APPENDIX C.1

CABLE CONSTRUCTION METHODOLOGY

Ballyvouskill - Coomataggart 110 kV Underground Cable Project

Construction Methodology

PE605-F0008-R00-005-000

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Construction Methodology

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1 Preface

This report has been compiled as a guide to provide suitable information on the standard trenching and ducting techniques required to complete the proposed 110 kV cable project. The completion of these works is detailed in a step by step guide along with the civil work aspects regarding joint bay construction, typical water crossing procedures and high voltage (HV) cable installation.

The methodologies in this report are the current expected methodologies for the construction of this project. These approaches may require localised variation during the detailed design and construction of the project depending on the best working practices and preferred construction techniques of the selected contractor at particular locations, following on-the-ground detailed design and survey. However, it is considered that the methodologies described in this report cover all construction possibilities and are adequate for an understanding by the Planning Authority of the proposed development, in the context of determining this Section 5 Declaration request.

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2 Introduction

This project consists of the installation of a new 110 kV underground cable (UGC) circuit to form a link between the existing Ballyvouskill 220/110 kV substation and the permitted but as yet unbuilt Coomataggart 110 kV substation. The UGC will be installed primarily along the public road network over a distance of approximately 31km.

It is the policy of ESB Wind Development that, in so far as possible, high voltage underground cables shall only be installed under public roads. One of the key advantages of laying cables under roadways is that there is usually no permanent impact on the environment additional to that caused by the presence of the roadway. When an underground cable is laid under an existing roadway the potential for impact is normally only a short term impact during the construction phase.

For underground cables, joint bays are required approximately every 600 - 800m, these joint bays are where the separate cable lengths are joined together. The joint bays proposed along the cable route will be located either within the existing road or, more likely, at suitable off-road locations which will be immediately adjacent to the carriageway in order to minimise the disruption to traffic. The selection of joint bay locations involved technical and environmental evaluation of the sites to ensure that the area is suitable for construction works. A working area is defined which provides adequate space for cable pulling and jointing around the joint bay. This working area will also provide space for movement of all construction vehicles. The working area will immediately adjoin the public road, as the cable will be diverted from the road into the off-road joint bay. Due consideration must also be given to the possible presence of existing underground and overhead services, traffic management requirements, landowner agreements and existing ground conditions. Once agreements with each landowner are reached, site investigations are carried out to prove these locations suitability and allow the civil works commence. Refer to **Volume 2, Figure 1 Underground Cable (UGC) Route** for a map of the proposed development.

A civil contractor carrying out the standard 110 kV trenching and ducting specification will complete between 50 to 70 linear metres of trench in a roadway per day depending on the site conditions. All road works involving cable and pipe laying e.g. watermains, broadband, television etc., require traffic management procedures when installing within public roads. It may be a temporary requirement that some roads are closed along particular sections of the cable route. This can have a disruptive effect locally on residents over the period of the installation works. In the case of wider roads, one carriageway may be closed with use of the other carriageway restricted and controlled by temporary traffic lights or a “stop and go” traffic management system. The traffic management plan and corresponding works will be carried out with the agreement of the local authority. **Appendix 3 of the Section 5 Declaration Report** provides a Traffic Management Plan.

3 Trenching and Ducting

3.1 Site Investigations

Site investigations along the proposed route will have been carried out in advance of the approved designs being finalised and before the contractor commences trenching and ducting civil works. These site investigations will include slit trenches along the road ways to detail the route and to ensure that there is sufficient space to install a 110 kV cable trench typically measuring approximately 0.6m (width) by 1.2m (depth). Construction drawings which detail the cable alignment and off road joint bay locations and river crossing proposals are made available to the contractor. Further site investigations may be required to gather additional information on the road cover available over existing bridges and culverts with the relevant local authority approval. There will be additional trial holes or bore holes required at the off-road locations for joint bays and river crossings.

3.2 Contractor's Duties

In advance of starting the works, the contractor or the appointed ESB Wind Development wayleave officer will liaise with all directly impacted landowners. The design engineer will also set out the route alignment, off road joint bay positions and river crossing alignments for the contractor.

