Work (General Application) Regulations; and
- Health and Safety Authority (HSA) Code of Practice for Avoiding Danger from Underground Services

5. How can I ensure a safe system of work?

When working near underground cables there are steps to follow which can help you reduce the risk of having an accident. These steps are covered in detail in the 'Code of Practice for Avoiding Danger from Underground Services' produced by the Health and Safety Authority and available from www.hsa.ie.

In this section we describe the three main ways you can make sure that you will have a safe system of work. You must:

a. use plans correctly to help you locate power cables (see 5.1);
b. use cable locating devices (see 5.2); and
c. use safe digging and drilling practices (see 5.3).

These three practices complement each other. You should use all three to ensure that you do not contact or cause damage to a cable buried in the ground.

5.1 How do I use plans to locate power cables?

Before you start work, you must have all of the cable plans for the location. Make sure that they are always kept on site while work is under way.

You should make sure cable plans:

- are up-to-date;
- cover all cable voltages at the location; and
- can be understood by you.

You should also make sure that you use cable plans:

- before starting to dig; and
- throughout all of the work.

Understanding plans and maps

You should understand the scale of the plans and be able to read and understand the map legends, symbols and guideline notes. However, you should understand that plans may only give an indication of the location, configuration (how they are organised) and number of cables present. You cannot rely on plans for accurate distance measurement.

Assume there are more cables than you know about

Always assume that there are more buried cables present than you have located. You should understand that service cables (small cables which bring electricity to a building or lighting point) are not usually shown on cable plans. This includes things like low voltage cables serving individual premises or other electrical supplies like:

- lamp posts,
- parking ticket machines,
- bus shelters,
- advertising hoardings, and
- traffic lights.

You should always check the area for signs that might suggest the presence of service cables and use a cable locator and safe digging practice (see 5.3).

Depth of cables

Most cable plans will not show you cable depths so you must never assume you know how deep cables are. This means you must always be cautious.

Some cables may be found at very shallow depths.

5.2 Use cable locating devices to help find cables

You should use suitable cable-locating devices along with the cable plans to find out as accurately as possible the position of underground cables in or near the work area. You should be trained and able to use the cable-locating device to locate underground cables.

Hum detectors

Hum detectors are used to locate a cable buried in the ground. An example of a hum detector is a cable-locating device set on power mode. Hum detectors are the easiest cable-locating devices to use, but they do not respond to unloaded (where no current is flowing) or direct current (where the current flows only in one direction) cables.

Hum detectors may also fail to detect:

- lightly loaded low voltage cables (such as those used for street lighting); and
- high voltage power cables.

Radio frequency detection mode

A locator with a radio frequency detection mode may detect unloaded, lightly loaded, direct current and high voltage power cables. This means that you should use this for additional back-up checks. Even where a locating device does not give a positive reading there may still be cables present and these may still be live.

Mark cable position on the ground

You should make the position of all cables located on the ground using waterproof paint or crayon.

5.3 Safe digging and drilling practices

1.	**Proceed with caution**
	Treat all cables found anywhere as 'live'.
2.	**Hand dig when possible**
	• Wherever possible, hand dig near buried cables. • Use insulated hand tools with wooden or fibreglass handles.
3.	**Watch those picks and crowbars**
	Take special care using picks or insulated crowbars.
4.	**Protect yourself**
	Wear gloves and eye protection.
5.	**Keep handheld power tools away from cables**
	Do not use hand held power tools within 0.5m of marked position of electricity cables
6.	**Follow advice for handheld power tools over marked cable lines**
	Do not use handheld power tools directly over a marked line of a cable unless:

you have already found the cable at that position by careful hand digging beneath the surface;

and

it is a safe depth (at least 300mm) below the bottom of the surface to be broken; or

you have used a physical barrier to prevent the tool striking the cable.

7. Keep using the cable locator right throughout the project

- When the surface has been broken out, use a cable locator again to reconfirm the position of services.
- You should use the cable locator frequently and repeatedly during the work.

8. Mechanical excavators

- Before using a mechanical excavator near electricity cables, you should excavate trial holes by careful hand-digging.
- Confirm the depth of the cable(s) at the point of work.
- You should not operate the excavator within a radial distance of 300mm (300mm in any direction) from the cable or cables.
- When using a mechanical excavator near electricity cables keep everyone clear of the bucket and the excavator while it is digging.

9. Watch out for concrete

Where an electric cable is embedded in concrete, arrange for the cable to be disconnected before breaking off concrete.

10. Protect exposed cables

Where cables become exposed for any reason, you should take suitable precautions to prevent damage while other works are going ahead. For example, you could use physical ways to do this like using timber boarding or sand bags.

11. Leave exposed cables alone

Do not use exposed electricity cables as a convenient step or hand-hold.

12. Don't move cables

- Do not handle or try to alter the position of exposed ESB electricity cables unless under the instruction of an authorised ESB person.
- Take extreme care where joints in the cables have been exposed.

13. Damaged cables, gas pipes or high pressure water mains

Watch out for even slight damage, like a scrape to the outer surface, to:

- electricity cables,
- gas pipes, or

• high pressure water mains.

If they are even slightly damaged, you should tell the owner of the property immediately. People should be kept well clear of the area until it has been made safe by the owner.

14. Keep contact numbers handy

You should have the 24-hour emergency contact number for ESB and other relevant utilities readily available for immediate contact if damage occurs to an:

- electricity cable,
- gas pipe, or
- high pressure water mains.

The ESB emergency telephone number for cable damages is 1800 372 999.

6. Diversion of underground cables

Contact ESB Networks as early as possible in the planning stage if you need to divert the underground network to make your construction work possible.

Cable diversions can take several months

Cable diversions can take several months due to things like:

- wayleave serving (sorting out the legal rights to access private land to install cables);

- road opening licence requirements; and
- ESB Networks workloads.

Sometimes, we cannot design a suitable cable diversion because there is no alternative route. Generally, it is significantly more costly and difficult to divert cables at the higher voltages.

7. What happens if you damage an underground cable?

Oil-filled cables

Some cables are filled with oil and if damaged, the oil may ignite leading to an explosion.

High voltage cables

Repairs to high voltage cables are extremely costly and time consuming. Costs can be more than €50,000.

Low voltage cables

Low voltage cables are unsafe to handle and can cause injury and electrocution. They are not safer than other voltages.

Loss of electricity supply

Damage to cables can cause loss of supply to customers. This may result in serious consequences for emergency services like hospitals.

National Grid at risk

For higher voltages the effects can extend to the entire national electricity grid.

Person responsible for damage must pay all costs

All costs associated with damage to cables must be borne by the party who did the damage.

8. What to do if someone is injured

Serious accident

If there is a serious accident, seek medical help immediately.

Contact the emergency services on:

- 112; or
- 999.

You should also phone the ESB Networks Emergency number:

- 1800 372 999.

Do not approach person until clear

Do not approach the injured person unless:

- they are well clear of the electrical hazard; or
- the electricity supply is confirmed to be **Off** by an ESB Networks authorised person.

Do not move the injured person unless they are in further danger

You should not move an injured person unless they are in further immediate danger.

Be cautious when attending a casualty

Anyone attending a casualty should be sure not to touch exposed cables, tools or machinery in case they are still live.

Guard the site

Guard the site so that other people do not enter the danger area.

Treat burns urgently

Any burns should be treated by trained medical staff and severe burns should receive urgent attention as they may prove fatal.

Have a first aid kit

A first aid kit should always be available.

9. Further safety information

ESB Networks provide a range of safety information on our website:

- www.esbnetworks.ie.

You can download free PDF versions of safety booklets and posters at: www.esbnetworks.ie

Our booklets

- Avoidance of electrical hazards when working near overhead electric lines
- How you can avoid hitting electrical cables when digging or drilling
- Construction Safety.
- Be Winter Ready.
- Farm Safely with Electricity.
- ESB Networks Electrical and Magnetic Fields.
- Consequences of Flooding for Electrical Safety.
- How you can avoid hitting electrical cables when digging or drilling

You can see our safety videos on our website

www.esbnetworks.ie

10. Useful contacts

How to contact ESB Networks

ESB Network's emergency number	1800 372 999
ESB Network's general queries number	1800 372 757

Use this general number to find about:

- new electricity connections;
- increased capacity;
- voltage enquiries; and
- safety and technical queries.

ESB Network's website	www.esbnetworks.ie

For cable maps and records

To get power cable maps or records:

Email us at:	dig@esb.ie;
Phone us at:	1800 928 960 +353 1 858 2060 This service operates Monday to Friday only.
Fax us at	01-638 8169
Write to us at:	ESB Networks Central Site, St Margaret's Road, Finglas, Dublin 11.

When applying to us for power cable maps or records, you should include:

- a map of the area where work is to take place;
- a contact name and phone number; and
- the email address where the information is to be sent.

Note: We will send maps to you by email within 10 days in PDF format.

How to contact the Health and Safety Authority (HSA)

Phone or website

- Phone: 01-614 7000
- Website: www.hsa.ie

Address

You can write to the HSA at:

HSA

The Metropolitan Building

James Joyce Street

Dublin 1

D01 K0Y8.

ESB Networks Emergency Number:

Phone 1800 372 999

(24 hour / 7 day service)

www.esbnetworks.ie

ESB NETWORKS

HEALTH AND SAFETY AUTHORITY

Code of Practice For Avoiding Danger From Underground Services

Our vision:
Healthy, safe and productive lives.

Table of Contents

Originally published in January 2010 by the Health and Safety Authority, updated in May 2016, The Metropolitan Building, James Joyce Street, Dublin 1.

Table of Contents continued

Foreword

The Health and Safety Authority, with the consent of Mr Gerald Nash TD, Minister of State for Business and Employment, publishes this amended Code of Practice, titled "*Code of Practice for Avoiding Danger from Underground Services*", in accordance with Section 60 of the Safety, Health and Welfare at Work Act 2005 (No. 10 of 2005).

The aim of the code of practice is to improve the level of safety with which excavation work, and other work involving underground services, is carried out. In particular, it aims to reduce the incidence of damage to underground services and in doing so to minimise risk to personnel who are involved in this work.

The code of practice provides practical guidance as to the observance of Part 5 of the Safety, Health and Welfare at Work (Construction) Regulations 2013 (SI No. 291 of 2013) which, inter alia, requires that adequate precautions are taken in any excavation, shaft, earthwork, underground works or tunnel to avoid risk to persons at work arising from possible underground dangers. Such dangers include underground cables or other distribution systems, the circulation of fluids and the presence of pockets of gas, and appropriate investigations to locate them must be undertaken before excavation begins. The Code of Practice also provides practical guidance as to the observance of Sections 19 and 20 of the Safety, Health and Welfare at Work Act 2005 in respect of relevant excavation work.

This amended code of practice comes into effect on Monday 30th May, 2016, and replaces the "Code of Practice for Avoiding Danger from Underground Services" issued by the Authority on 11 January, 2010. Notice of the issue of this amended code of practice, and revocation of the 2010 code of practice, was published in the Iris Oifigiúil on Friday 27th May, 2016.

As regards the use of codes of practice in criminal proceedings, section 61 of the Safety, Health and Welfare at Work Act 2005 provides as follows:

61.– (1) Where in proceedings for an offence under this Act relating to an alleged contravention of any requirement or prohibition imposed by or under a relevant statutory provision being a provision for which a code of practice had been published or approved by the Authority under section 60 at the time of the alleged contravention, [subsection (2) shall have effect with respect to that code of practice in relation to those proceedings.

(2) (a) Where a code of practice referred to in subsection (1) appears to the court to give practical guidance as to the observance of the requirement or prohibition alleged to have been contravened, the code of practice shall be admissible in evidence.

(2) (b) Where it is proved that any act or omission of the defendant alleged to constitute the contravention—

(i) is a failure to observe a code of practice referred to in subsection (1), or

(ii) is a compliance with that code of practice, then such failure or compliance is admissible in evidence.

(3) A document bearing the seal of the Authority and purporting to be a code of practice or part of a code of practice published or approved of by the Authority under this section shall be admissible as evidence in any proceedings under this Act.

Dr. Marie Dalton
Secretary to the Board
Health and Safety Authority

1.0 Introduction

1.1 Background

This Code of Practice (COP) replaces the Code of Practice for Avoiding Danger from Underground Services issued by the Authority in 2010 and is the result of a joint initiative between the Health and Safety Authority, Construction Industry Federation, Irish Congress of Trade Unions, key utility companies/service providers and local authorities that are involved in the provision and maintenance of vital underground services. This COP takes into account legislative changes in the Safety, Health and Welfare at Work Act 2005 and the Safety, Health and Welfare at Work (Construction) Regulations 2013.

The aim of this COP is to improve the level of safety with which excavation work is carried out. In particular, it aims to reduce the incidence of damage to underground services and in doing so to minimise risk to personnel who carry out this work.

1.2 Status of the Code of Practice

This COP is published by the Health and Safety Authority under Section 60 of the Safety, Health and Welfare at Work Act 2005 and with the consent of the Minister of State at the Department of Jobs, Enterprise and Innovation.

This COP is intended to provide practical guidance to utility/service providers, clients, designers, planners, project supervisors (both design process and construction stage), contractors, safety representatives and any personnel who are involved in work where there is a risk from underground services.

A failure to observe any part of this COP will not in itself render a person liable to civil or criminal proceedings. However, where the COP gives practical guidance on the observance of any of the relevant statutory provisions, compliance or non-compliance with those provisions may be admissible as evidence in criminal proceedings. The requirements of this COP are without prejudice to the general obligations placed on employers and others by the current Safety, Health and Welfare at Work Act, Construction Regulations and other associated occupational safety, health and welfare legislation.

1.3 Scope of the Code of Practice

This COP gives recommendations and practical guidance on how to carry out excavation work safely in the vicinity of underground services. In this context 'excavation' means any work that involves penetrating the ground at or below surface level.

Excavation carried out in the vicinity of underground services includes work associated with a new or existing building that may involve the risk of damaging underground services. It encompasses all excavation work carried out on roadways, streets, footpaths and other open areas where there is a likelihood of buried underground services.

This COP also contains guidance on how to prevent future damage to services that are currently being installed.

2.0 General

2.1 Introduction

Electricity cables, gas pipes, water pipes and sewers, if damaged, may pose a direct danger to personnel who are working on the site. Damaged telecommunications cables may also be hazardous, although direct risk of personal injury is rare.

If an electricity cable, telecommunications cable, gas pipeline or water main suffers any impact or any damage, however slight, the incident must be reported to the network operator without any undue delay. Refer to Appendix 5, item 12.

2.2 Electricity cables

Injuries that result from damage to live electricity cables are usually caused by the explosive effects of arcing current and by any associated fire or flames that may follow when the sheath of a cable and the conductor insulation are penetrated by a sharp object such as the point of a tool, or when a cable is crushed severely enough to cause internal contact between the sheathing and one or more of the conductors. Typically, this causes severe and potentially fatal burns to the hands, face and body.

Some high-voltage electricity cables (e.g. 38kV and higher voltage) are filled with oil and, if damaged, the oil may auto-ignite and create an explosion or fire. Injuries may also be caused by the explosive effects of cable materials being vaporised by large currents. There is also a risk of electric shock when underground services are damaged.

Incidents may also arise from cables that have been damaged, but have not been reported to the relevant utility/service provider and, therefore, have not been repaired. In such circumstances nearby services such as plastic gas pipes may be at risk from damaged live electricity cables, which could create explosions or increase the risk of fire.

2.3 Gas pipes

Damage to gas pipes can cause leaks and may lead to high-pressure gas being released, with associated flying debris, noise, fires or explosions. There are two types of damage:

- Damage that causes an immediate leak following a pipe rupture. Those most likely to be at risk are the personnel carrying out the work and others in the immediate vicinity.

- Damage that causes a leak some time after the event. For example, damage to a pipe wrapping or surface may occur while work is being carried out and this damage may lead to a leak at a later date. Damage may also occur after the work has been carried out. For example, poor reinstatement may leave a pipe inadequately supported or subjected to unequal forces. Those most likely to be at risk are members of the public.

Refer to Section 10 and Appendix 2 for requirements.

2.4 Water pipes and sewers

While damaged water pipes are less likely to cause an injury, a jet of water emanating from a high-pressure main could injure people or damage adjacent underground services. In addition, a water leak from an underground pipe could wash away subsoil, thereby reducing support for adjacent services, roads and structures. There is also a risk of flooding trenches or low-lying areas such as nearby basements.

Sewers are generally gravity fed, but some sewage is pumped at pressure. While the main risk to people associated with damage to sewers is the possibility of contamination, these pipes may also emit gases such as methane or hydrogen sulphide. At certain concentrations, methane may be flammable.

Water mains and sewers require ongoing maintenance to ensure that they function effectively; clear access should always be maintained to pipes, especially near flanges, valves, manholes etc. The laying of gas pipes or electricity cables in parallel above or in immediate proximity to a water main or sewer substantially increases the risk of injury to the crews who may have to carry out subsequent maintenance tasks.

2.5 Telecommunications cables

Although damage to telecommunications cables may be very expensive, generally there is no direct risk of personal injury. However, damage to cables can pose a risk to the general population served by these cables. A breakdown in service can result in isolation from essential services such as fire brigade, ambulance and gardaí. Therefore, it is imperative that all precautions necessary are taken to avoid damaging telecommunications cables. If damage does occur, it must be communicated to the utility/service provider without delay. In case of damage to a fibre optic cable, it is advised that an individual should never look into either end of a severed fibre optic cable as laser light might damage eyesight.

2.6 Accumulation of gases

Flammable and toxic gases from sewers and other services may enter and accumulate in service ducts, particularly if ducts have been damaged. Such gases may also accumulate in chambers and manholes and may pose a risk to personnel who are carrying out work in these areas. The gas may also be transported in these ducts to nearby structures where the risk of explosion may be even greater.

> Where entry into a confined space is necessary, the requirements identified in the Confined Space Code of Practice must be complied with.

3.0 Role of the client

3.1 Introduction

Clients play a very important role when it comes to safety and health on construction projects. The Safety, Health and Welfare at Work (Construction) Regulations 2013 define a 'client' as a person for whom a project is carried out.

The Construction Regulations place duties on the client. Clients must make assessments and only appoint competent designers or contractors for the works. If the construction project involves more than one contractor, has a particular risk or will last longer than 30days/500 person days they must appoint a competent project supervisor design process (PSDP) and a competent project supervisor construction stage (PSCS). Project supervisors co-ordinate the management of health and safety with regard to the design and construction of the project.