The contractor will obtain plans, maps and other relevant information about buried services from statutory authorities and other public utilities. The contractor will also ensure that the relevant road opening concessions have been obtained from the local authority.

The contractor's general work requirements will be:

- Present professionally drafted traffic management plans for each stage of the works.
- Secure each work area with adequate protective barriers and organise traffic signs and traffic management controls to the approval of the Engineer.
- In off road locations, a temporary hardstand working area will be created and fenced to facilitate the joint bay construction and associated traffic. These working areas will be removed upon completion of the cable installation and jointing works.
- Provide secure and clean storage facilities for all ducting and trenching materials, cable installation equipment and cable drums.
- Carry out a surface check for underground services with appropriate detection equipment.
- Clean and sweep adjacent public roadways and footpaths during and after the works.
- Saw cut to full depth of existing asphalt/bitmac layers and/or concrete surfacing. In grassed fields, carry out the works in accordance with specification.
- A rock breaker or other approved method will be used to break the trench section of the road surface.

- Commence excavation on all trench sections with due attention to the presence of other services and to the grade of the trench. Hand dig when within 500 mm of services and around trees. Note that a length of 12 m of proven excavation will be exposed ahead of any commencement of ducting. This is to allow for the bending of ducts to avoid obstacles and the possible requirement for digging back on re-commencement of new excavation if an obstacle is encountered within the 12 m.
- Where possible, crossing of existing services will be carried out at right angles. The contractor will provide a standard minimum 300 mm vertical clearance between the proposed ducts and the existing services to be crossed.
- Where possible, the contractor will ensure a minimum distance of 500 mm horizontal separation is maintained between the edge of the power ducts and existing services.
- Simultaneously load and remove soil, and dispose in compliance with all relevant legislation, to a site or sites to be selected by the contractor and agreed with the relevant authority. In grassed fields the excavated soil will be stored within the wayleave and reused on reinstatement.
- Protect all services against damage due to trenching, ducting, backfilling and compaction.
- Remove all ground water from the trench. Treat and dispose of the waste water in accordance with current legislation and best practice, under permit from the local authority if required.

3.3 General Methodology

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

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

7. Carefully surround and cover ducts with CBGM B material in accordance with the drawings and thoroughly compact without damaging ducts.

8. Place red cable protection strip on top of compacted CBGM B over each set of ducts as shown on the drawings.

9. Place and thoroughly compact CBGM B material or Clause 804 backfill or soil backfill as specified and place warning tape at the depth shown on the drawings.

10. For concrete and asphalt/bitmac road sections, carry out immediate permanent reinstatement in accordance with the specification and to the approval of the local authority and/or private landowners, unless otherwise agreed with local authorities. (**See Plate 2 and Annex B**)

11. For unsurfaced/grass sections, backfill with suitable excavated material to ground level leaving at least 100 mm topsoil or match existing level at the top to allow for seeding or replace turves as per the specification of the local authority or landowner.

12. Clean and test the ducts in accordance with the specification by pulling through a brush and mandrel. Install 12 mm polypropylene draw rope in each duct and seal all ducts using robust duct end seals fitted with rope attachment eyes in preparation for cable installation at a later date. All the works should be witnessed by a Clerk of Works (CoW).

Plate 1 : Typical 110 kV cross section

Plate 2 : Reinstatement of road surface over trench

3.4 Project Specific Methodology

1. Trenching and ducting works will be confined to within the existing road corridor except where the route needs to deviate slightly from the public road at joint bay locations or at watercourse crossings. Aspects of trenching which require particular attention in this instance include: 1. management of trench spoil, 2. trench de-watering, 3. adding CBGM B. Industry accepted best practice will be applied at all times in dealing with the above.

2. Soil management: For all trenching along the road, all excavated material will be taken off site in trucks and disposed of, under licence from the County Council, thus preventing any contaminated run-off to roadside drains during heavy rainfall. In off road areas where the top 400-500 mm of topsoil will be set aside within the wayleave for later reinstatement, these stockpiles will be stored at least 15 m back from drains and watercourses on level ground with a silt fence inserted at the base.

3. Trench de-watering: Ground water and surface water accumulating in the base of trenches will not be pumped directly to roadside drains or watercourses unless it is clean and free from solids. Solids-contaminated water will be discharged to a designated percolation area designated by a competent person if the soil is not water logged. In the case of heavy contamination the water will either be tankered off site for disposal in a licensed facility or pumped to a portable on-site settlement tank for treatment. These operations will be monitored by a designated competent member of the construction team on a regular basis to ensure that they are working effectively.

4. Adding CBGM B: Temporary storage of CBGM B will be on hardstand areas only where there is no direct drainage to surface waters and where the area has been bunded e.g. using sand-bags and geotextile sheeting or silt fencing to contain any solids in run-off.

4 Joint Bay Details

4.1 Introduction

Joint bays are locations where separate lengths of cable are joined together. These are required approximately every 600 – 800m and will for the most part be located off road but adjacent to the public road, there are 39 joint bays located along the Ballyvouskill - Coomataggart 110 kV route as shown in **Volume 2 Figure 2A and 2B Construction Details** and also as detailed in **Annex A, C and D** of this Report. These joint bays will be located underground and will be completely reinstated/back filled during reinstatement works.

4.2 Typical construction

Joint bay dimensions are typically in the order of 6 m long, approximately 2.5 m wide and approximately 2.5 m deep and are designed to be covered over and the land above to be potentially available for agricultural use following reinstatement.

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

1. The contractor will excavate a pit for joint bay construction, including for a sump in one corner.
2. Grade and smooth floor; then lay a 75 mm depth of blinding concrete (for in situ construction) or 50 mm thick sand (for pre-cast concrete construction) on 200 mm thick Clause 804 granular material.
3. In situ construction. Construct 200 mm thick reinforced concrete floor slab with sump and starter bars placed for walls as detailed on the drawings. **(See Annex C)**
4. In situ construction. Construct 200 mm thick reinforced concrete sidewalls as detailed on the drawings. (**See Plate 3 and Annex C**)
5. In situ construction. Remove formwork and backfill with suitable backfill material in grassed areas or Clause 804 material once ducting has been placed in the bay. Backfill externally with granular material to NRA Specification for Roadworks. (**See Plate 4 and Annex C**)
6. Pre-cast concrete construction. Place pre-cast concrete sections on sand bedding. (**See Plate 5 and Annex D**)
7. Where joint bays are located under the road surface the joint bay will be backfilled with compacted layers of Clause 804 and the road surface temporarily reinstated as specified by the local authority.
8. Precast concrete covers may be used as temporary reinstatement of joint bays at off road locations. These covers are placed over the constructed joint bay and are then removed at the cable installation stage of the project.
9. At a later date to facilitate cable installation and jointing, reinstate traffic management signage, secure individual sites, re-excavate three consecutive joint bays and store excavated material for reuse.

10 The cable is supplied in pre-ordered lengths on large cable drums (**See Plate 6**). Installing “one section” of cable normally involves pulling three individual conductors into three separate ducts. The cable pulling winch must be set at a predetermined cut off pulling tension as specified by the designer. The cable will be connected to the winch rope using approved suitably sized and rated cable pulling stocking and swivel or the pulling head fitted by the cable manufacturer (**See Plate 7).** A sponge may also be secured to the winch rope to disperse lubricant through the duct. Lubrication is also applied to the cable in the joint bay before it enters the duct.

11 Once the “two sections” of cable (total of 6 conductors) are pulled into the joint bay (**see Plate 8**), a jointing container is positioned over the joint bay and the cable jointing procedure is carried out in this controlled environment. (**See Plate 9**)

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

4.3 Project Specific Construction Methodology

Activities associated with joint bay construction include: 1. site access and ground preparation, 2. soil excavations, 3. pit de-watering, 4. concrete pouring and 5. back-filling with cement-bound sand.

The following aspects of best practice construction have been listed in the same order and are based on the “worst case scenario” assumption that the joint bay is near a water course or surface drainage channels. Clearly, in open level ground with few drains, the construction complexities are much lower.