Clients have a legal duty to be reasonably satisfied that the appointed project supervisors to carry out the work are competent to do so and will dedicate sufficient resources to the project to comply with their legal safety obligations.

3.2 Information from clients

Clients or their agents have a duty to pass on any relevant information relating to underground services that may be in their possession to the PSDP or the PSCS. This information should be as up to date as possible. The client should also make available a copy of any Safety File that is relevant to the construction work that is about to be undertaken.

3.3 Other duties that may apply

In accordance with Section 15 of the Safety, Health and Welfare at Work Act 2005, it is the duty of each person (or company) who has control to any extent of any place of work, or any part of a place of work, to take such measures as are reasonable for them to take to ensure, so far as is reasonably practicable, that the place of work is safe and without risk to health. In certain cases, this provision may be applicable to clients who commission projects that will involve carrying out excavation work near underground services.

Section 17 of the 2005 Act specifies duties to be complied with by persons who commission or procure construction work. Such persons must appoint in writing a competent person or persons to ensure, so far as is reasonably practicable, that the project is designed and is capable of being constructed to be safe and without risk to health.

4.0 Design process roles

4.1 Definition of designer

'Design' covers the preparation of drawings, design details, specifications and bills of quantities. A 'designer' is defined as any person who is involved in such work.

4.2 Project supervisor design process

All designers' work should be co-ordinated by a project supervisor for the design process (PSDP). The PSDP has a duty to prepare and provide to the project supervisor for the construction stage (PSCS) a preliminary safety and health plan if the project is expected to last more than 30 days or 500 person days, or if it contains a 'particular risk', as defined in the Safety, Health and Welfare at Work (Construction) Regulations 2013. One such 'particular risk' is working near high-voltage power lines (i.e. voltages greater than 1.0 kV), including overhead lines and underground cables.

The preliminary safety and health plan must contain an overall description of the project, its proposed timescale and appropriate information relating to other work on the site. It must also specify any work related to the project that will involve 'particular risks'.

Unforeseen circumstances may arise during the execution of the project and may result in a design change. This may in turn have safety, health and welfare implications. The PSDP has a duty to co-ordinate the designers in relation to the safety, health and welfare implications of any change in the original design.

The PSDP must prepare a Safety File for the project and present it to the client when the project is complete.

> Where new services are being laid it is important that they do not prevent access to existing services. Any risk to crews carrying out maintenance on the existing services caused by the laying of new services must be identified at an early stage and minimised as far as is reasonably practicable.

> The Principles of Prevention must be applied at all stages of the design process.

4.3 Use of plans during design

Where possible, the designers should obtain up-to-date maps and records of all potentially hazardous underground services in order to allow them to consider, at the design stage, the risks posed by those services. Plans and maps should be made available to prospective contractors at tender stage or contract negotiation stage. Before beginning any work on a site, the contractor should be satisfied that the drawings supplied contain the most up-to-date information available for the area in which the works are to be carried out.

4.4 Underground services and building work

4.4.1 Relocating underground services some distance away from the proposed construction site may provide a reasonably practicable means of avoiding the risk of causing damage to these services. Any request for the relocation of services should allow for sufficient time for the relevant utility/service providers to evaluate such proposals and carry out their work.

Buildings and other permanent structures should not be erected over underground services because this may create additional risks for construction workers and could prevent future access to those services. If it is not possible to avoid erecting a structure over an underground service, arrangements should be made with the relevant utility/service provider to relocate the service if this is practicable.

4.4.2 Other options to relocating the services may include:

- Repositioning structures or parts of structures to ensure that contact with underground services is avoided while the work is being carried out.
- Arranging for the supply contained within the underground services to be disconnected during the work.
- If neither of these options is practicable, then choosing methods to avoid contact, such as using ground beams to protect the service(s), may present a reasonably practicable option.

4.4.3 Designers should take into account any ancillary work that may be required, including the erection of perimeter fencing and walls or the construction of roadways. Early identification and planning are essential if risks are to be controlled.

4.4.4 Where new services such as electrical or gas supplies are being installed, it may be possible to reduce risks by not installing or commissioning these services until other ground works and installation works have been completed.

4.5 Underground services in paths and roadways

4.5. The options facing designers who are planning a new service in a roadway may be more limited. In order to select a route that avoids contact with existing services, it is important to have access to the most up-to-date information about those services. One option is to choose a route that has a low density of underground services. For example, a cable television duct might be routed at the side of a road, if that site has a reduced cable density. Designers of gas pipelines should also be aware of the requirements contained in IS 328:2003 Code of Practice for Gas Transmission Pipelines; IS 265:2000 Installation of Gas Service Pipes and I.S. 329:2003+A1:2009 Code of Practice for Gas Distribution Mains.

4.5.2 Having reduced the risks to a level as low as is reasonably practicable by design, information should be provided by the designer(s) about the risks that remain. In most cases the best way of informing those physically excavating in the vicinity of underground services is by providing the information on drawings, ensuring that the information given is the best available.

5.0 Construction stage roles

5.1 Project supervisor construction stage

The role of a project supervisor construction stage (PSCS) is to co-ordinate the project from a health and safety perspective. The PSCS must also develop the safety and health plan, which should outline how the management of the safety, health and welfare of on-site personnel is to be achieved. In addition, the PSCS must facilitate safe access to the site and co-ordinate the overall implementation of safe working procedures.

5.2 The contractor

All contractors on site must co-operate with the PSCS to allow the PSCS to comply with his or her statutory obligations and all contractors have a duty to co-operate with each other on issues concerning health and safety. The contractor must also supply accurate information in a timely fashion to the PSCS to allow for the preparation of the Safety File.

Contractors must carry out a site-specific risk assessment. They should also ensure that their employees have adequate training and that any plant or machinery is, so far as is reasonably practicable, safe and does not pose a risk to health. Contractors should also put in place measures to ensure that the health and safety of personnel employed by them will not be adversely affected by the work being carried out.

Sections 6 to 13 of this COP set out practical measures for protecting the safety, health and welfare of employees and non-employees while excavation work is being carried out in the vicinity of underground services.

5.3 Utility/service providers

All undertakings that have underground services should ensure that their records and maps are maintained as accurately as possible. They should make these records readily available to designers and contractors, as appropriate (see Section 7.3).

In circumstances where a utility/service provider is asked to provide permanent services for a building development, that company will be acting in the role of contractor. Therefore, while it is on site, it will be required to comply with any directions given by the PSCS. However, in circumstances where the provision of services is physically separated and demarcated from the site, then the utility company may assume the role of client for the purposes of the Safety, Health and Welfare at Work (Construction) Regulations 2013.

The utility/service providers should make all reasonable efforts to facilitate clients, designers and contractors to manage the safety risks arising from work activities close to underground services.

5.4 Employees

Safe systems of work must always be adhered to. All workers on site must take reasonable care to protect their own safety and the safety of others who might be affected by their actions. They must not engage in any behaviour likely to endanger health and safety on site. They should report without delay any defects in the safety and health regime that might endanger anyone in the workplace.

Employees must also attend training and assessments as might reasonably be prescribed by their employers with regard to health and safety and they must not misrepresent the level of training which they have attended.

6.0 Safe system of work

6.1 Introduction

Underground utility networks are a common feature in both rural and urban areas and their presence should be assumed until proved otherwise. The guidance given in this COP aims to minimise the risk involved in work that may expose persons to inadvertent contact with underground networks. It sets out a safe system of work that is based on obtaining as much information as possible about buried services before excavation or other ground penetration work begins and using that information to ensure that the work is carried out safely.

6.2 Basic elements

In the context of this COP, a safe system of work is defined as having three basic elements:

- **Plans:** Plans or other suitable information about all buried services in the area should be obtained before excavation work begins (see Section 4 and Section 7.4). This material should be passed on as early as is reasonably practicable by the designer through the project supervisors to the contractor who is tendering for, or is negotiating the carrying out of, the works.

  Plans that were used at the design stage and at the tendering stage may be out of date by the time excavation work begins. Therefore, before beginning any such work, the contractor should check that the plans supplied are the most up to date available.

  Account should also be taken of possible indications of the existence of underground services such as the presence of houses or other buildings, lamp posts, illuminated traffic signs, pit covers or evidence of reinstated trenches. However, the absence of such indicators does not necessarily mean that underground services do not exist.

- **Locators:** Suitable cable- and pipe-locating devices should be used in conjunction with any available plans to determine as accurately as possible the position of metallic underground services in or near the proposed work area. It should be noted, however, that these devices do not detect plastic pipes (see Section 8).

- **Safe digging practices:** Excavation work should be carried out carefully and should follow recognised safe digging practices (see Section 9).

These key elements – plans, locators and safe digging practices – complement each other and all three should be used when working near buried services. Using one element alone is not enough.

6.3 Employees

Employees should receive adequate instruction and training in the above procedures (see Section 14). A suggested job aid for workers' information is set out in Appendix 5. It is particularly important that anyone who is using a locator should have received thorough training in the use and limitations of that particular type or model of device. Most manufacturers will provide such training, and employers should ensure that this is adequate for their employees' needs.

Under the Safety, Health and Welfare at Work (Construction) Regulations 2013 persons carrying out certain named tasks – including locating underground services, signing, lighting and guarding on roads and assisting in the implementation of health and safety at roadworks – are required to be in possession of a relevant and valid Construction Skills Certification Scheme (CSCS) card. Training and instruction requirements are dealt with in Section 14.

6.4 Procedures

The organisation and arrangements necessary for avoiding danger from underground services should form part of employers' statutory Safety Statements. Written, site-specific risk assessments of the work being undertaken should be carried out and may include the appropriate use of the relevant Safe System of Work Plans (SSWP).

7.0 Use of plans in the preparation of projects

7.1 Introduction

Up-to-date plans of all potentially hazardous underground services in the area should be obtained before excavation work begins. Where possible, providers of all relevant underground services should be consulted. It should be noted that there may be more than one service provider in a particular catchment area for certain types of utility. For example, while most electricity cables under roads and other public areas are owned by ESB Networks, many electricity cables are the property of local authorities and are used for providing services such as public lighting, traffic lights and so on.

7.2 Emergency works

In the case of emergency* works it may not be possible to obtain all requisite up-to-date plans prior to beginning excavation work. In such situations, all other aspects of safe digging practice should be complied with (see Section 9) and the work should be carried out in the same manner as if there were underground services on the site.

7.3 Availability of plans from utility/service providers

7.3.1 Utility/service providers should make available either up-to-date, readable plans that show the recorded line and depth (where known) of all underground services in the proposed work area, or they should provide other suitable information that achieves the same objective. The inclusion of a symbol key will generally be necessary to help the recipient understand the plans.

7.3.2 Utility/service providers should do everything that is reasonably practicable to ensure that such information is made available to enquirers. They are likely to receive many routine applications for information and they should consider how best to make this information available at short notice. In cases where utility/service providers have reservations about releasing copies of plans for commercial or security reasons, they should offer an alternative method of co-operation. For example, they might send a representative to the site to communicate the requisite information to designated contractor personnel only.

7.4 Use and limitation of plans

Plans vary in scale, content and style and adequate instruction and training in how to read and interpret them should be given to anyone who needs to use them.

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* If the question arises in criminal or civil proceedings as to whether works were emergency works, it is for the person alleging that they were to prove that this was the case. Clients and contractors should not use 'emergency' work as an excuse to justify a failure to plan properly when starting work without plans or other suitable information about underground services in the area.

Plans may give an indication of the location, configuration and number of underground services on a particular site. However, they are rarely drawn accurately to scale and, even if they claim to be accurate, they should not be relied upon in order to obtain accurate distance measurements. Errors may have been made during drafting or the scale may have been altered during reproduction, particularly if the original data was obtained from a microfiche slide or a digital map. Accuracy may be further limited because:

- Use of low-scale maps may not give a reasonable indication of location or configuration of underground services. Where possible use 1:500 in preference to 1:1000.
- The position of reference points (e.g. the kerb line) may have changed since the plans were prepared.
- The re-grading of a particular surface area may mean that the depths shown on the plan are no longer correct.
- Fixtures such as cables may have been moved without the knowledge of the utility/service provider.
- In many cases service connections are not marked.
- Services that appear as straight lines on a map may, in fact, be laid out in a snake-like formation; excessively long cables may have been laid in horizontal loops outside substations and switch rooms.
- Plans may show spare ducts.
- The routes of older services in particular may not have been recorded and so the absence of records should never be taken as proof that the area in question is free of underground services.

To determine the actual position of services and the depth of these services on site, safe digging practices must be used at all times. Such practices include the use of detection equipment and the hand digging of trial holes as required. See Section 9.

8.0 Cable- and pipe-locating devices

8.1 Position of services

The position of any services in or near the proposed work area should be pinpointed as accurately as possible by means of a locating device. This device should be used in conjunction with plans and other relevant information (see Section 8.2) as a guide to the possible location of services and to help interpret the signal.

8.2 Types of locating devices

The main types of locator available are:

- **Hum detectors:** (e.g. a cable-locating device set on power mode) are receiving instruments that detect the electromagnetic field radiated by live electricity cables, which have a current flowing through them. However, these instruments will not detect service connection cables to unoccupied premises or street lighting cables during the daytime, as little or no current will be flowing through those cables at that time. They may also fail to detect some well-balanced high-voltage cables that generate little magnetic field. It should be noted that the absence of current in a live cable does not in any way alter the risk of injury to a person if the cable is damaged.

- **Radio frequency detectors:** (e.g. a cable-locating device set on radio mode) are receiving instruments that respond to low-frequency radio signals, which may be picked up and re-emitted by cables and long metallic pipes. If radio frequency detection is used, other metallic objects may re-radiate the signal and results may vary appreciably according to locality, length of the buried cable or pipe, distance from the termination and geographical orientation.

- **Transmitter-receiver instruments:** With these instruments a small portable transmitter or signal generator is connected to a cable or pipe, or placed very close to it, so that the signal is induced into it. The receiver then detects that signal. Usually, some part of the cable or pipe will need to have been located in advance of the operation in order to ensure that the transmitter is positioned correctly. Transmitter-receiver instruments generally require more skill to operate than other types of locators. They may, however, provide useful information in difficult situations where using other locator equipment has not proved successful. In addition, they can provide a depth-measuring facility.

- **Metal detectors:** Conventional metal detectors will usually locate flat metal covers, joint boxes and so on, but may well miss round cables or pipes. They can be a useful tool for finding inspection points, which may provide connection points for a transmitter for use of transmitter-receiver instruments.

- **Ground-penetrating radar:** Such devices are capable of detecting anomalies in the ground, which may indicate the presence of an underground service. However, the sole use of this method would not determine the precise nature of the service and it should be used in conjunction with maps and other information about the services and ground conditions present. It is also preferable that this technique is used together with more conventional forms of locating device.

Most commercially available instruments use more than one of these techniques and may also include a depth-measuring facility.

8.3 Locating the service

The degree of confidence with which buried services may be detected depends on a number of factors such as the characteristics of the devices being used; the type and depth of the service; the magnitude of any electric current carried by the service cable; the effects of other cables and metal pipes close by; and the training, skill, hearing and experience of the operator.

A locator may not be able to distinguish between cables or pipes running close together and may represent them as a single signal. If two cables or pipes are sited one above the other, it may not detect the lower one. For that reason, frequent and repeated use of the locator should be made during the course of the work.

A locator may not detect plastic pipes or other non-metallic ducts and services unless:

- A metallic tracer wire has been laid with the pipe, which enables a signal transmitter-receiver to be used. Plastic gas, water, sewage pipes and fibre optic cables are the most likely type of non-metallic services to be encountered and some of these may have been laid with metallic tracer wires.

- A small signal transmitter is inserted into and then pushed along the pipe. This is a sophisticated technique and is not likely to be appropriate for many sites.

A locating device should always be used in accordance with the manufacturer's instructions, including being calibrated at regular intervals and not being used outside the specified date. A locating device should be checked regularly and maintained in good working order.

The line of any identified services should be noted and marked with waterproof crayon, chalk or paint on paved surfaces. Any residual markings should be erased after excavation, as far as possible.

On grassed or unsurfaced areas, wooden pegs should be used. Steel pins, spikes or long pegs, which could damage services laid at shallow depth, should not be used.

Under the Safety, Health and Welfare at Work (Construction) Regulations 2013, persons carrying out the task of locating underground services are required to be in possession of a Construction Skills Certification Scheme (CSCS) card. This is dealt with in more detail in Section 14.6.

9.0 Safe digging practices

9.1 Excavating

Once plans and a locator device have been used to determine the position of underground services, excavation may proceed. This work should be carried out carefully, following recognised safe digging practices.

Trial holes should be dug using hand tools to confirm the position of any buried services. Special care should be taken when digging above or close to the assumed lines of any such services. Hand-held power tools are the main source of danger to personnel and they should not be used too close to underground services. (See Appendices 1 and 2 for advice on appropriate safety margins for electricity cables and gas pipelines respectively.)

Hand tools, incorrectly used, are a common cause of accidents. However, if they are used carefully and if the approximate position of services has been determined through the use of plans and locators, these tools may provide a satisfactory method for exposing underground services. Every effort should be made to excavate alongside the service rather than directly above it. Final exposure of the service by horizontal digging is recommended as the force applied to hand tools may be controlled more effectively.

In particular:

- Spades and shovels should be used rather than other tools. They should not be thrown, or spiked into the ground. Rather, they should be eased in with gentle foot pressure.

- Picks, pins or forks may be used with care to free lumps of stone and other materials and to break up hard layers.

- Picks should not be used in soft clay or other soft soils in areas close to buried services.

Particular care should be taken in cases where gas leak search techniques, such as barholing, are used. Refer to Bord Gáis guidance material for advice. Similar precautions should apply when piles or earth rods are being driven into the ground.

Alternative excavation methods such as hydro or air digging tools and vacuum excavation may be used in certain circumstances. However, a detailed, site-specific risk assessment will need to be carried out first to estimate the specific risks associated with the use of these techniques, such as the presence of gas, spark ignition and injuries from ejected soil.

9.2 Damaged services

If an underground service suffers damage, no matter how slight, the utility/service provider should be informed immediately.

In the case of electricity cables, gas pipes, fibre optic telecommunications cables or high-pressure water mains, arrangements should be made to keep personnel well clear of the area until the damage has been repaired or otherwise made safe by the utility/service provider.

9.3 Identification of services

Failure to identify underground services correctly can cause accidents. Correct identification may prove difficult as the utility/service providers may have used a wide variety of materials and colours over a number of years. It is important to remember that colours may appear differently under poor or artificial lighting. In addition, ducts may well contain any one of a number of services, irrespective of the type or colour of the duct.