1. Site access and ground preparation: The access track from the road to the joint bay and back will have the surface layers of soil stripped and terram laid, followed by a layer of Clause 804 aggregate to form a working surface for vehicles, thereby preventing soil damage and rutting. This surface will be regularly assessed for damage and additional aggregate added if required. The area around the edge of the proposed joint bay which will be used by heavy vehicles will also be surfaced with a terram cover and stone aggregate to minimise ground damage. Any roadside drains within the temporary works area will be culverted and check dams made from stone or sandbags covered with terram will be inserted upstream and downstream of these culverts to intercept any solids generated during the insertion or which wash out during the works. If the ground slopes from the working area toward a watercourse or if there is evidence of solids washing off the works area toward nearby watercourses or drains, a silt fence with

straw bales, will be interposed between the works area and the watercourse.

2. Soil excavations: All unwanted excavated material will be taken off site in trucks and disposed of, under licence from the County Council. Any soil required for reinstatement that will be temporarily stockpiled on site will be placed at least 15 m back from the nearest watercourse on level ground and will be ringed at the base by silt fencing and be regularly monitored by a designated competent person for signs of solids escape. In which case an additional line of silt fencing with straw bales will be added.

3. Pit de-watering: If the joint bay needs to be dewatered, this will be pumped to a percolation area if the soil is not saturated, otherwise a settlement tank will be used to remove any solids from the de-waterings.

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

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

Plate 3 : Typical joint bay under construction (in-situ)

Plate 4 : Completed joint bay prior to cable installation (in-situ)

Plate 5 : Typical joint bay under construction (pre-cast)

Plate 6 : HV cable pulling procedure (Typical drum set-up)

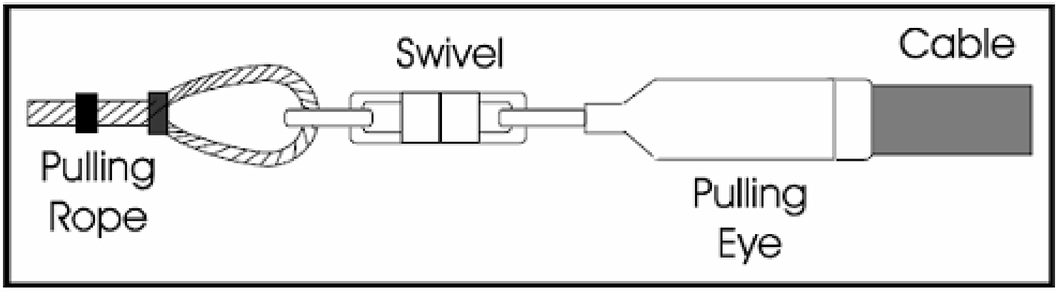


Plate 7 : Swivel and pulling eye

Plate 8 : HV cable pulling procedure (Typical pulling winch set-up)

Plate 9 : HV cable jointing container

5 Water Crossings

5.1 Introduction

A detailed survey of the drainage along the cable route revealed 147 individual watercourses which are marked in **Volume 2, Figure 2A and 2B Construction Details**. Existing road bridges over water courses cannot always accommodate high voltage cables. In such cases it will be necessary to pass underneath the water course. Crossings of smaller ditches and drains will be carried out by open trench using damming and overhead pumping (refer to sections 5.2 to 5.4 below). Crossing of larger watercourses will be carried out using a trenchless technique (at 6 No. locations), where the cable ducting passes below the river bed.

The crossing of streams and rivers will be carried out by open trench method or trenchless methods. The open trench method of crossing streams and rivers can be carried out by “damming and fluming” method or “damming and pumping” method as discussed below.

The cable ducts will be installed above a water course structure where sufficient depth is available above the crown or capping stone of a piped or stone culvert water crossing. Site investigations will be undertaken to determine the depth of material between the finished road surface/grass margin and the top/crown of the water crossing structure. Where depths of 850 mm or greater are present, the cable ducting will pass over the water crossing. Additional protection measures such as higher strength concrete and galvanized steel plates will be installed in these locations as shown in **Annex E Typical Trench Cross Section for Crossing Over Culverts or Services.**

The method adopted at particular locations will be implemented only with the approval of Inland Fisheries Ireland (IFI). Where applicable, the construction will take place outside the salmon spawning period from October to April unless otherwise agreed with IFI.