Some services are very similar in appearance and the following approaches should be adopted until such time as their identity has been positively confirmed:

- The housing for some water pipes and a significant proportion of electricity cables and telecommunications cables are made from black plastic. If a black plastic-covered service is encountered, it should be assumed to be a live electricity cable until proved otherwise. A small percentage of directly buried electricity cables are red in colour, these should not be mistaken for red-coloured electricity cable ducting.

- Iron and steel water pipes may look very similar to gas pipes. Therefore, if any iron or steel pipe is uncovered, it should be handled as if it is a gas pipe.

- Some services run in ducts, which may make these services difficult to identify. Where red ducts are uncovered, the services inside those ducts are likely to be electricity cables of modern installation and they should be treated as such. Where yellow ducts are uncovered, they are likely to be gas pipes and should be treated as such. Black and orange ducts have been used as standard colours for electricity cables in the past and they should be handled as if they contain electricity cables.

- Electricity cables may also be installed in concrete pipes, steel pipes and in plastic ducts in a range of colours. Where there is any doubt about the identity of an exposed service, it should be treated as if it is an electricity cable or gas pipe until proved otherwise.

- Telecommunications cables may be installed in concrete pipes, smooth black ducting or grey corrugated ducting. All cables should be assumed to be live until disconnected and proved to be safe. Contractors should obtain written confirmation of disconnection from the utility/service provider before removing a redundant service or arrange for the utility/service provider to remove the service.

All new buried plastic piping should meet the requirements of Irish Standard (IS) 370:2007 for new installations (see Appendix 6). For example, new ducts installed since 2005 for electricity cables (where the voltage exceeds 125V) should be coloured red. See also Appendix 1 for other relevant specification details.

While colour coding is intended to give an indication of which service is contained within the buried plastic piping, caution must be exercised until the precise nature of the service has being confirmed.

9.4 Support to exposed services

Services uncovered in an excavation may need to be supported and should never be used as handholds or footholds by personnel when climbing out of an excavation.

9.5 Back-filling

Back-filling of any excavation should be carried out carefully. Warning tiles, bricks, tapes and any other protective materials that are lying above the services should be replaced in their original position unless an expert adviser confirms that the original position was incorrect. If the original position turns out to have been incorrect, then the warning tiles and other materials should be placed above the services to which they refer.

Warning tape should not be used for any other purpose (such as guarding an excavation trench) and waste tape should not be left in the excavation area when it is back-filled.

Fill material that contains items such as large pieces of rock and hardcore should not be used as this could cause damage to the services.

For specific advice on back-filling in the vicinity of gas pipes (i.e. where long-term damage is a particular hazard) see Appendix 2. Alternatively, utility/service providers may provide direction and advice on how to back-fill trenches in which their services have been exposed.

9.6 Burial of existing services

If underground services have been found to be too shallow, or if the plans or other information have proved to be inaccurate, the relevant utility/service provider should be informed – preferably before the excavation is back-filled. The utility/service provider should then amend its records accordingly.

9.7 Protection against burns

Burns are the main injuries that result from damage to live electricity cables, or from fire or explosion following a gas leak. Burns are likely to be most severe where skin is not covered and therefore, based on a site-specific risk assessment, appropriate skin cover for hands, arms, legs and upper body should be used.

The wearing of protective clothing should never be used as a substitute for a safe system of work.

9.8 Insulated digging tools

Where excavation work is being carried out near live cables, the use of insulated tools is strongly recommended. Generally, tools such as shovels, spades or picks should have insulated fibreglass or wooden handles. Fibreglass crowbars are also available and these should be used where feasible. If this is not feasible, then the crowbars should be fitted with insulated handles.

10.0 Safe systems of work for trenchless methods

Increasingly, trenchless methods are being used for the laying or renovation of underground pipes and cables, particularly in cases where it is necessary to avoid disturbing surface areas. The most widely used techniques are impact-moling, pipe-bursting and auger-boring. Care should be taken when using trenchless methods to avoid colliding with, and thereby damaging, other services. With moling and pipe-bursting it is also important not to work too close to other services as displaced soil may escape into nearby pipes or ducts.

As moling takes place underground, the actual path taken is unseen and not guaranteed, the pertinent risks associated with moling must be taken into account at both the design and construction stages. Possible damage using trenchless methods includes damage to structures and damage to other services.

Consideration must be given to the location of all services present and may involve appropriate consultation with the relevant utility/service providers. Competent planning, organisation and implementation will be required before and during trenchless works. The recommendations for safe digging practices outlined in Section 9 must be referred to.

Plans, locators and trial holes should be used to determine the position of existing services. The path of the equipment to be used should then be calculated accordingly. In order to avoid danger and allow sufficient clearance for the maintenance of existing services, the general guideline is that the minimum clearance between adjacent services should be either 300mm or one and a half times the diameter of the pipe being laid, whichever is the greater. For electricity cables, gas mains, telecommunications cables and water mains, clearances for maintenance work should be a minimum 300mm in all directions. Trenchless methods (moling/directional drilling) must not take place within ten metres of a gas pipeline unless the gas network operator has been consulted.

In certain circumstances, clearances may need to be varied. Therefore, contractors should take into account factors such as the construction of adjacent plant; ground conditions; bore diameter; the accuracy and reliability of the technique/equipment being used; and whether the other plant is parallel or crossing the proposed line. In addition, the requirements of nearby utility/service providers may need to be taken into account.

Moles are prone to deflection from their planned course and, if there are existing services in the vicinity, a mole-tracking device should be used. Where trenchless methods are being used, all equipment which is electrically bonded to the mole should be earthed at all times in case the equipment strikes a power cable and this causes it to become live. As an additional precaution, an equipotential mat can be used for the operator to stand on.

The use of no-dig technology carries its own risks. Several recorded examples exist where, unknown to the installing contractor, a new service such as a gas main had been pushed through a sewer pipe, resulting in a blockage in the sewer pipe. The subsequent use of clearing techniques such as jetting machines by the sewer maintenance teams put these crews at risk when they unknowingly cut through the gas pipe.

11.0 New housing developments

Underground services that are located within the confines of partly completed new housing developments are especially prone to damage from the numerous site operations that may need to be carried out.

The construction of a single trench may help to control the position and separation of underground services. Where services are laid on a partly developed site, special arrangements may be required for their temporary protection at vehicle/plant crossing points.

Close liaison should be maintained between the developers, their contractors and the utility/service providers. A marked-up plan of the estate, showing the up-to-date position of underground services (including any variations from planned routes) should be kept on site and referred to in advance of carrying out excavations or other ground penetration works.

12.0 Installation of new services near existing services

New underground services often have to be laid in ground that already contains other services. Where it is reasonably practicable to do so, the utility/service provider that is planning the new installation should aim to position it in such a way that it is separated from all existing underground services by an adequate distance. Guidance on the requisite distances to be maintained may be found in the UK publication *National Joint Utilities Group (NJUG) Guidelines on the Positioning and Colour Coding of Underground Utilities' Apparatus 2013*. The Irish Standard for colour code for buried plastics piping (IS 370:2007) should be referred to (see Appendix 6). Every effort should be made to comply with these standards (unless otherwise noted in this COP) or other equivalent standards of good practice for new installations in order to minimise risk to personnel now or at some future date.

Where the installation of a new service is likely to obstruct access to an existing service for more than a few metres, then all reasonably practicable measures should be used to avoid this situation. In particular, the practice of laying multiple ducts directly above other services should be avoided.

In circumstances where it is not possible to comply with the recommended services separation standard, because of underground services congestion or some other factor, the relevant utility/service provider must be contacted and as great a separation as is reasonably practicable should be maintained.

Designers and contractors must be aware that if placing services in parallel to existing utilities that are closer than the specified distances, unacceptable risks may be introduced, particularly to persons who at a later stage may require access for utility maintenance.

Unless formal agreement has being obtained from the utility/service provider or the relevant person representing the utility/service provider there should be no circumstance where access is restricted to existing services. Access to services is essential for maintenance work and possible emergency response.

13.0 Demolition sites

Special difficulties may arise in the case of service terminations in a derelict property or on a demolition site.

Contractors who plan to engage in demolition work have a duty to give adequate notice to the relevant gas, electricity and water authorities of their intention to carry out this work. Demolition should not begin until the relevant authorities have confirmed in writing that the supply has been disconnected or some other appropriate safeguarding action has been taken.

As noted in Section 4, there is an onus on the PSDP who is co-ordinating the design team to identify hazards associated with the existing environment, including known hazardous underground services.

Underground services on industrial or commercial sites may be the property of the site occupier. A contractor who is planning to demolish buildings or plant on such a site should contact the site occupier or the site owner to ensure that all relevant services are isolated before demolition work begins.

Even where supplies have been disconnected, contractors should be aware that:

- Services that run through a site may not be providing a service to that site.
- Bottle-ended or pot-ended cables must be treated as live unless confirmed otherwise.
- Some services may not have been recorded on the original plans and, consequently, may not have been identified or disconnected.

14.0 Training and instruction

14.1 Introduction

Digging close to underground services is potentially dangerous. Both the workers and the supervisors who are involved in this activity need an appropriate level of knowledge, skills and experience in order to ensure that the work is carried out safely. Anyone who does not possess these attributes should work under the close supervision of someone who does have the requisite experience and competencies.

14.2 Provision of information and instruction

Prior to work commencing on site all employees/operatives must be given appropriate information and instruction, through induction, toolbox talks or other equivalent means of communication. The information and instruction provided may include all or some of the following, as appropriate:

- Completion and communication of a relevant Safe System of Work Plan.
- Site-specific risk assessments.
- Operating procedures.
- Permits to work procedures.
- Relevant drawings, maps and other related information.

14.3 Training for supervisors and operatives

In accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013, operatives must satisfactorily complete the one-day Safe Pass safety awareness programme. However, this is an introductory course in construction safety and does not in itself provide sufficient training in relation to the hazards and risks involved in digging close to underground services.

Personnel* who are involved in either the supervision or carrying out of excavations in the vicinity of hazardous underground services should be appropriately trained in one or more of the following areas, as required:

- Planning of the work.
- Legislation.

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* These include workers who manually work on excavations in streets, utility/service provider employees who manually work on excavations and those directly supervising these workers. Excavator drivers may be excluded if they received sufficient relevant training on an excavator driving course. However, if they are involved in excavation outside the excavator, they should receive the stipulated training.

- Risk assessment.
- Liaison with utility/service providers.
- Use of plans and drawings from the various utility/service providers.
- Appropriate use of cable- and pipe-locating devices.
- Location of underground services (CSCS, see Section 14.6.1).
- Identification of services.
- Safe digging practices.
- Personal protective devices.

Refresher training will be required periodically depending on the work being carried out by personnel. Employees should not refuse reasonable offers of training; they should co-operate with their employers regarding training and they should make relevant documentation demonstrating receipt of training available for inspection as appropriate.

14.4 Site-based direct managers/supervisors

Those involved in direct management and supervision of site-based work require relevant competencies to deliver safety standards on site. They will need health and safety training in order to:

- Assess and prioritise the risks on a particular project.
- Design safe systems of work that are appropriate to specific site conditions.
- Prepare clear, simple safety method statements that can be used and understood by site workers.
- Check that suitable personal protective clothing and appropriate equipment has been provided and is being used correctly.

14.5 Role of the project supervisor construction stage in training

As part of their duty to co-ordinate site safety, the PSCSs must have a system in place for checking that on-site operatives have been appropriately trained, even if those operatives are not their employees. The PSCS should have a system in place for ensuring that all craft and general construction workers on site have an up-to-date Safe Pass card and appropriate Construction Skills Certification Scheme (CSCS) cards where required.

14.6 Construction Skills Certification Scheme

The Construction Skills Certification Scheme (CSCS) is managed by the Further Education and Training Authority, SOLAS. This scheme is backed up by legislation, in particular Schedule 5 of the Safety, Health and Welfare at Work (Construction) Regulations 2013. The regulations list tasks which are common to the construction industry. If a task is listed in the schedule then you must hold a CSCS card to carry out that task on a construction project. Some of the common CSCS tasks in relation to avoiding dangers from underground services are set out in the sections below.

A large number of underground services are located under roads (including footways, cycle tracks, roadways etc.). Carrying out construction work on or near a roadway brings additional hazards, the most obvious being live traffic. The Safety, Health and Welfare at Work (Construction) Regulations 2013 (SI No. 291 of 2013) sets out the CSCS training requirements in regards to protecting workers and the public when working on roads.

For further information on the CSCS, contact SOLAS Tel: + 353 (0) 1 53302500 or Email: info@solas.ie.

14.6.1 Locating of underground services (CSCS): The 2013 regulations require persons carrying out the task of locating underground services to be in possession of a CSCS card. Contractors must ensure that underground services are located before excavation begins. This task and the methods involved are dealt with in detail in Section 8.

14.6.2 Signing, lighting and guarding (CSCS): Where any construction work which obstructs the roadway (part of the road where vehicles travel) or where pedestrians, people with disabilities or cyclists are diverted on to the roadway due to construction work, there must be on that site at all times when road signing, lighting and guarding is being installed, modified or removed, at least one person who has been issued with a valid construction skills registration card relating to signing, lighting and guarding on roads. In general this relates to works which interfere with the roadway traffic. Furthermore, the works both on and off the roadway must also be supervised by a competent person who has been issued with a valid construction skills registration card relating to signing, lighting and guarding on roads.

14.6.3 Assisting in the implementation of health and safety at roadworks (CSCS): When construction works on roads are in progress you must have a person on site who has been issued with a valid construction skills registration card relating to ‘assisting health and safety at roadworks’, where the person possessing a valid signing, lighting and guarding CSCS is not present. In general this relates to work which does not interfere with the roadway traffic.

HEALTH AND SAFETY AUTHORITY

Appendices

Appendices 1 to 4 give advice on matters relating to each of the five main types of underground services (gas, electricity, water and telecommunications). This is additional information and should be read and used in conjunction with the advice contained in the main text.

Appendix 1: Electricity cables

Plans

A1.1 The electricity service providers should be consulted wherever possible and all relevant plans obtained. (Note: While most electricity cables are owned by ESB Networks, many underground cables are the property of local authorities and are used for the provision of services such as public lighting, traffic lights and so on. Other underground cables may be the property of public bodies or private companies.)

A1.2 The representation of underground cables on plans may vary depending on the density of the underground networks (i.e. the number of cables running in close proximity), the scale of the plans and local historical recording conventions. Advice for interpretation should be sought from the issuing office. It should be noted that low/medium-voltage cables and high-voltage cables may be shown on separate plans.

Cable-locating devices

A1.3 While hum detectors (e.g. cable-locating devices set on power mode) are the easiest devices to use, they do not respond to unloaded or direct current cables. Furthermore, they may fail to detect lightly loaded low-voltage cables (such as those used for street lighting) and well-balanced high-voltage cables. A locator with a radio frequency detection mode may detect these cables and, therefore, should be used for additional back-up checks.

In some situations it may be possible to use a generator (genny) to induce a traceable signal on to a cable and this signal can then be used to trace the position/depth of the cable at locations remote from the genny using a cable detector.

A1.4 Even where a locating device does not give a positive reading, there may still be cables present and these may still be live.

A1.5 If a cable that is recorded on a plan cannot be located, appropriate assistance or advice should be sought. If digging has to start before such assistance or advice has been obtained, extreme care should be taken.

Safe digging practices

A1.6 In the vast majority of cases there will be no permanent surface markers or other visible signs to indicate the presence of a buried cable. Even if no cables are shown on plans or detected by a locator, a close watch should be kept for any signs that might indicate their presence.

A1.7 Underground cables are normally laid in trenches between 400mm and one metre deep. However, depths should never be assumed. Cables are often found just below the surface. As a result, therefore, even shallow excavations may present a source of danger. This factor should always be borne in mind, particularly if the ground has been disturbed or if there are cellars or other structures such as bridges in the area, which may have prevented cables being laid at standard depths.

A1.8 Cables may have been laid in any of a number of different ways – directly in the ground with a bed or surround of fine soil or sand; in earthenware or concrete pipes; in pitch-filled cast iron formers; or in plastic pipes or ducts. Occasionally they may be encased in steel pipes, or a covering of tiles, bricks, slabs, timber boards or coloured plastic marker tape may be laid above them. However, such coverings may have been disturbed and moved subsequently and should not be relied upon to give an accurate indication of cable position. These factors further emphasise the importance of using safe digging practices.

A1.9 During digging work, a careful watch should be kept for evidence of cables and repeat checks should be made with a locator to determine more precisely the position of any cable. Note: a cable should be considered positively located only after it has been safely exposed. Even then, digging should proceed with care, as there may be other cables, particularly high-voltage cables, nearby or lower down.

A1.10 Occasionally, cables are terminated in the ground by means of a seal or some other form of external mechanical protection. These pot-ended or bottle-ended cables should always be treated as live and should not be assumed to be abandoned or disused. They may be difficult to detect with locators even when live.

A1.11 When joints on electricity cables are encountered, they should be treated with extreme care. The joints may be enclosed in cast iron, earthenware or plastic casings. They need proper support and should never be disturbed, except following consultation and agreement with the utility/service provider.

A1.12 The use of hand-held power tools to break up paved surfaces often leads to accidents. Where practicable, such power tools should not be used within 500mm of the indicated line of a cable buried in or below a hard surface. Where power tools have been used to break away the surface from the indicated line of the cable, it should then be positively located by careful hand digging under the hard surface. The material under the hard surface should be removed gradually until the cable is exposed. If the cable is not exposed, then it must be assumed to be embedded in the hard surface. Where possible, a cable locator should be used as a depth guide down the side of the excavation.

The 500mm safety margin may be reduced:

- Where congestion of buried cables renders it impracticable.

- Where surface obstructions limit the space available; but only if the line of the cable has been positively identified by plans and confirmed by a locator.

Because it may be difficult to confirm depth, hand-held power tools should never be used over the cable unless either:

- The cable has already been exposed by digging under the surface to be broken out and is at a safe depth (at least 300mm) below the bottom of the hard surface material.

or

- Physical precautions have been taken to prevent the tool striking the cable. Advice on the safe use of hand tools is given in Section 9.

A1.13 Excavating close to electricity cables buried in concrete is dangerous. For this reason alone electricity cables should not be buried in concrete and the utility/service providers should ensure that their employees and contractors are aware that this practice is unacceptable.

A1.14 Using mechanical means to break up concrete can cause damage to cables. If the cable is live, anyone present is likely to be injured.

A1.15 Alternative routes should be carefully considered as a means of avoiding cables that are buried in concrete.

A1.16 Where it is necessary to break away or disturb the concrete in which a cable is embedded, the utility/service provider should be asked to disconnect it from the supply, or an alternative safe method of excavation should be agreed with the utility/service provider before excavation work begins. It is important to note that the use of powered hand tools close to cables is likely to represent the greatest risk of injury.

A1.17 Where a buried cable has been disconnected from the supply to allow for safe excavation, it is essential that liaison should be maintained between the parties involved to ensure that the work has been completed and that workers have cleared the site before the cable is reconnected.

A1.18 Where mechanical excavators are being used in an area likely to be in the vicinity of underground cables, the work should be arranged in such a way as to ensure that damage to cables is avoided. In addition, all personnel should be kept well clear of the excavator bucket while digging work is going on.

Drivers should be instructed to remain in the cab if a cable is struck. If the driver has to leave the cab, he or she should jump clear of the machine, rather than climb down, to avoid the risk of electrocution. A designated person should be assigned to guard the excavator and ensure that no person enters the area or touches either the excavator or the cable until the utility/service provider has made the damaged cable safe.

A1.19 The most common injuries resulting from cable accidents are flash burns, splatter burns from molten metal or ignited oil and electrical burns. Burns are likely to be most severe where skin is not covered and therefore, based on a site-specific risk assessment, appropriate skin cover for hands, arms, legs and upper body should be used.

A1.20 Accidents sometimes occur after underground cables have been exposed. Cables should not be used as handholds or footholds by anyone climbing in and out of the trench. Where a cable that is exposed for more than one metre crosses a trench, support should be provided. If the exposed length is less than one metre, support should still be considered if joints have been exposed or if the cable appears otherwise vulnerable to damage. If advice or help is needed, the cable service provider should be contacted.

Suitable precautions should be taken to prevent damage from ongoing work in the excavation area (e.g. by use of physical means such as timber boards or sand bags). Cables that are lying at the bottom of an excavation area should be protected by nail-free wooden planks, troughing or some other suitable means. Care should be taken not to use materials or equipment that could damage or penetrate the outer sheath of the cables. Cables should not be moved aside unless the operation is supervised by the utility/service provider. Precautions should be taken to prevent access to exposed cables by children or other unauthorised personnel.

A1.21 Hard or sharp materials, such as pieces of rock, large stones, hard-core or surplus concrete, should not be tipped into open cable trenches. Advice on back-filling cable trenches should be obtained from the cable service provider. As a general rule, all exposed cables should be back-filled with a 75mm minimum surround of compacted sand. Disturbed tiles and bricks should be replaced and new yellow-coloured warning tape should be placed above the excavated area.

A1.22 Any damage to an electricity cable should be reported immediately to the cable service provider and work should not be undertaken in the vicinity of a damaged cable until the service provider has investigated its condition. (Some cables may automatically 'trip out' when damaged, but these may be re-energised at any time unless the cable service provider is notified of the damage.)

Recommended standards for new underground electricity cable installations on new developments and in existing roads and streets

A1.23 Buried electricity cables may be laid either directly in the ground or they may be installed in impact-resistant ducts or pipes. As a general guideline, new cables should be installed at depths of approximately 450mm in footpaths and driveways and at greater depths of approximately 600mm when installed in road carriageways or grassed areas. However, local conditions may dictate that these depths vary, particularly where pipes and cables cross, or where underground structures or other obstructions are crossed. Depths may also vary at entrances to buildings, beside street furniture and at underground link disconnection boxes. Deviation from the recommended standards outlined above should only occur if local conditions make compliance impracticable. If cables are buried at shallower depths than those recommended, then this should be noted on the record drawings.

The clearance in all directions between underground electricity cables and other services should be approximately 300mm. With the exception of crossing points, services should not be laid above electricity cables. This is because, following installation, continuous access will be required for the repair of faults or the installation of new service connections. These connections are usually jointed live in the case of low-voltage mains cables.

While there is no agreed industry standard in Ireland governing the relative lateral positioning of services in footpaths, general guidance may be found in the UK publication *National Joint Utilities Group (NJUG) Guidelines on the Positioning and Colour Coding of Underground Utilities' Apparatus 2013.* Efforts should be made to comply with this standard, or other equivalent standards of good practice in relation to the positioning of new installations.

Colour marking and strength specification of ducts for underground electricity cables

A1.24 All new underground ducts laid for the installation of electricity cables of 125V or greater must be **RED** in compliance with IS 370:2007 (see Appendix 6) and must carry the warning: **DANGER ELECTRICITY CABLES**. They must also conform to the deformation and impact resistance requirements and all other requirements as set out in the 'Material Specification' (see Section A1.25).

A1.25 Material specification for red uPVC and MDPE ducting for the installation of underground electricity cables

	MAINS CABLE DUCT	HOUSE SERVICE CABLE DUCT
Duct outside diameter (mean)	125.0mm – 125.4mm	50mm
Duct type	uPVC, 6m lengths; Spigot and socket type	MDPE, 6m straight lengths or 50m coils
Duct rating	Normal duty per EN 50086 – 2 specification	750N – EN50086 – 2
uPVC quality	100% virgin material	100% virgin material
Duct colour – outside	Red – BS Type 5252 04E53 – 04E56	Red as for 125mm Minimum 1mm thickness of colour
Duct deformation requirement	Must pass EN50086 – 2 <5% deformation requirement for 450N loading on 200mm sample	Must pass EN50086 – 2 - :1996 <5% deformation for 750N loading on 200mm sample
Impact resistance	Per 50086 – 2 12 samples; 5kg striker: 570mm fall height:>28 Joules – no crack in at least 9 samples	As for 125mm
Duct minimum wall thickness	The larger of the two criteria: (1) Wall thickness to pass 5% deformation /impact requirement above and (2) Minimum wall thickness of 3.8mm (required for cable pulling)	Duct wall thickness based on 750N loading test
Duct end; spigot end	Spigot: plain end bevelled to allow easy jointing of duct on site, minimum thickness of plain end to be 1.3mm, bevel length 5mm	Duct ends bevelled to allow jointing of duct on site
Circumferential mark on plain pipe end for correct push-in distance	Circumferential mark required to indicate correct push-in distance for duct jointing for spigot and socket joints. Location: 105mm – 110mm to suit socket length below	Clear circumferential mark required to indicate correct push-in distance for duct jointing using standard 50mm couplers
Duct ovality including socket	2.00mm max.	1.4mm max.
Eccentricity of socket relative to duct	None allowed and no angle allowed between socket centre line and the duct longitudinal axis to avoid ripping cable sheath during cable pulling	None
Duct inner surface	Smooth, low-friction surface completely free of ripples, sharp edges and protrusions. Friction coefficient <0.28	As for 125mm ducting Friction coefficient <0.28

	MAINS CABLE DUCT	HOUSE SERVICE CABLE DUCT
Legend content:	'DANGER ELECTRICITY CABLES'	'DANGER ELECTRICITY CABLES'
Repetition rate/gap between legend	150mm max gap between adjoining legends	150mm max gap between adjoining legends
Colour of legend, size of lettering	Black NOTE: 3 lines of 20mm @ 120°	Black 2 X 8mm – 10mm height @ 180° apart
Batch No./name of manufacturer and date of manufacture	6mm minimum lettering size	6mm minimum lettering size
Red colour fastness	One year minimum required so as to provide 12-month storage period at builders' providers premises One year outdoor weathering test required or suitable accelerated colourfastness test	One year minimum required so as to provide 12-month storage period at builders' providers premises
All bends for 125MM duct	All angles: radius = 1.2m minimum for 22, 45 and 90° material as per pipe specification above. (3.8mm minimum thickness)	
Bend ovality	2mm max (same as for pipe)	
Couplers for 50mm OD duct		Slip or rubber gasket type with no internal obstructions/sharp edges. A centering ridge is required that does not protrude

Appendix 2: Gas pipelines

A.2.1 General requirements

Natural gas, which is highly flammable, is transported in a network of polyethylene and steel pipes at pressures up to 85 bar. Damage to a gas main may result in large volumes of gas escaping into the atmosphere in an uncontrolled manner. Even if there is no smell of gas, any damage to a gas pipe should be reported, regardless of how minor the damage might appear. An immediate repair may prevent an accident at a later stage due to a stress failure at the location of the original minor damage.

Most underground gas pipes are the property of gas transmission or distribution companies. One notable exception to this is private 'metered' estates, which may have gas piped to users from a bulk liquefied petroleum gas (LPG) tank. In such cases, the service provider should be able to supply the requisite information. Estates that comprise privately owned dwellings do not normally have a site owner or manager. In such circumstances information may be obtained from the LPG supplier, whose name and telephone number (manned twenty-four hours each day) should be displayed in the bulk storage vessel compound. The risks associated with leaking LPG are even greater than those associated with leaking natural gas as it is heavier than air and does not disperse as readily. In addition, it can travel great distances below ground level before accumulating at low levels.

All personnel who are involved in carrying out work near underground gas plant should observe the specific requirements set out by the gas network operator. Network operator staff or representatives must have access to underground and above-ground plant at all times. Unauthorised repairs to gas pipes must not be made. If there is any doubt about the need to carry out repairs, the advice of the relevant gas network operator company should be sought.

Natural gas pipeline infrastructure in Ireland may be categorised as transmission pipeline or distribution pipeline.

A.2.2 Transmission pipelines

See Section A.2.4 for requirements common to both transmission and distribution pipelines:

Transmission pipelines operate at internal pressures between 7 bar and 85 bar. They are the primary spine pipelines that transfer gas throughout the country. They are constructed from steel with a black or concrete coating and may have marker posts at intervals along their length, particularly at field boundaries and road crossings.

- Transmission gas pipelines are generally between 150mm and 1000mm in diameter and coated in yellow and/or encased in black wrapping.

If a transmission main is identified within ten metres of any intended excavations (including vertical boring), then work must not proceed until the gas network operator has been consulted. See greater distance requirements in relation to special operations in Section A.2.2.7.

The network operator should be consulted before commencement of excavation works within ten metres of any large pressure reduction plant, i.e. above-ground gas installation (AGI) or district regulator installation (DRI), as shown on the map records.

Gas Networks Ireland: 'Dial Before You Dig' enquiries: 1850 427 747.

A.2.2.1 Locating the transmission pipeline: The gas network operator should arrange for locating and marking out of the pipeline as well as for the supervision of the digging of any trial holes necessary to confirm the position of the pipeline.

A.2.2.2 Orientation and location: Where a new service is to cross either above or below an existing transmission gas pipeline, the normal minimum distance between the outside of the pipeline and the service to be installed should be 600mm.

In special circumstances this distance may be reduced at the discretion of the network operator's engineer. At such crossings both the pipeline and the new service should be suitably supported to prevent any future settlement and the back-fill should be packed and consolidated to the satisfaction of the network operator's engineer (see Section A2.2.6).

As a general rule, no new service should be laid parallel to an existing transmission gas pipeline. However, in special circumstances (e.g. motorways) a new service may be laid parallel to an existing pipeline provided that there is adequate clearance (normally 600mm) between them and provided that the service is not laid in parallel either directly above or below the existing pipeline.

A.2.2.3 Cathodic protection: Transmission gas pipelines are cathodically protected. Where a new service is to be laid and similarly protected, the network operator (once notified) is obliged to carry out interaction tests to determine whether its system is adversely affected.

A.2.2.4 Pressure testing: Hydraulic testing of other installations (e.g. high-pressure water mains) should not take place within eight metres of an existing transmission gas pipeline unless precautions have been taken to mitigate the effects of a possible burst. These precautions may include the use of pre-installation tested pipe, sleeving, barriers etc. as agreed with the gas network operator's engineer.

A.2.2.5 Excavation: Where it is necessary to excavate below a transmission gas pipeline, the pipeline must during all stages of the operation be supported to the satisfaction of the gas network operator's engineer. On completion, permanent supports should, if necessary, be constructed to avoid future settlement.

Mechanical excavation by powered tools is not permitted within a distance of three metres and the use of hand-held power-assisted tools should not be permitted within 1.5 metres of a transmission gas pipeline or associated equipment. Consideration may be given to a relaxation of these limits provided that prior notice of the excavating methods to be used is given to the network operator and the safeguards to be employed are agreed between all parties.

To avoid damage during construction work, exposed gas pipelines must be protected as directed by the network operator's engineer.

A.2.2.6 Back-filling: Parties responsible for the new works should give the gas network operator at least forty-eight hours notice of their intention to back-fill under, over or near an existing transmission pipeline. The gas network operator's representative must be in attendance during all back-filling operations and advise on the suitability and degree of consolidation of back-fill material around the pipeline. Any damage to the coating of the transmission gas pipeline, even if minor in extent, must be brought to the notice of the gas network operator so that any necessary repairs may be carried out before back-filling is completed. The gas network operator must make repairs as efficiently and as quickly as practicable.

A.2.2.7 Special operations: *Explosives* must not be used within 400 metres of gas transmission pipelines (30 metres for distribution pipelines), without prior consultation with the gas network operator.

Piling and/or demolition works; the gas network operator must be consulted before any piling is carried out within 15 metres of an existing gas pipeline.

A.2.3 Distribution pipelines

Distribution pipelines operate at internal pressures less than 7 bar. They transmit gas at medium pressure (more than 100 mbar and less than 7 bar) or low pressure (less than or equal to 100 mbar) and are mainly constructed from polyethylene (PE).

The pipeline is predominantly yellow in colour, but may have brown or black stripes. Mains gas pipelines usually run parallel to property in the footpath, grass verge or road and range in size from 63mm to 315mm diameter. Service gas pipelines are connected to mains and run to a meter position at the property and range in size from 20mm to 63mm diameter.

Note: There is a limited use of steel pipes in areas like bridges or where only shallow depths can be achieved Gas Network Ireland: 'Dial Before You Dig' enquiries: 1850 427 747.

A.2.4 Requirements common to both transmission and distribution pipelines

Requirements under A.2.2 take precedence in the vicinity of transmission pipelines.

A safe system of work must always be followed – refer to Section 6.

Work involving piling, demolition, directional drilling, use of explosives or hot works may require special precautions to be taken.

A.2.4.1 Planning and obtaining utility maps: It is imperative that early contact is made with the gas network operator to obtain a gas network map and that this is made available to operatives on site for the duration of any works. The responsible person should ensure that operatives on site understand the map and are continually informed of any updates.

A.2.4.2 Identifying distribution mains and services: Where the presence of gas mains which operate at pressures greater than 7 bar is indicated (i.e. a transmission pipeline), the gas network operator must be consulted before work begins.

The depth of cover from gas distribution mains laid in a roadway is normally 750mm. For those laid in a footway it is normally 600mm. The depth of cover for gas service connections is normally 450mm in both roadways and footpaths. However, at entry points to buildings, the depth of cover for a service connection may be 375mm. It is important to note that these depths are merely a guide and pipes may be found at shallower levels. For example, pipes such as those passing over cellars or in the vicinity of bridge structures may have been laid at shallower levels, or the depth of cover may have been reduced after the pipe was installed due to other works such as road alterations being carried out in the area.

Polyethylene mains may have been inserted into redundant cast iron or ductile iron gas mains. Marker tiles may have been used above gas pipes, for example where they have been laid at a shallow depth in bridge structures or above cellars.

Polyethylene mains may have a coloured plastic marker tape above them. The presence of gas plant may also be indicated by valve boxes and marker posts. Marker posts/plates are sometimes used to indicate the position and size of valves or siphons on gas mains. However, such markers may have been disturbed and should not be relied upon as an accurate indicator of pipe position.

Plans do not normally show the position of service connections. Their existence should be assumed and it may be possible to estimate the probable line of the service connection pipe from the gas meter boxes/cabinets, house entry points, service risers and gas valve covers, or from the point of entry to the premises. Older buildings may have no visible signs of a service, as the service may run directly into the building underground, with the meter fitted internally. In these cases a check should be made inside the building to identify the service route to the meter position.

A.2.4.3 Safe digging practices and avoidance of pipeline impact:

(i) Excavations near gas pipelines: Where gas pipes cross, or are parallel and close to excavations, changes in back-fill may cause differential ground settlement and increased stress in the pipe. Where pipes are parallel and close to excavations, the degree of risk depends on the depth of the excavation, the distance of the pipe from the excavation and the type of soil. If an excavation is likely to affect support for a gas pipe, the gas network operator should be consulted. If gas pipeline or gas plant relocation is necessary, the gas network operator should be contacted to arrange diversion before work begins.

The network operator should be consulted before commencement of excavation works within ten metres of any large pressure reduction plant, i.e. above-ground gas installation (AGI) or district regulator installation (DRI), as shown on the map records.

(ii) Pipe locators: Before excavation, locator devices that use radio frequency detection or transmitter-receiver technology should be used to help locate metallic gas pipes. However, it should be noted that the majority of distribution gas pipelines are made of polyethylene and cannot be traced by such devices. This factor further reinforces the importance of using plans and safe digging practices.

(iii) Road construction work: If road construction work is being carried out close to the top of a gas pipe, the gas network operator should be consulted to give guidance on specific precautions to be taken.

(iv) Mechanical excavators: Mechanical excavators pose the highest risk and **should not** be used within three metres of a gas transmission pipeline or within 0.5 metres of a gas distribution pipeline.

Gas pipes may have projections such as valve housings, siphons and stand pipes and these will not be shown on the plans. In order to allow for these projections, mechanical excavators should not be used within the distances identified above.

(v) Hand-held power tools: Hand-held power tools may damage buried gas pipes and they should be used with care until the exact position of an underground pipe has been determined. They should not be permitted within 1.5 metres of a transmission gas pipeline or associated equipment.

(vi) Hand digging: Plastic gas pipes should be located by hand digging before mechanical excavation begins. It may also be necessary to use this method to locate metallic pipes if their position has not already been determined by a pipe-locating device. The use of hand digging is particularly important for service connection pipes, which will not be marked on plans. The recommended method is to dig a trial trench along the road near the kerb, or on the footpath, where the depth of the service connection pipes is likely to be at its shallowest. Once the position and depth of the pipes have been determined, work may proceed.

(vii) Special operations: *Explosives* must not be used within 400 metres of a gas transmission pipeline (30 metres for a distribution pipeline), without prior consultation with the gas network operator.

Piling and/or demolition works; the gas network operator must be consulted before any piling is carried out within 15 metres of an existing gas pipeline.