Appropriate measures will be put in place by the contractor to prevent ground damage on the access routes to watercourse crossings on both banks, particularly where the ground is soft or slopes steeply toward a crossing. This will prevent solids reaching a watercourse from damaged access tracks.

All the river crossings have been assessed by the Project Aquatic Ecologist – refer to **Appendix 5 Aquatic Ecology Report**.

5.2 Ditch/Drain & Culvert Crossing

Open Trench (Damming and pumping)

The crossing of ditches and drains can be achieved by damming and pumping of the water flow overhead. Silt traps, such as geotextile membrane, straw bales etc. will be placed downstream of the trenching location prior to construction to minimise silt loss. A dam will be constructed using sand bags. Temporary pump sump(s) will be provided to house the pumps used to move the water downstream. The pumping rate will be suitable to move the flow rates. The cable ducts will then be installed in the ditch / drain bed as described in section 3. Following the installation of the cable ducts, the bed of the ditch / drain will be re-instated with original or similar material. The duration of this process will vary depending on the site location, crossing length, ground/weather conditions etc.; however, it would typically take 1 - 3 days to complete each crossing.

Where less than 850mm of cover is available between the road surface and top of the culvert structure the ducting trench will pass under the culvert maintaining a minimum off 300mm clearance between the underside of the culvert and cable ducting. In piped culvert locations the trench will be excavated while maintaining the pipe structure, the watercourse will be over pumped during this excavation. Where minor stone culverts are crossed the entire culvert structure across the full width of the road will be replaced with an appropriately sized twin walled storm water pipe. The watercourse will be over pumped during this installation while the stone culvert is being removed and storm pipe is installed. Culverts will only be replaced after consultation with the Project Aquatic Ecologist, County Council and IFI. All over pumping procedures will be carried out as described below in option 2.

Where more significant stone culverts are encountered the ducting will cross under the watercourse on either the upstream or downstream side of the culvert structure by either of the two options described below.

5.3 Stream/River Crossing

Option 1 - Open Trench (Damming and fluming)

The crossing of the stream/river will be achieved by fluming the existing river flow through one or more pipes depending on the size of the flows in the stream/river. The flume pipe(s) will be approximately 10 m long and the diameter suitable to accommodate the existing flows.

Where applicable, under the supervision of an aquatic ecologist, spawning gravels will be removed at the stream crossing areas where construction will take place. The extent of spawning gravel removal will be agreed for each site with IFI prior to construction commencing.

1. The flume pipe(s) will be set out on the bed of the existing stream.
2. A dam will be constructed using sand bags and suitable clay material around the flume pipe(s) and across the stream so that all the flows are diverted through the pipe(s).
3. Silt traps, such as geotextile membrane, straw bales etc. will be placed downstream of the in-river trenching location prior to construction, to minimise silt loss.
4. Excavate the proposed trench in the dry stream bed and under the flume pipe(s). If required, a temporary pump sump can be established and a pump used to remove any additional water. This water will be pumped to a percolation area if the soil is not saturated, otherwise a settlement tank will be used to remove any solids from the de-waterings.
5. Install the cable ducts in the stream bed or install a precast concrete slab incorporating the ducts, ensuring the designed cable route alignment is maintained.
6. Following the installation of the cable ducts, the stream bed will be re-instated with original or similar material and the spawning gravels replaced under the supervision of the aquatic ecologist.

7. Once the stream bed is appropriately re-instated the dam and the flume pipe(s) will be removed thus restoring the stream to its original condition.