(viii) Crossing points: In cases where heavy plant and other machinery may have to cross the line of a gas pipe during construction work, the number of crossing points should be kept to a minimum. These points should be clearly indicated and crossings at other positions along the line of the pipe should be prevented. Where the pipe is not adequately protected by an existing road, crossing points should be suitably reinforced with sleepers, steel plates or a specially constructed reinforced concrete raft. The gas network operator will advise on the type of reinforcement necessary.

(ix) Hot work: If hot work, such as welding or laying hot bitumen, is to be carried out adjacent to gas pipes or installations and there is any risk of that work affecting the integrity of a pipe or pipe surface, the gas network operator should be consulted. Gas pipelines, their protective coating and above-ground plant must be protected against damage by heat transfer, sparks or naked flames.

(x) Uncovering a gas pipe during excavation: If a gas pipe with a damaged wrapping is uncovered during excavation work, the gas network operator should be informed so that repairs may be carried out to prevent future corrosion and leakage.

Pipe restraints or thrust blocks close to gas mains should never be removed.

(xi) Positioning of structures in the vicinity of gas pipelines: Manholes, chambers or other structures should not be built over, around or under a gas pipeline or gas plant. Work should not be carried out that results in a reduction of cover or other protective measures without prior consultation with the gas network operator.

(xii) Use of concrete or other hard material: Concrete or other hard material should never be placed or left under or near any gas pipe as this could cause pipe fracture at a later date. Concrete back-fill or slabbing should not be used within 300mm of a gas pipe or associated connections.

(xiii) Back-filling distribution pipelines after excavation work: If a gas pipe is uncovered during excavation work, the back-fill should be adequately compacted, particularly beneath the pipe itself. This measure is designed to prevent any settlement that could subsequently damage the pipe. The back-fill should comprise fine material or sand and should not contain stones, bricks, lumps of concrete etc. It should be suitably compacted to give comparable support and protection to that provided before excavation. Power compaction should not take place until a 200mm cover of selected fine-fill is in place.

Any protective measures, such as marker tape or marker tiles, should be reinstated.

A.2.5 In the event of damage to a gas pipeline

In the event of damage to a gas pipeline, work should cease immediately and the following precautionary measures should be taken:

- Do not turn any electrical switches on or off (e.g. ignition switches).
- Do not operate any plant or equipment.
- Move people away from and upwind of the affected area.
- Restrict employee and public access to the affected area.
- Prevent smoking, the use of naked flames, the use of mobile phones and other ignition sources in the vicinity of the leak.
- Report the leak/damage immediately to the gas network operator emergency number.
- Provide accurate information on your location and the nature of the incident.
- Do not attempt to repair the damage.
- Do not cover up a damaged main or service pipeline, this may lead to the gas travelling through ducts, sewers, chambers or voids and potentially building up inside a premises or confined space.
- Do not turn off any gas valves in the road or footpath (you may be causing further problems by doing so).
- Assist the gas network operator emergency personnel as required to safeguard life and property.

It is critical that any damage to gas pipelines, even if the pipe does not appear to be leaking, is reported to the gas network operator.

Gas Networks Ireland Emergency Number: 1850 20 50 50.

Appendix 3: Water pipes and sewers

The appropriate records office should be contacted and the location of all sewers, water mains, kiosks, meters and wiring/cable ducting should be determined before any excavation work begins. The location of mains on drawings should be taken as approximate. In general, if there is a sewer or water main (diameter greater than or equal to 300mm) in the vicinity, then the appropriate service provider engineer should be contacted in order to co-ordinate the excavation work.

Mains runs must be marked out before excavation begins.

During excavation, in addition to the safe digging practices previously outlined in this COP, the following precautions should be taken:

- If a water main spans a road cutting or similar excavation, then the main must be adequately braced so that no movement takes place.
- If a pipe anchor is exposed, then excavation must cease and the appropriate engineer must be contacted.
- Fittings (ferrules, air valves and so on) should not be interfered with.
- Excavation in the vicinity of mains must be carried out by hand in order to avoid damage to the pipe.

If the pipe in question is a high-pressure trunk main, then the following additional precautions must be adhered to:

- No personnel should be positioned inside the trench while the mechanical excavator is operating, in case a high-pressure break occurs.
- Continuous inspections are essential in order to determine whether the next excavation level is clear.
- If any leak is discovered, then the service provider must be contacted immediately and the area sealed off to keep it safe and to prevent members of the public from gaining access.

In relation to the installation of new services, in particular gas or electricity services near existing water or sewer mains, the following additional precautions are recommended:

- No new service should be laid above or along the length of an existing water main or sewer.
- Where the new services have to cross a water main or sewer this should be done at right angles as far as is reasonably practical.
- New installations should always avoid blocking access to valves, flanges etc., where subsequent maintenance may be required.
- Where a new service is likely to limit access for future maintenance to the service, contact with the relevant local authority should be made in advance of the works.

Appendix 4: Telecommunications cables

Pre-planned work

A4.1 The cable providers should be consulted wherever possible and all relevant plans obtained. (Note: While most telecommunications cables are owned by Eir, many underground cables are the property of local authorities or private companies.)

A4.2 The representation of underground cables on plans may vary depending on the density of the underground networks (i.e. the number of cables running in close proximity), the scale of the plans and local historical recording conventions. Advice for interpretation should be sought from the issuing office.

Cable-locating devices

A4.3 While using cable-locating devices to locate underground telecommunications cables you must understand the limitations of each operating mode and the need to use both power and radio modes to locate the underground service.

A4.4 Even where a cable-locating device does not give a positive reading, there may still be cables present. Cable-locating devices will not detect fibre optic cables.

A4.5 If a cable that is recorded on a plan cannot be located, appropriate assistance or advice should be sought. If digging has to start before such assistance or advice has been obtained, extra care should be taken to avoid damaging the cable.

Safe digging practices

A4.6 In the vast majority of cases there will be no permanent surface markers to indicate the presence of a buried cable. Frequently, however, the presence of marked communications manhole covers or other street furniture will indicate the presence and general run of telecommunications cables. Even if no cables are shown on plans or detected by a cable-locating device, a close watch should be kept during excavation for any signs that might indicate their presence.

A4.7 Underground telecommunications cables are normally laid at adequate and sufficient depth in trenches but depths should never be assumed. Cables must not be laid just below the surface.

If in doubt the network provider should be contacted.

A4.8 Cables may have been laid in any of a number of different ways. In urban areas steel wire armoured telecommunications cable can be found buried directly in the ground or in ducting of various colours ranging in size from 25 to 100mm, Telecommunications cable may also be found in earthenware or concrete pipes. Occasionally they may be encased in steel pipes. Coloured plastic marker tape may be laid above the ducting.

A4.9 During digging work, a careful watch should be kept for evidence of cables and repeat checks should be made with a cable-locating device to determine more precisely the position of any cable.

A4.10 Any damage to a telecommunications cable should be reported immediately to the cable service provider. No work which involves back-filling around the damaged cable should be undertaken until the service provider has investigated its condition and carried out any required repairs.

A4.11 Recommended standards for new underground telecommunications cable installations on new developments and in existing roads and streets are to be adhered to. However, local conditions may dictate that these depths vary, particularly where pipes and cables cross or where underground structures or other obstructions are crossed. The clearance in all directions between underground telecommunications duct and other services should be approximately 300mm. With the exception of crossing points, services should not be laid above telecommunications duct. This is because, following installation, continuous access will be required for the repair of faults.

A4.12 While there is no agreed industry standard in Ireland governing the relative lateral positioning of services in footpaths, general guidance may be found in the UK publication *National Joint Utilities Group (NJUG) Guidelines on the Positioning and Colour Coding of Underground Utilities' Apparatus 2013*. Efforts should be made to comply with this standard, or other equivalent standards of good practice in relation to the positioning of new installations.

Appendix 5: Suggested job aid for workers on a safe system of work for digging

WORKER JOB AID

Safe System of Work for Digging

These Guidelines apply to all work which involves penetrating the ground at or below surface level.

When working near buried services USE

- Maps
- CAT
- Safe Digging System
- Company Policies & Procedures

All 4 complement each other

Always be aware that the depth of cover may be very shallow and that there may be no bricks, warning tape or other protection in place. Always assume that there will be more services than you can find.

BEFORE You Start Digging

✔ **Ensure you have appropriate Utility Plans** *Remember*: service connection cables & pipes from *the main to buildings or public lights may not be shown*

Look Out For

- *Manhole Covers*
- *Valve Covers*
- *Lamp Posts*
- *Houses/Buildings*
- *Meters, Coms. Network*
- *Signs of Previous Digging*

→ *Services*

✔ **Always use Cable Locator (CAT) to trace all services**

✔ **Mark the positions of the cables & pipes** *using waterproof crayon, chalk or paint*

✔ **Highlight & Assess the Hazards and ensure all relevant staff are aware of the hazards, especially** when electric cables and/or gas mains are in vicinity of work area.

IMPACT

- Inspect Site Location. Look for indicators to services
- Mark the location of services on the surface before digging
- Plans and Maps should be available & used on site before digging
- Always assume that there will be more services than you can find
- CABLE LOCATOR should always be used (in Power & Radio modes) before starting work and throughout the course of the work
- Take Care. Where ever possible hand dig close to buried services. Observe 'SAFE DIGGING PRACTICE'

Page 2

WORK USING 'SAFE DIGGING PRACTICE'

1. Where ever possible **Hand Dig** near buried services

2. Take special **CARE** using picks, pins or crowbars

3. Wear **Gloves** & other appropriate **PPE** *(Personal Protective Equipment)*

4. Do not use hand held power tools within 0.5 metres of marked position of electricity cables unless the number of services makes it impossible or surface obstructions reduce the space available.

5. Do not use hand held power tools directly over marked line of cable **UNLESS** -
   a) You have already found the cable at that position by careful hand digging beneath the surface AND it is at a safe depth (at least 300mm) below the bottom of the surface to be broken **OR**
   b) Physical means have been used to prevent the tool striking it.

6. When the surface has been broken out use CAT again to re-confirm position of services. Frequent and repeated use should be made of CAT during the course of the work.

7. Before using a mechanical excavator in the vicinity of electricity cables, trial holes should first be excavated by careful hand digging. Confirm the depth of the cable(s) at the point of work. The excavator should not be operated within a radial distance of 300mm from the cable(s).

8. When using Mechanical Excavator in the vicinity of electricity cables keep everyone clear of bucket while it is digging

9. Where an electric cable is embedded in concrete, arrange for the cable to be SWITCHED OUT before breaking off concrete.

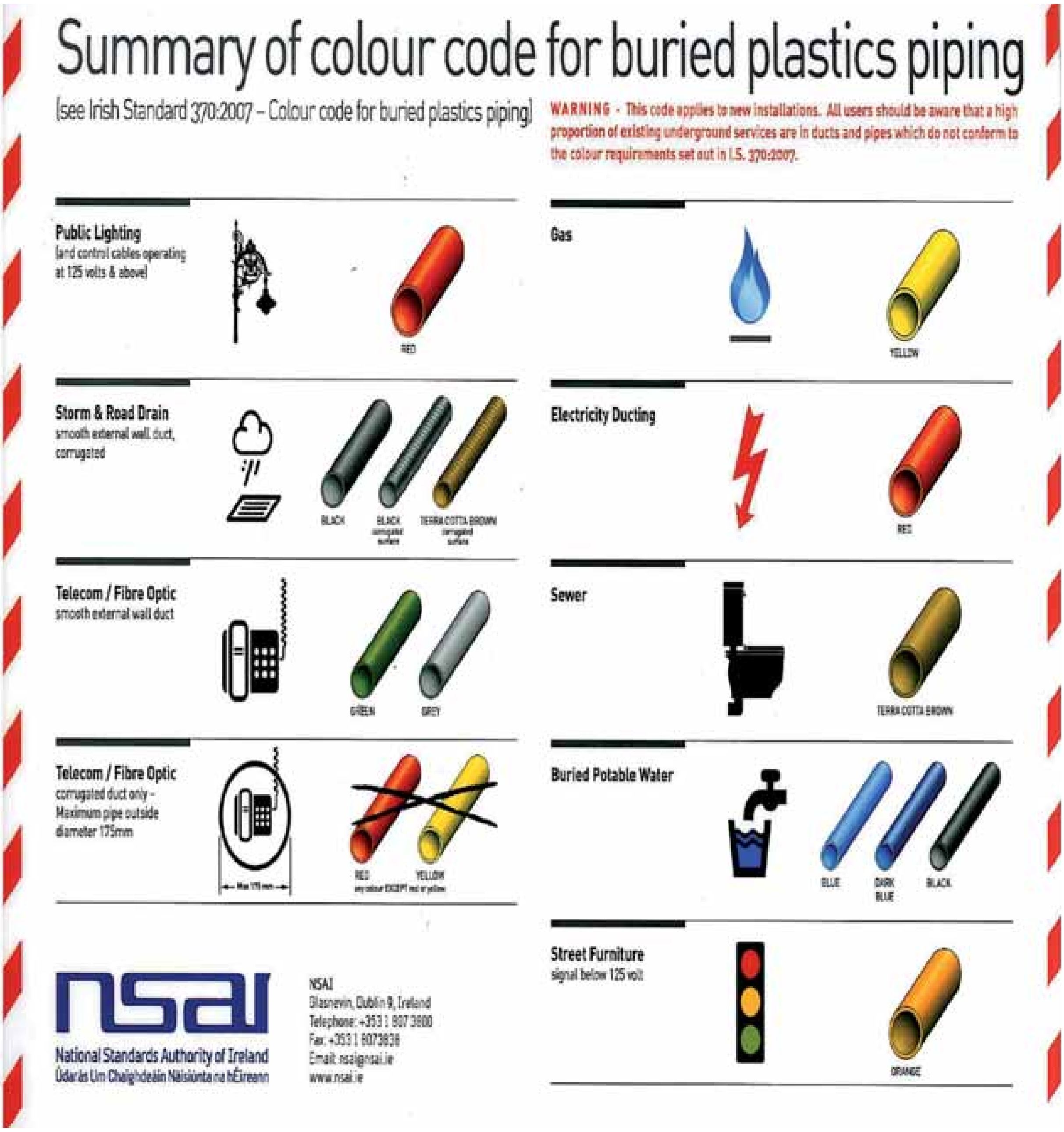
10. Do not use exposed electricity cables as a convenient step or hand hold.

11. Do not handle or attempt to alter the position of an exposed electricity cables (unless under the direction of approved ESB personnel). Extreme care should be taken where joints have been exposed.

12. If an electricity cable, gas pipe or high pressure water mains suffer any damage, however slight, the owner should be informed immediately and people should be kept well clear of the area until it has been made safe by the owner.

13. Backfill around services with sand and use appropriate utility warning marker tape. Do not build into manhole or other structure or encase in concrete.

Appendix 6: Summary of IS 370:2007



Appendix 7: Useful contacts

ESB Networks

For all emergencies, including any damage to underground electricity cables or plant, call **1850 372 999 (**or if you are phoning from outside Republic of Ireland 00 353 21 2382410).

For other ESB Networks queries, including general queries in relation to underground electricity cables, overhead lines, new connections etc., call 1850 372 757, email: dig@esb.ie or see area office addresses at: www.esb.ie/esbnetworks.

For all ESB Networks map records (underground cables, overhead lines and other plant):

(a) Write to Central Site, ESB Networks, St Margarets Road, Finglas, Dublin 11.
(b) Send a fax to 01 638 8169.
(c) Email: dig@esb.ie
(d) Register for access to electronic map records (make arrangements via (a) or (c) above).

All map requests should include the following information: (i) a site map/area map with geographic reference, (ii) a return postal address and (iii) a telephone contact number.

Map records that have been requested as set out above will be delivered by post. Allow up to ten days for delivery.

ESB Networks provides a range of safety material, such as booklets, posters, cab stickers and DVDs addressing the issue of electrical safety. This material is free and may be obtained by calling 1850 372 757 or by email request to: esbnetworks@esb.ie. Some of this material is also available for free download from: www.esb.ie/esbnetworks.

Gas Networks Ireland

24 Hour Emergency Service:	**1850 20 50 50**
Gas Networks Ireland 'Dial Before You Dig':	1850 427 747
Gas Networks Ireland Transmission Enquiries:	021 453 4562

Email: dig@gasnetworks.ie

EIR

'Click Before You Dig'

http://support.eir.ie/article/clickbeforeyoudig

Eir Home: 1800 773 729

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International callers
00353 1 6147000
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ISBN 978-1-84496-226-6

HEALTH AND SAFETY AUTHORITY

HSA0447

APPENDIX C

- EirGrid standard crossing drawings

1	2	3	4	5	6	7	8

A

B

STANDARD 110kV CABLE DRAWINGS
STANDARD CROSSING BELOW
3rd PARTY SERVICE FOR 125mm DUCTS

C

DRAWING No.	SHEET No.	DESCRIPTION	REVISION No.
XDC-CBL-STND-H-003	001	STANDARD 3rd PARTY CROSSING 125mm INDEX SHEET	00
XDC-CBL-STND-H-003	002	STANDARD 3rd PARTY CROSSING 125mm BELOW IN FULL FLAT FORMATION	00
XDC-CBL-STND-H-003	003	STANDARD 3rd PARTY CROSSING 125mm BELOW IN TREFOIL FORMATION	00

D

E

F

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00	FIRST ISSUE	DA	DG	CF	09/03/2020

EirGrid plc
The Oval, 160 Shelbourne Road,
Ballsbridge, Dublin 4, Ireland

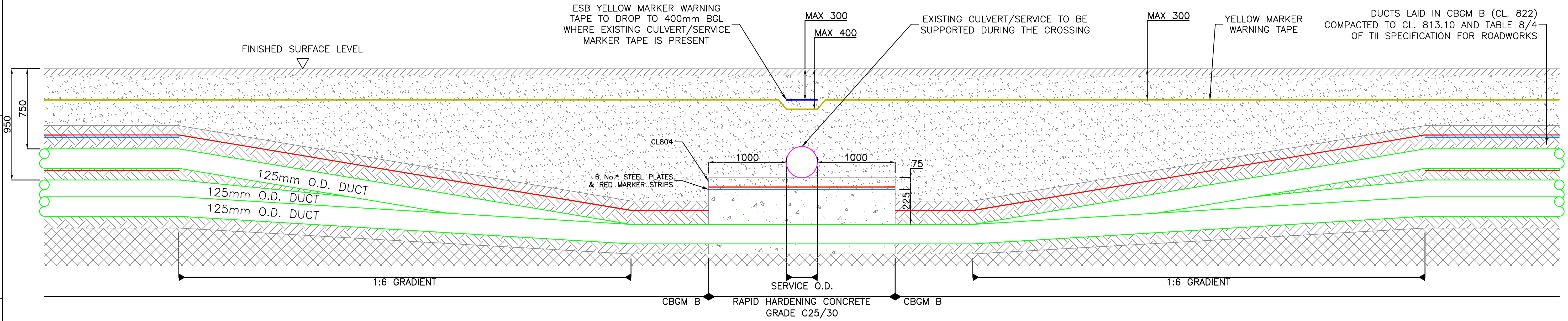
Telephone: +353 1 677 1700
Fax: +353 1 661 5375
Email: info@eirgrid.com
Web: www.eirgrid.com

STANDARD 110kV CABLE DRAWINGS

DRAWING TITLE
STANDARD 3rd PARTY CROSSING
125mm
INDEX SHEET

No of Shts	SIZE	SCALE
3	A3	N/A

DRAWING NUMBER	SHEET	REV
XDC-CBL-STND-H-003	001	00

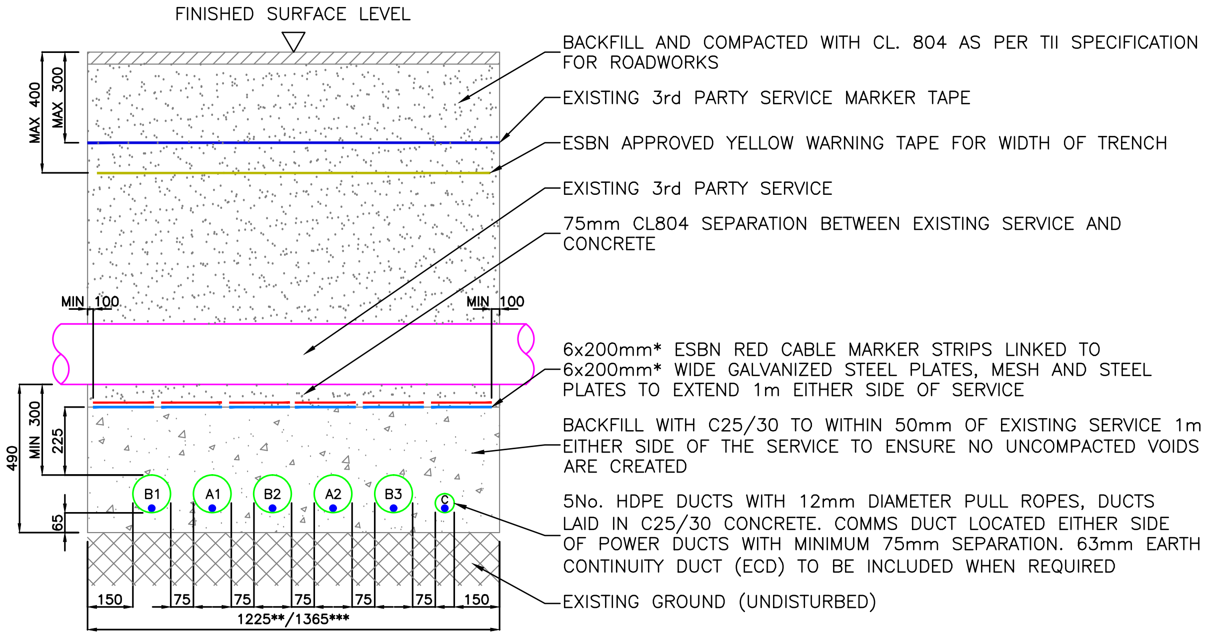


NOTES:

1. ALL PRODUCTS AND MATERIALS TO BE UTILISED DURING CONSTRUCTION TO COMPLY WITH EIRGRID FUNCTIONAL SPECIFICATION, ESBN STANDARDS, TII SPECIFICATION FOR ROAD WORKS AND ALL RELEVANT IRISH (EUROPEAN) AND BRITISH STANDARDS.
2. 300mm MINIMUM VERTICAL AND HORIZONTAL CLEARANCES TO BE OBSERVED BETWEEN CABLE DUCTS AND THIRD PARTY SERVICES (e.g. GAS PIPES, WATER MAINS, CULVERTS, etc.) IN THE CASE OF HIGH RISK 3rd PARTY SERVICES, GREATER CLEARANCES MAY BE REQUIRED. DESIGNER TO CONSULT EIRGRID AND 3rd PARTY SERVICE OWNERS FOR GUIDANCE.
3. STEEL PLATES MUST COVER DUCTS. NO OVERLAP IS REQUIRED HOWEVER STANDARD DIMENSIONS MAY RESULT IN AN OVERLAP. SPACING OF 25mm TO BE MAINTAINED BETWEEN STEEL PLATES TO PREVENT THE TRANSFER OF STRAY CURRENT.
4. THE MINIMUM CLEARANCE BETWEEN ALL HV AND COMMUNICATION DUCTS IS 75mm, BUT INCREASED SPACING MAY BE REQUIRED IN ORDER TO ACHIEVE THE CABLE RATING (TO BE CONFIRMED BY DESIGNER CABLE RATING CALCULATIONS).
5. DRAWING IS INDICATIVE ONLY, TO BE USED TO AID IN THE DESIGN OF THE RELEVANT INFRASTRUCTURE.
6. TEMPLATES ARE TO BE USED AT 5m INTERVALS DURING DUCT INSTALLATION IN CBGM. PRE-MADE 75mm WIDE CONCRETE SPACERS TO BE USED DURING DUCT INSTALLATION IN WET CONCRETE.
7. HAND DIG WITHIN 500mm OF EXISTING SERVICE.
8. WHERE AN EARTH CONTINUITY CONDUCTOR (ECC) IS REQUIRED, A MIN 63mm DUCT TO BE INSTALLED OUTSIDE OF PHASE DUCT.
9. IF EXISTING SERVICE MARKER TAPE IS NOT PRESENT, THE ESBN YELLOW MARKER TAPE SHOULD BE INSTALLED AT MAXIMUM 300mm BELOW FINISHED SURFACE LEVEL.

- RED MARKER STRIP
- YELLOW MARKER WARNING TAPE
- EXISTING SERVICE MARKER STRIP
- 6mm GALVANISED STEEL PLATE
- RAPID HARDENING WET CONCRETE C25/30
- CBGM B (CL. 822), COMPACTED TO CL. 813.10
- BACKFILL, COMPACTED (CL. 804)
- EXISTING GROUND

FULL FLAT FORMATION FOR CROSSING BELOW 3RD PARTY SERVICE



A= 125mm O.D. HDPE DUCT FOR COMMUNICATIONS
B= 125mm O.D. HDPE DUCT FOR HV CABLE
C= 63mm O.D. HDPE DUCT FOR EARTH CONTINUITY CONDUCTOR

* 5x200mm STEEL PLATES AND RED MARKER WHERE ECC IS NOT REQUIRED
** MIN 1225mm WHERE ECC NOT REQUIRED
*** SEE NOTE 8

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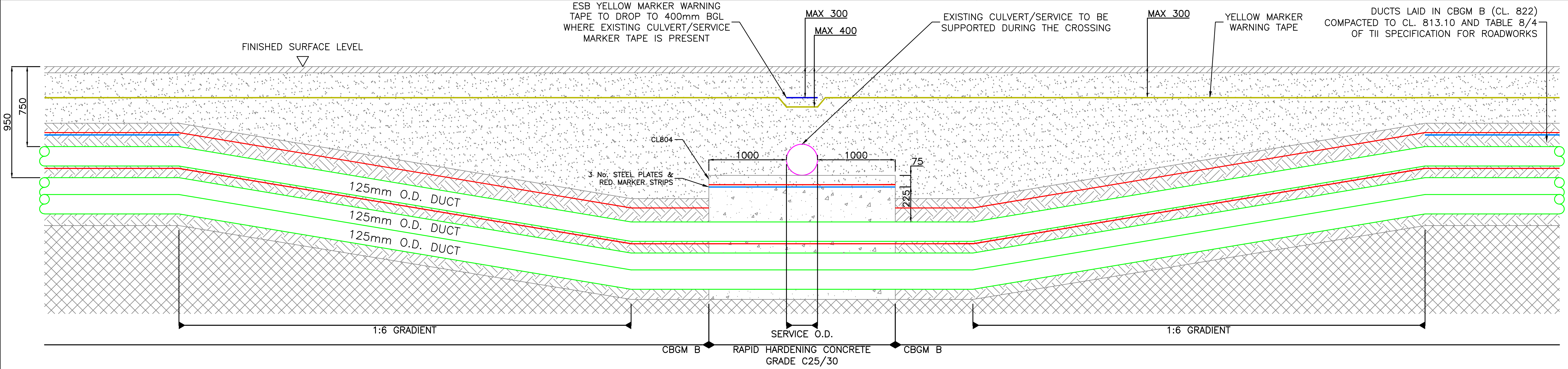
Fax: +353 1 661 5375
Email: info@eirgrid.com
Web: www.eirgrid.com

STANDARD 110kV CABLE DRAWINGS

DRAWING TITLE
STANDARD 3rd PARTY CROSSING 125mm BELOW IN FULL FLAT FORMATION

No of Shts	SIZE	SCALE
3	A3	N/A

DRAWING NUMBER	SHEET	REV
XDC-CBL-STND-H-003	002	00



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4. THE MINIMUM CLEARANCE BETWEEN ALL HV AND COMMUNICATION DUCTS IS 75mm, (CABLE RATING CALCULATIONS TO BE REQUIRED FOR ACCEPTANCE).
5. DRAWING IS INDICATIVE ONLY, TO BE USED TO AID IN THE DESIGN OF THE RELEVANT INFRASTRUCTURE.
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YELLOW MARKER WARNING TAPE
EXISTING SERVICE MARKER STRIP
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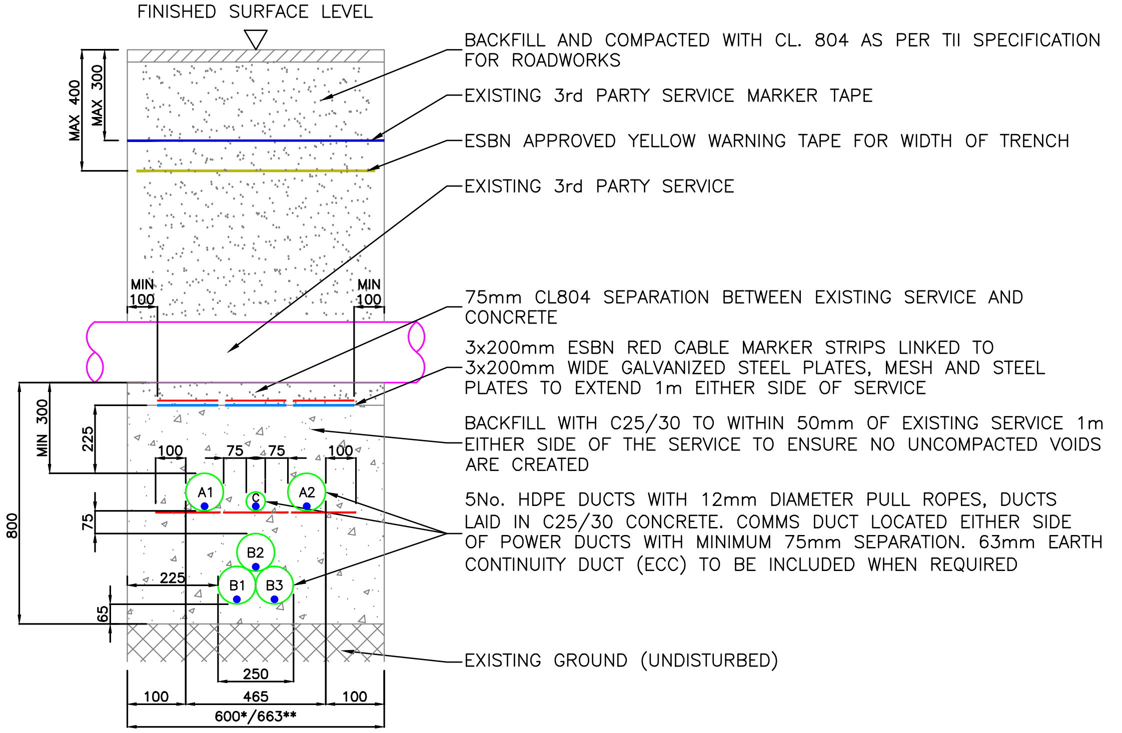
CBGM B (CL. 822), COMPACTED TO CL. 813.10
BACKFILL, COMPACTED (CL. 804)
EXISTING GROUND

TREFOIL FORMATION FOR CROSSING BELOW 3RD PARTY SERVICE



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C= 63mm O.D. HDPE DUCT FOR EARTH CONTINUITY CONDUCTOR

* MIN 600mm WHERE ECC NOT REQUIRED
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Web: www.eirgrid.com

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STANDARD 110kV CABLE DRAWINGS

DRAWING TITLE: STANDARD 3rd PARTY CROSSING 125mm BELOW IN TREFOIL FORMATION

No of Shts	SIZE	SCALE
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DRAWING NUMBER	SHEET	REV
XDC-CBL-STND-H-003	003	00

1 2 3 4 5 6 7 8

A B C D E F

STANDARD 110kV CABLE DRAWINGS
STANDARD CROSSING ABOVE
3rd PARTY SERVICE FOR 125mm DUCTS

DRAWING No.	SHEET No.	DESCRIPTION	REVISION No.
XDC-CBL-STND-H-001	001	STANDARD 3rd PARTY CROSSING 125mm INDEX SHEET	00
XDC-CBL-STND-H-001	002	STANDARD 3rd PARTY CROSSING ABOVE IN FULL FLAT FORMATION 125mm HV DUCTS	00
XDC-CBL-STND-H-001	003	STANDARD 3rd PARTY CROSSING ABOVE IN TREFOIL FORMATION 125mm HV DUCTS	00

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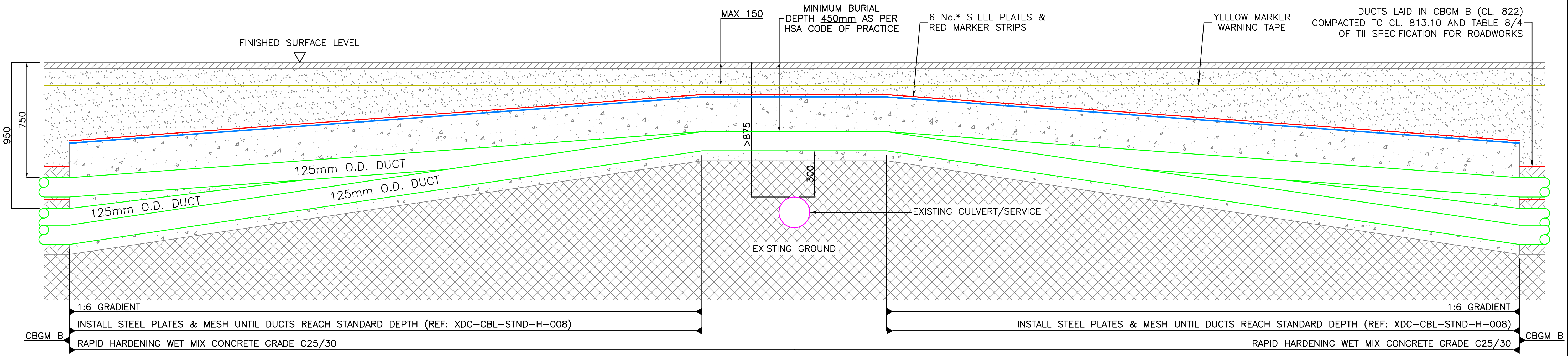
Email: info@eirgrid.com
Web: www.eirgrid.com

STANDARD 110kV CABLE DRAWINGS

DRAWING TITLE
STANDARD 3rd PARTY CROSSING
125mm
INDEX SHEET

No of Shts 3 | SIZE A3 | SCALE N/A

DRAWING NUMBER XDC-CBL-STND-H-001 | SHEET 001 | REV 00



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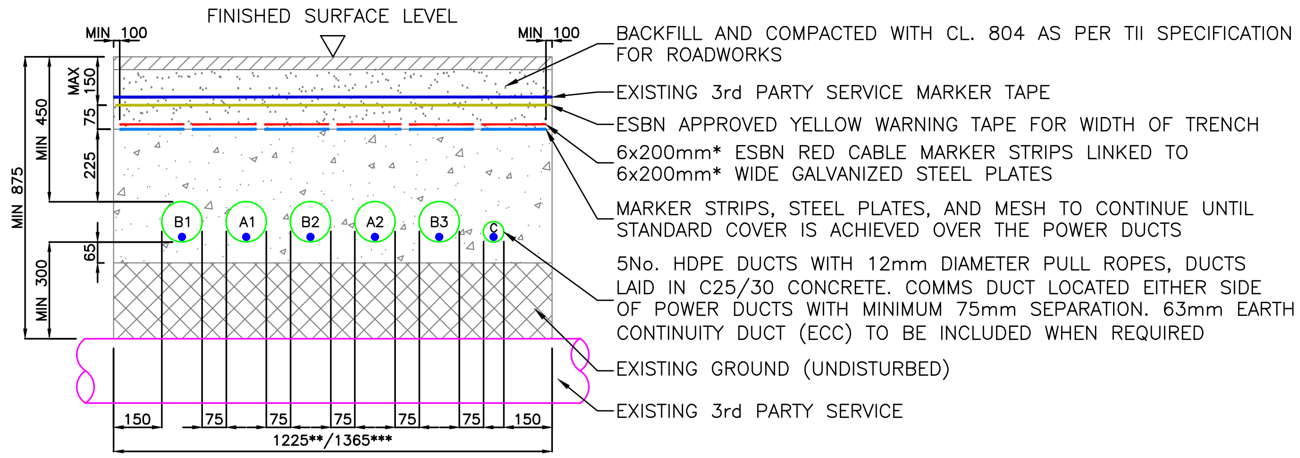
7. MINIMUM BURIAL DEPTH IS 450mm.
8. HAND DIG WITHIN 500mm OF EXISTING SERVICE.
9. WHERE AN EARTH CONTINUITY CONDUCTOR (ECC) IS REQUIRED, A MIN 63mm DUCT TO BE INSTALLED OUTSIDE OF PHASE DUCT.