Option 2 - Open trench (Damming and pumping)

1. The crossing of the stream/river will be achieved by damming the existing river upstream of the proposed crossing area.
2. Where applicable, under the supervision of an aquatic ecologist, spawning gravels will be removed at the stream crossing areas where construction will take place and will be stored appropriately to be used during the reinstatement stage of the crossing. The extent of spawning gravel removal shall be agreed for each site with IFI prior to construction commencing.
3. Silt traps, such as geotextile membrane, straw bales etc. will be placed downstream of the in-river trenching location prior to construction, to minimise silt loss.
4. A dam will be constructed using sand bags and suitable clay material.
5. Temporary pump sump(s) will be provided to house the pumps used to move the water downstream. The pumping rate will be suitable to move the flow rates of the existing stream.
6. Install the cable ducts in the stream bed as described in section 3 or install a precast concrete slab incorporating the ducts.
7. Following the installation of the cable ducts the stream bed will be re-instated with original or similar material and the spawning gravels replaced under the supervision of the aquatic ecologist.
8. Once the stream bed is appropriately re-instated the dam and the pumps will be removed thus restoring the stream to its original condition.

5.4 Project Specific Methodology - Open Cut Crossing

It is proposed to undertake all open-cut watercourse crossings during the May to September period in order to avoid the period of salmon and trout spawning. Subject to the approval of IFI and following their agreement based on receipt of an approved method statement from the contractor, the damming and pump-over or damning and fluming method of open-cut crossing will be used at the following locations as identified on Table 1 below and **Volume 2, Figure 2A and 2B Construction Details**. Where sufficient depth (850 mm plus) is present over the crown of a water crossing/culvert, the cable route will not interfere with and will pass over the water course, refer to **Annex E Typical Trench Cross Section for Crossing Over Culverts or Services.**

Table 1 Open Cut Crossing Locations

Open Cut Crossing Locations
S1-S12
S14-S20
S22-S42
S45-S48

S50-S66

S68-S147

It is noted that no watercourses can be entered or crossed without prior notice to and approval by the IFI. Aspects of these crossing methods which are highlighted for best practice construction are detailed below and relate to the following aspects: 1. Site access and ground preparation, 2. In-stream habitat damage within the footprint of the crossing and immediately downstream, 3. Watercourse damming process, 4. Trench excavation, 5. De-watering of the trench excavation, 6. Pumping over, and 7. Site reinstatement.

1. Site access and ground preparation: The access track to the watercourse crossing will be prepared in the same way as that for the joint bays, i.e. topsoil stripping, followed by terram laying and the addition of a layer of aggregate to protect the ground from rutting. This will also be undertaken parallel to the crossing point in order to protect the bank from heavy vehicle damage.

2. In-stream habitat damage: All clean coarse surface material (gravel, cobbles and boulders) on the bed of the river or stream to a depth of 20 cm will be removed. A thinner layer will be removed if deeper material is mainly clay or sand. This will be set aside back from the watercourse on a geotextile base for use to reinstate the stream bed surface.

3. Watercourse damming: At damming and pumping sites the damming will be undertaken using sand bags and/or clean stone covered with an impermeable layer of thick polythene or similar material in order to minimise the use of clay materials. If managed carefully, these materials should be reusable at several crossing sites. At sites to be flumed the diameter of the flume pipe will be chosen to accommodate flows at the time with spare capacity to cover that predicted over the period that the works would be expected to last. Construction of the dam around the flume pipe will require use of clay material to create a practical seal. In this case the dam will be designed to reduce to a minimum the amount of clay to be used. The clay used will be puddle clay or equivalent.

4. Trench excavation: Material excavated from the trench (and an upstream pump sump if required) will be placed on terram on level ground as far back from the watercourse’s edge as is practicable and surrounded on its downslope side by a silt-fence to prevent solids re-entering the stream. This material if deemed suitable can be used to partially backfill the trench. However, a significant amount will be in excess and will be removed off site under licence from the County Council.

5. De-watering of watercourse crossing excavation: Dewaterings of the excavation will be treated on site using settlement tanks before the settled water is returned to the watercourse. A second tank in series with the first will be used if the first isn’t sufficient to remove enough solids.