(red line)	RED MARKER STRIP
(yellow line)	YELLOW MARKER WARNING TAPE
(dark blue line)	EXISTING SERVICE MARKER STRIP
(blue line)	6mm GALVANISED STEEL PLATE
(hatch)	RAPID HARDENING WET CONCRETE C25/30
(hatch)	CBGM B (CL. 822), COMPACTED TO CL. 813.10
(hatch)	BACKFILL, COMPACTED (CL. 804)
(hatch)	EXISTING GROUND

FULL FLAT FORMATION – REDUCED DEPTH FOR CROSSING OVER 3RD PARTY SERVICE



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B= 125mm O.D. HDPE DUCT FOR HV CABLE
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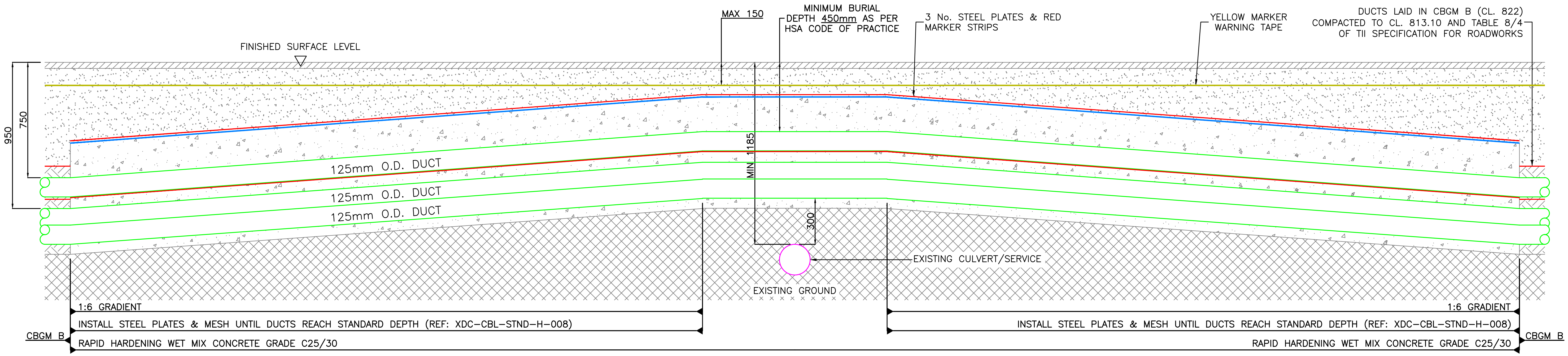
STANDARD 110kV CABLE DRAWINGS

DRAWING TITLE: STANDARD 3rd PARTY CROSSING ABOVE IN FULL FLAT FORMATION 125mm HV DUCTS

No of Shts	SIZE	SCALE
3	A3	N/A

DRAWING NUMBER	SHEET	REV
XDC-CBL-STND-H-001	002	00



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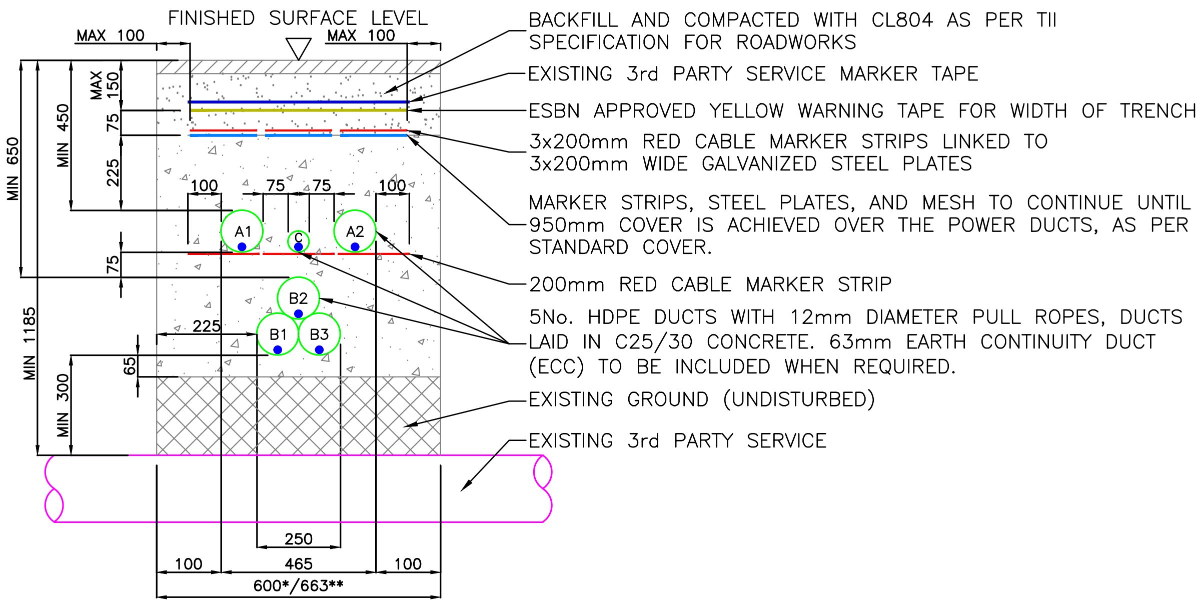
BACKFILL, COMPACTED (CL. 804)
EXISTING GROUND

TREFOIL FORMATION – REDUCED DEPTH FOR CROSSING OVER 3RD PARTY SERVICE



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STANDARD 110kV CABLE DRAWINGS

DRAWING TITLE
STANDARD 3rd PARTY CROSSING ABOVE IN TREFOIL FORMATION 125mm HV DUCTS

No of Shts	SIZE	SCALE
3	A3	N/A

DRAWING NUMBER	SHEET	REV
XDC-CBL-STND-H-001	003	00

Coole Wind Farm

Grid Route Connection RFI

Westmeath County Council Submission – Bridge Crossings

Ionic Consulting Ltd
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IONIC CONSULTING

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Addressee

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Disclaimer

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This document has been prepared by

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BE MSc CEng MIEI
Senior Civil Engineer Ionic Consulting

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Cormac Ó Dubhthaigh
BE MEngSc CEng MIEI
Civil Engineering Manager
Ionic Consulting

This report has been authorised by

Cormac Ó Dubhthaigh
BE MEngSc CEng MIEI
Civil Engineering Manager
Ionic Consulting

1. Introduction

The proposed Coole Wind Farm is located north of the village of Coole, County Westmeath. The wind farm 110kV grid connection is proposed between the wind farm site and the existing ESB 110kV Mullingar Substation. The overall route is approximately 26km in length.

In response to the Coole wind farm and grid route planning application to An Bord Pleanála, Westmeath County Council (WCC) submitted observations on the proposed development in a submission dated 1st June 2021. The submission raised observations from Westmeath County Council Transportation Section in relation to Bridge Crossings 3 (Shrubbywood Bridge) and 10 (Clonava Bridge) and this report aims to provide a response to the queries raised. Figure 1 shows the location of the two bridge crossings.

Consultation with Westmeath County Council

During the FI response period, Coole Wind Farm Ltd. engaged with Westmeath County Council Transportation Section on the observations raised in relation to Bridge Crossings 3 and 10. A meeting was held on 10th October 2022 between representatives of Coole Wind Farm Ltd, Westmeath County Council (Transport Department), MKO (Lead Planning & Environmental Consultant) and Ionic (Electrical/Civil Engineering Consultant). All feasible crossing options at the time were presented and discussed at the meeting including the options as submitted in the EIAR (Clonava Bridge: Options A and B; Shrubbywood Bridge: Option A) and alternative options (Clonava Bridge: Options C, D & E; Shrubbywood Bridge: Options B, C and D) as detailed in this report below. Shortly before the meeting with Westmeath County Council, EirGrid had provided an informal indication that they would give consideration to a solution involving splitting the grid connection ducts into both verges of a bridge crossing in some specific circumstances and therefore the further alternative options, Clonava Bridge Option E and Shrubbywood Bridge Option D, were presented.

The Council's main concerns related to the potential of proposals to compromise future maintenance or rehabilitation work on the bridges and requested further alternative options be considered.

Through a number of subsequent phone calls between representatives of Coole Wind Farm Ltd. and Westmeath County Council, the additional alternative options were discussed. It was agreed that prior to commencement of development security in a form to be agreed with the Planning Authority could be put in place to safeguard future maintenance or rehabilitation work at these bridge crossings.

Westmeath County Council were agreeable to this proposal, and it is noted that WCC raised no objection to the proposed development in principle.

Figure 1 Bridge Location Plan

2. Bridge Crossing No. WH L1825-001.00 (Clonava Bridge)

Westmeath County Council in their submission raised issues with Option A and Option B (methods 3 and method 4 respectively as outlined in Chapter 4 Description, Section 4.8.7.5) for the Clonava Bridge on the basis that Option A could reduce capacity by reducing the effective road width and that Option A and Option B could compromise future maintenance or rehabilitation work. In their submission, the Council requested that the developer provide an alternative method for placing of the proposed ducts and electricity cables across the River Inny.

In the meeting with Westmeath County Council (10th October 2022) the Council also raised concerns regarding potential damage to the external conduit (Option B) in the case of an impact to the bridge parapet. They also raised concerns that the proposals presented during the meeting would compromise future maintenance or rehabilitation work on the bridges by leading to increased cost of the works.

As noted in the previous section, following subsequent phone calls with WCC it was agreed that prior to commencement of development security in a form to be agreed with the Planning Authority could be put in place to safeguard future maintenance or rehabilitation work at these bridge crossings. Westmeath County Council were agreeable to this proposal, and it is noted that WCC raised no objection to the proposed development in principle.

Alternative crossing options are presented below, and illustrative drawings are included in Appendix A. Option A and B were previously submitted with the original planning application and therefore are not included here again. Options C, D and E are presented in response to the Council's submission and subsequent meeting.

Method 5 Directional Drilling was set out as an option for this bridge crossing in Chapter 4 Description, Section 4.8.7.5. Following a site inspection and topographical survey completed 8th September 2022 this option has now been ruled out due to observations made of an exposed piled foundation on the south bank. The riverbank in front of and underneath the foundation had been scoured away and it was possible to see the upper sections of the driven piles at the support. It was observed that the piles were tightly and irregularly spaced. Furthermore, the driven piles were raked at random angles. As there are eight supports to the bridge with piles of unknown depth and arrangement, it is not considered feasible to drill through the piled foundations.

WCC stated in their submission that Option A was not acceptable as it will reduce the capacity of the bridge by reducing the bridge road width from 5.50m to 4.65m. The road width of 5.50m is calculated by taking the clear distance between the inside of the two parapet walls and subtracting 0.3m either side (6.1m – 0.3m – 0.3m = 5.5m). The dimension of 5.5m therefore assumes that vehicles will drive over ~0.3m of each concrete verge.

It should also be noted that the current kerb to kerb width of approximately 4.88m for two traffic lanes is below the general recommended width of 6m (2 no. lanes of 3m width). As a result, vehicles were generally observed driving close to the centre of the roadway (when no other traffic was approaching). It was also observed that vegetation was growing along sections of the kerb lines, and this indicates that the full kerb to kerb width of the road is not generally trafficked. Given the rural location of the structure, traffic levels on the road are low.

For Option A, the dimensions between the inside faces of the parapets remains the same and concrete verge are still provided. Therefore, the same useable width of 5.5m will be maintained across the structure. The concrete verge containing the ducts will be designed for vehicular wheel loading at detailed design stage, and the integrity of the concrete verges will be demonstratable by analysis and calculation.

Option A proposes reducing the kerb-to-kerb width by approximately 0.23m to 4.65m. A topographical survey was completed along the bridge and the road width between the grass verges on the structure was found to vary, but generally ranges from 4.2m to 4.5m. As noted above, the effective width of 5.5m would still be provided with Option A and therefore the capacity of the structure should not be reduced from the current scenario. It should be noted that there is also an advantage of providing a wider concrete verge on one side of the bridge, as it can act as a more effective footway across this relatively long bridge.

Figure 2 View along Clonava Bridge, showing the grass growing along the road in front of the concrete verges

In the meeting with Westmeath County Council (10th October 2022) the Council also raised concerns regarding potential damage to the external conduit (Option B) in the case of an impact to the bridge parapet. WCC also indicated a general preference not to attached utilities externally along bridges. Option B indicates the position of the conduit below the bottom of the parapet; therefore, any direct impact would not be transferred directly into the ducting conduit. The conduit and the support system will be designed to ensure the integrity of the HV cables and the safety of road users.

2.1 Option C Ducts in concrete verge (trefoil formation)

Option C for Clonava Bridge is illustrated on drawing COLE d005.3.3, refer to Appendix A. This option would involve laying the power ducts in a trefoil formation within a slightly widened and raised concrete verge. The ESBN Specification requires that a minimum 100mm cover be provided to ducting in a flat formation arrangement within a concrete footway, however given the duct arrangement increased cover may be required.

This option would necessitate slightly widening one of the concrete verges in order to provide the width required to place the ducts together in one verge. The communications and earthing ducts would be placed either side of the power ducts, or alternatively they could be split away and placed in the opposite verge (refer to Option E).

The benefit of this option would be that ducting works would be concentrated on one side of the structure and requires a relatively minimal reduction in the road carriageway. This option is not a standard EirGrid or ESBN design detail and would require a detailed review process with both parties to confirm their acceptance.

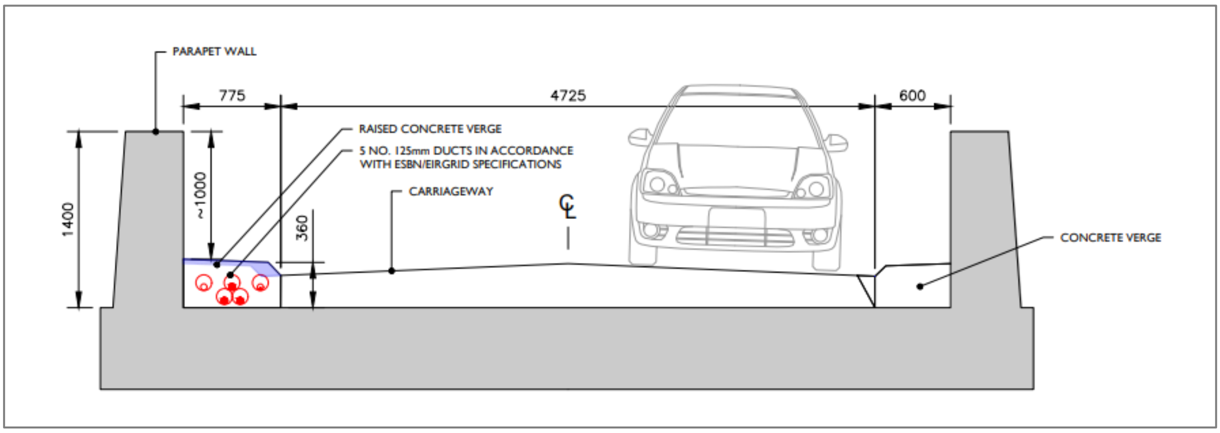

Figure 3 Clonava Bridge Option C

2.2 Option D Ducts within the road (flat formation)

Option D for Clonava Bridge is illustrated on drawing COLE d005.3.6, refer to Appendix A. This option would involve laying the ducts in a flat formation within the road carriageway. The EirGrid Specification requires that a minimum 450mm cover be provided to ducting in this arrangement (refer to Figure 5). This option would necessitate raising the road, verge and parapet wall levels across the bridge by approximately 0.3m in order to provide the minimum coverage to the ducts.

Raising the road level could result in significant additional load being applied to the bridge structure. Lightweight fill material (e.g., a foamed concrete) could be used in order to maintain a similar total applied dead load, and a structural assessment would be completed.

A parapet wall structural assessment would also be required to assess the parapet walls and determine what, if any, strengthening measures would be required for the raised parapet.

The benefit of this option would be that it maintains the current widths of the road carriageway and concrete verges.

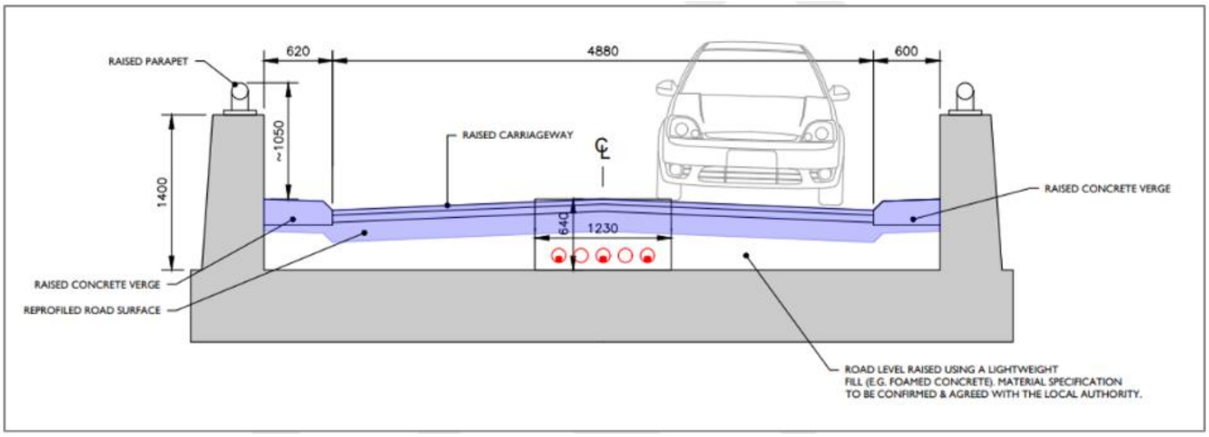

Figure 4 Clonava Bridge Option D

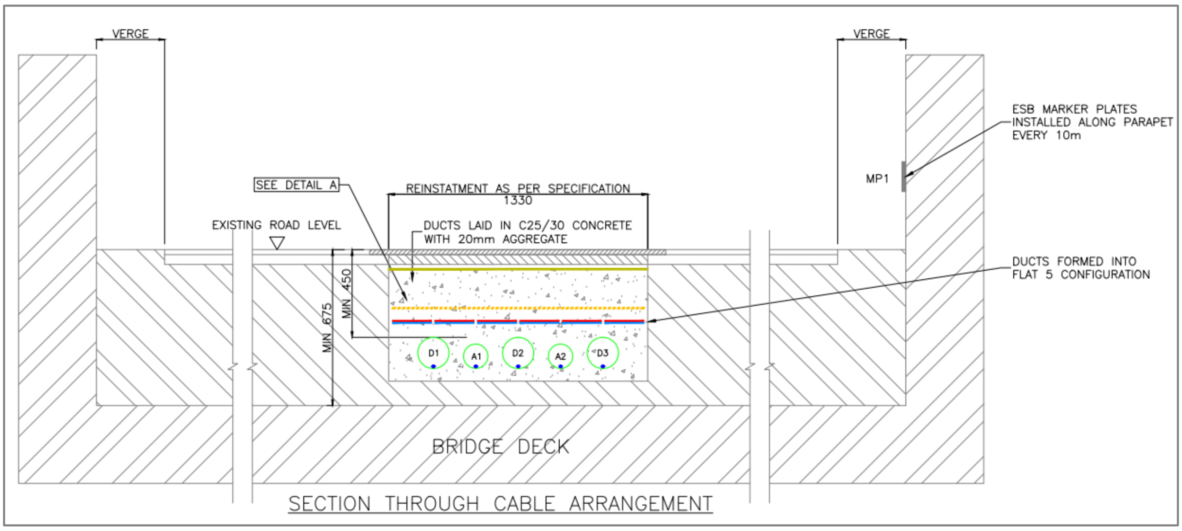

Figure 5 EirGrid standard bridge crossing detail, ducting laid within the carriageway

2.3 Option E Ducts split into both concrete verges

Option E for Clonava Bridge is illustrated on drawing COLE d005.3.7, refer to Appendix A. This option would involve laying the ducts in a flat formation within the two concrete verges. The ESBN Specification requires that a minimum 100mm cover be provided to ducting in this arrangement. This option would necessitate slightly widening one of the concrete verges in order to provide the width required to place the 3 power ducts on one side, and the communications and earthing duct in the opposite verge.