6. Pumping over: Pumped over water will be directed to a splash plate to prevent erosion of the river bed at the downstream side.
7. Site reinstatement: The surface coarse substrate which was set aside will be used to reinstate the stream bed after the ducts have been installed and the flume pipe has been removed as well as all the damming materials. All surfaces will be re-instated to the satisfaction of the landowner and re-seeded to assist soil stabilisation. A silt fence will be placed along the river bank where the works were undertaken in order to prevent solids washed off the works area during heavy rainfall entering the stream while the surface adequately re-vegetates. This measure will be particularly important at sites which slope to the edge of the watercourse.

5.5 Stream/River Crossing

Option 3 - Trenchless Installation

It is common practice to use trenchless technology to install cable ducting under wider watercourses where technically viable. The trenchless technology chosen may depend upon many different factors such as the length of the trenchless section, ground conditions at the specific site, the suitability of staging areas either side of the trenchless section and budget costs. These trenchless installation methods may involve horizontal directional drilling, micro tunnelling, pipe ramming, pipe jacking or auger boring.

The most commonly used method of trenchless installation utilised on HV cable circuits in Ireland at present is Horizontal Directional Drilling (HDD). Examples include the installation of 200 m long cable ducts under the river Dodder for ESB and 270 m long 450 mm diameter steel gas pipe under the M1 motorway in County Down for Bord Gáis. In 2009, cable ducts were successfully installed across the River Corrib near the Quincentenary Bridge in Galway. Lessons learnt from that crossing have been incorporated into the methodology for this HDD crossing. There are 6 No. watercourses which will be crossed using HDD including 13, 21, 43, 44, 49 and 67. Refer to Table 2 below and **Volume 2, Figure 2A and 2B Construction Details.**

5.6 Methodology for Trenchless Installation

In order to accommodate the drill and associated operations, entry and exit pits within compound areas are required either side of the river.

Setting up the Site

Access to the entry and exit pits will be via a newly constructed temporary access or existing access road/track. Silt fences will be erected around the entire work area at both entry and exit pits prior to the drilling contractor preparing a laydown area of approximately 30 m x 25 m. The works area will be a minimum of 15 m back from the river and within this zone, the natural vegetative cover will not be altered and no construction traffic will use the area so that the natural filtering capacity of the vegetation if required will remain intact. If areas are overgrown with thick vegetation, a section of it will be removed appropriately and disposed of via a licensed waste contractor. The area is then levelled where required by using the bucket of a 360º excavator and overlain with 'Terram' geotextile and 200 mm of Clause 804 material which will be removed on completion. Stripped topsoil will be stored on level ground at least 15 m back from the river and ringed by silt fencing to prevent solids washout. The boundaries of the rig up area and exit area would both be defined with security fencing positioned to ensure adequate access is maintained. Entry and exit pits (2m x 2m x 2m) are excavated using an 360° excavator and the resultant spoil bunded in 0.5mm PVC liner within the designated working areas. A steel box (1m x 1m x 2m) is placed in the ground to control drilling fluid returns from the borehole..

Drilling Rig, Pipe Handling Trailer/Control Cabin

The drilling rig contains a diesel/hydraulic power unit with operations controlled at the drillers console. The rig will have pollution pans, wireline steering tool connections for directional drilling monitoring, air purge system, water washdown system and a high pressure, hot water washer. The pipe handling trailer has a driller's cabin, hydraulic crane and drill pipe transport trays.

Drilling Fluids Circulation System

Typically, the drilling fluid consists of water and sodium bentonite which is NSF/ANSI Standard 60 certified for use in drilling water wells etc. NSF (originally National Sanitation Foundation) is the American public health and safety organisation. Alternatives to sodium bentonite are approved by the statutory environmental agencies in the USA, UK and elsewhere. The drilling fluid to be used for this project will be approved in advance by the local authority and the relevant statutory environmental agencies. The fluid which transports the drilled material is circulated through a secure system as described below.

The major components of this system are storage tanks, a mud pump, a mud-mixing hopper and a solids removal system. Centrifugal pumps circulate drilling fluid returns through the mud cleaners before being pumped back downhole. Solids removed from the drilling fluid are diverted into skips for safe disposal. Drilling fluids returning to the surface are diverted through a conductor pipe to a mud pan on the surface. The ability to clean and re-circulate drilling fluids keeps the volume of drilling fluids required to a minimum.