The benefit of this option would be that it effectively maintains the current widths of the road carriageway and concrete verges. This is not a standard EirGrid or ESBN design detail and would require a detailed review process with both parties to confirm their acceptance of such a proposal.

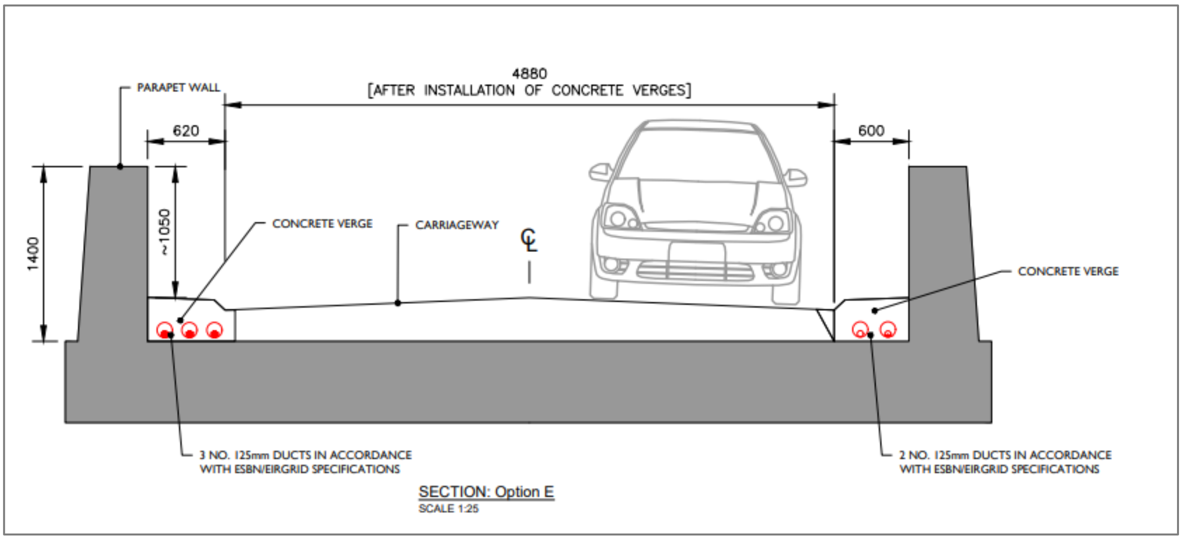

Figure 6 Clonava Bridge Option E

A site investigation including trial excavations over the bridge structures will be undertaken at detailed design stage to confirm the available depths for the options above.

2.4 Summary – Clonava Bridge (WH L1825-001.00)

As noted in the previous sections, following discussions with WCC it was agreed that prior to commencement of development security in a form to be agreed with the Planning Authority could be put in place to safeguard future maintenance or rehabilitation work at these bridge crossings.

Regarding Option A, a topographical survey of the road across the structure was completed and further clarification is provided in relation to the Council's concerns relating to this option in Section 2. This option is a standard method for ESBN for crossing bridges and is detailed on the ESBN Standard Specification for 110kV Network Ducting/Cabling.

In relation to Option B, in the meeting (10th October 2022) the Council raised concerns regarding potential damage to the external conduit and a further clarification and commitment is provided in response in Section 2. This option is a standard method for ESBN of crossing bridges with restricted space and is detailed on the ESBN Standard Specification for 110kV Network Ducting/Cabling.

Options C, D and E are presented in this report in response to the Council's submission and the subsequent meeting with WCC (10th October 2022).

Options C and E are variations of Option A, with the ducting placed within the concrete verges. While Option A requires a wider concrete verge on one side of the bridge, both of these options would allow wider concrete verges on both sides of the structure. Options C and E are non-standard EirGrid or ESBN design details and would require a detailed review process with both parties to confirm their acceptance.

Option D would allow the current road and verge widths to be maintained, thereby addressing the councils concerns regarding road capacity. The proposed duct arrangement is also a standard EirGrid design detail.

3. Bridge Crossing No. WH L1825-002.00 (Shrubbywood Bridge)

Westmeath County Council in their submission raised issues with Option A (method 4 as outlined in Chapter 4 Description, Section 4.8.7.5) for the Shrubbywood Bridge on the basis that Option A could compromise future maintenance or rehabilitation work. In the meeting with Westmeath County Council (10th October 2022), the Council also raised concerns regarding potential damage to the conduit in the case of an impact to the bridge parapet and indicated a general preference not to attached utilities externally along bridges.

In their submission, the Council requested that the developer provide an alternative method for placing of the proposed ducts and electricity cables across the River Inny.

Alternative crossing options are presented below, and illustrative drawings are included in Appendix A. Option A was previously submitted with the original planning application and therefore is not included here again. During the meeting (10th October 2022), WCC indicated that Option B, directional drilling, would be an acceptable option as it would not necessitate placing high voltage cables across the bridge.

Option B was previously submitted with the original planning application and further information on this option is provided below. Options C and D are presented in response to the Council's submission.

As noted in the previous sections, following subsequent phone calls with WCC it was agreed that prior to commencement of development security in a form to be agreed with the Planning Authority could be put in place to safeguard future maintenance or rehabilitation work at these bridge crossings. Westmeath County Council were agreeable to this proposal, and it is noted that WCC raised no objection to the proposed development in principle.

In relation to Option A, the Council also raised concerns regarding potential damage to the external conduit) in the case of an impact to the bridge parapet. Option A indicates the position of the conduit below the bottom of the parapet; therefore, any direct impact would not be transferred directly into the ducting conduit. The conduit and the support system will be designed to ensure the integrity of the HV cables and the safety of road users.

3.1 Option B Directional Drilling

During the meeting (10th October 2022), WCC indicated that Option B would be an acceptable option as it would not necessitate placing high voltage cables across the bridge.

Option B for Shrubbywood Bridge is illustrated on drawing COLE d005.3.4, refer to Appendix B. This option involves directionally drilling the ducts underneath the bridge and river. The EirGrid Specification requires that where the minimum standard "vertical cover" requirements cannot be achieved within the road, e.g., bridge crossings, then horizontal directional drilling should be investigated as an option. A topographical survey has been completed to assess the vertical and horizontal profile of the potential drill, and the drilling profile and pit locations are indicated on drawing COLE d005.3.4. Prior to detailed design stage, ground investigation will be undertaken to further assess and determine the type and depth of the bridge foundations.

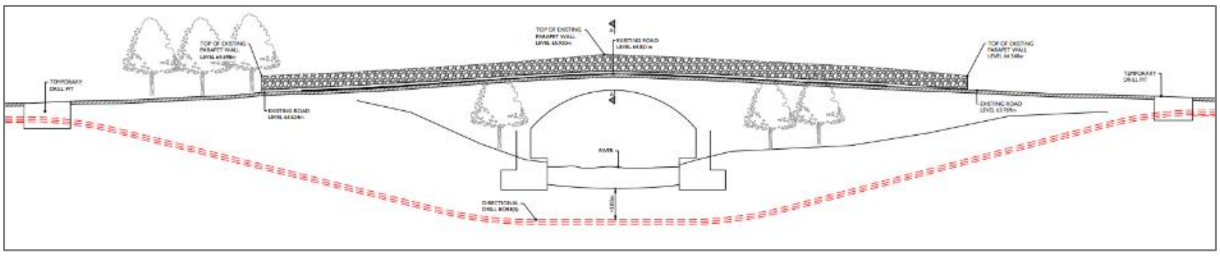

Figure 7 Shrubbywood Bridge Option B

3.2 Option C Ducts in the road (flat formation)

Option C for Shrubbywood Bridge is illustrated on drawing COLE d005.3.5, refer to Appendix B. This option would involve laying the ducts in a flat formation within the road carriageway. The EirGrid Specification requires that a minimum 450mm cover be provided to ducting in this arrangement (refer to Figure 5). This option would necessitate raising the road, verge and parapet wall levels by approximately 0.5m at the crown of the bridge, in order to provide the minimum coverage to the ducts. The roads on approach to the bridge would also be raised, in order to tie in with the higher level at the centre of the bridge.

Raising the road level could result in significant additional load being applied to the bridge structure. Lightweight fill material (e.g., a foamed concrete) could be used in order to maintain a similar total applied dead load, and a structural assessment would be completed. This option would also affect the road profile (and driver sightlines across the bridge) and a detailed road geometric design would be required at detailed design stage to establish the extent of road reprofiling required.

A parapet wall structural assessment would also be required to assess the parapet walls and determine what, if any, strengthening measures would be required for the raised parapet.

The benefit of this option would be that it maintains the current widths of the road carriageway and concrete verges, while providing a standard EirGrid cable crossing design.

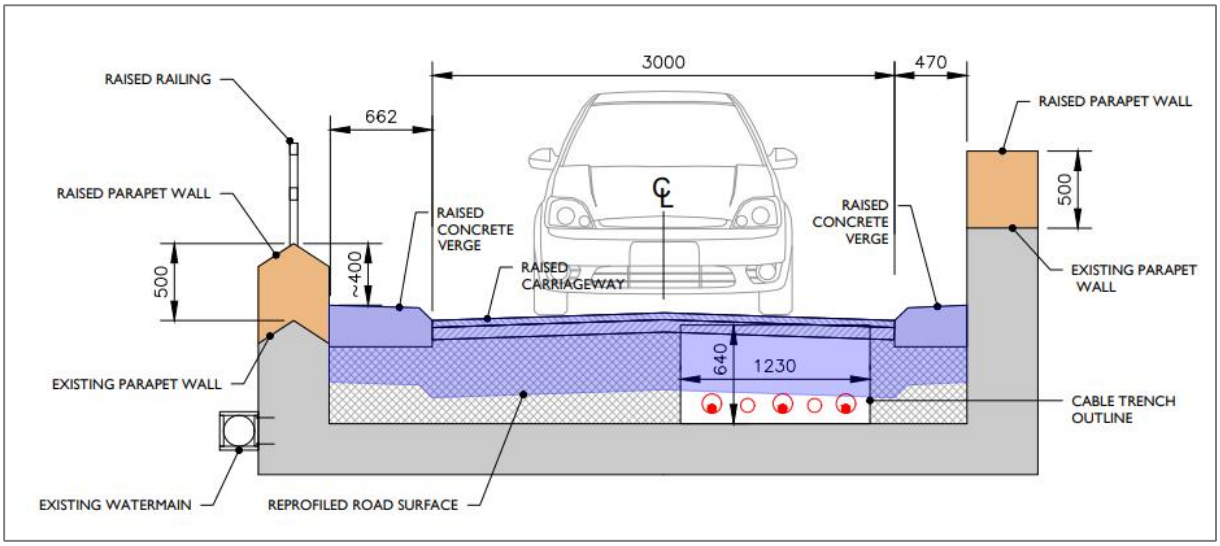

Figure 8 Shrubbywood Bridge Option C

3.3 Option D Ducts split into both concrete verges

Option D for Shrubbywood Bridge is illustrated on drawing COLE d005.3.8, refer to Appendix B. This option would involve laying the ducts in a flat formation within the two concrete verges. The ESBN Specification requires that a minimum of 100mm cover be provided to ducting in this arrangement. This option would necessitate rearranging the concrete verges, so that the wider verge is located on the north side of the bridge away from the water main. This would enable the 3 power ducts to be placed on one verge, and the communications and earthing duct in the opposite verge. The road and concrete verges would also need to be raised by approximately 150mm at the crown of the arch, with the road profile also raised on approach to the bridge in order to tie in with existing road levels.

The benefit of this option would be that it effectively maintains the current widths of the road carriageway and concrete verges and limits the depth of the raised road over the bridge. As detailed above, this option is not a standard EirGrid or ESBN design detail and would require a detailed review process with both parties to confirm their acceptance of such a proposal.

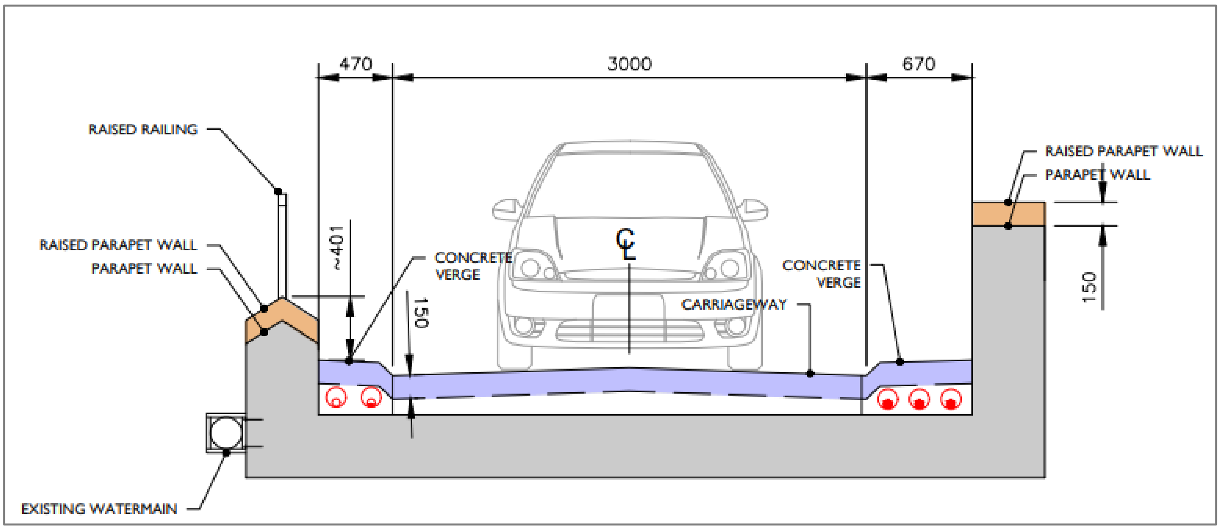

Figure 9 Shrubbywood Bridge Option D

A site investigation including trial excavations over the bridge structures will be undertaken at detailed design stage to confirm the available depths for the options above.

3.4 Summary – Shrubbywood Bridge (WH L1825-002.00)

As noted in the previous sections, following discussions with WCC it was agreed that prior to commencement of development security in a form to be agreed with the Planning Authority could be put in place to safeguard future maintenance or rehabilitation work at these bridge crossings.

In relation to Option A, in the meeting (10th October 2022) the Council raised concerns regarding potential damage to the external conduit and a further clarification and commitment is provided in response in Section 2. This option is a standard method for ESBN of crossing bridges with restricted space and is detailed on the ESBN Standard Specification for 110kV Network Ducting/Cabling.

WCC indicated (meeting of 10th October 2022) that Option B, directional drilling, would be an acceptable option as it would not necessitate placing high voltage cables across the bridge. The EirGrid Specification requires that where minimum standard "vertical cover" requirements cannot be achieved within the road, e.g., bridge crossings, then horizontal directional drilling can be utilised as an option.

Options C and D are presented in this report in response to the Council's submission and the subsequent meeting with WCC (10th October 2022).

Option C would allow the current road and verge widths to be maintained and is also a standard EirGrid design detail. However, it would involve raising the road level across the structure.

Option D places the ducting within the concrete verges. While this option requires a wider concrete verge on one side of the bridge, it would maintain concrete verges on both sides of the structure. Option D is a non-standard EirGrid or ESBN design detail and would require a detailed review process with both parties to confirm their acceptance.

4. Roadworks Guidelines & Standards

WCC in their submission raised a query in relation to compliance with the Purple Book. The planned works for the 110kV grid connection will be designed and built using the following guidelines and standards:

- Purple Book "Guidelines for the Opening, Backfilling and Reinstatement of Openings in Public Roads" Rev 1 (April 2017)
- Any other relevant local authority or TII standard

At detailed design stage, the grid route designer will prepare a full set of drawings and specifications covering all proposed works, and WCC will be given an opportunity to review and comment on the proposals as part of a detailed design review process.

APPENDIX A

- Bridge Crossing No. WH L1825-001.00 (Clonava Bridge) Drawings

Drawing No.	Revision	Drawing Name
COLE d005.3.3	B	Clonava Bridge Crossing WH-L1825-001.00 Proposed Option C
COLE d005.3.6	A	Clonava Bridge Crossing WH-L1825-001.00 Proposed Option D
COLE d005.3.7	A	Clonava Bridge Crossing WH-L1825-001.00 Proposed Option E

Please refer to Appendix 1 of the FI Drawings Pack (enclosed separately)

APPENDIX B

- Bridge Crossing No. WH L1825-002.00 (Shrubbywood Bridge) Drawings

Drawing No.	Revision	Drawing Name
COLE d005.3.4	C	Shrubbywood Bridge Crossing WH-L1825-002.00 Proposed Option B
COLE d005.3.5	C	Shrubbywood Bridge Crossing WH-L1825-002.00 Proposed Option C
COLE d005.3.8	B	Shrubbywood Bridge Crossing WH-L1825-002.00 Proposed Option D

Please refer to Appendix 1 of the FI Drawings Pack (enclosed separately)