Auxiliary Equipment

This includes generators, excavators, telehandlers, bowsers etc. The drilling rig and fluid handling units will be placed in a bund (bunded 0.5 mm PVC) to ensure that any spills or storm water run-off is captured and managed.

Bore Design

In order to accommodate 5 No. 125 mm ducts, a bore diameter of approximately 500 mm will be required.

Following examination of the ground conditions based on geological mapping and site investigation results, a longitudinal profile of the bore will be designed. The profile will be designed so that the risk of negative impact on the river and existing lands and structures will be negligible.

Bore Construction

A pilot hole is drilled from the entry pit at an initial angle of approximately 15^{o} to 20^{o} to the horizontal. The hole will pass through the overburden into the bedrock and travel underneath the river bed before emerging through the overburden in the exit pit. The drill will pass through the bedrock layer below the river bed. The depth of the drill below the river bed will have been determined from site investigations. Drilling depths are of a magnitude that will significantly reduce the risk of water pollution as there is a thick layer of rock between the drill and the river bed.

Drilling fluid is pumped down the drill string and through the downhole motor, which converts the fluid's hydraulic power to mechanical power and rotates the drill bit. The drill bit is oriented by the surveyor, and the driller pushes the drill string into the ground maintaining the bore path. The drilled cuttings are flushed back by the drill fluid flowing via nozzles in the bit, up the annulus to surface, where they are separated from the fluid fraction for disposal. A comprehensive closed-loop drilling fluid mixing and circulation system with recycling capability will be utilised to minimise the volume of fluids required on site. Constant monitoring of fluid volume, pressure, pH, weight and viscosity will be undertaken. Constant attention will also be given to amount of cuttings produced so that no overcutting takes place and that hole cleaning is maintained. Any excess drilling fluid which collects in the exit pit will be transported by road to the entry pit from where it will be re-circulated.

A proprietary steering system, guided by tri-axial magnetometers and accelerometers that provide real time directional information to the surveyor at the driller's console, will be used to navigate the bores.

Once the pilot hole has been completed, a larger Tungsten Carbide Insert (TCI) hole-opener will fitted to the drill string at the exit side and pulled back through the bore to the entry side. The hole will thus be reamed to the required 500 mm diameter. This reaming may be executed in one or more incremental stages. A 125 mm drill pipe will be added from the exit side to ensure that a mechanical presence is always within the bore.

Duct Installation

The ducts will be laid out on the exit side in preparation for installation. Each duct will consist of a continuous coil of maximum length 200 m. This will depend on transport and handling capabilities. Additional straight lengths of 13.5 m will be butt fusion welded on to the 200 m coils and will be externally and internally debeaded prior to installation.

When the ducts are ready and the drill hole diameter has been proven, a towing assembly consisting of tow heads, a swivel and a reamer will be used to pull the ducts into the bore. Close attention is paid to modelled drag forces during pullback with constant monitoring of load stress undertaken to ensure that modelled tensile stress, collapse pressures, hoop stress and buckling stress are not exceeded.

The ducts will be cleaned and proven and their as-laid location surveyed.

The HDD ducts will be connected to the ducts which will have been installed in trenches at the entry and exit pits.

Waste Disposal

As outlined above, the selected drilling fluid will be non-toxic. Nevertheless, the system is designed and operated so as to contain the fluid and the drilled arisings and dispose of them safely.

During drilling, the control and minimisation of waste fluids are the responsibility of the Fluids Technician and the Drilling Superintendent. Fluids can be minimised by the following procedures:

1. Cleaning and recirculating the drilling fluid.
2. Maintaining excellent fluid properties (pH, density, viscosity, gel strength, shear strength) while drilling to eliminate the need for additional drilling fluid.
3. Monitoring of borehole volumes, flow rates, pressures and drag characteristics to ensure that all cuttings are being circulated out of the borehole and that critical annular fluid velocities are not exceeded maintaining laminar flow to prevent eddying and sloughing of the borehole.

The fluid used is inert clay and can be classified in the European Waste Catalogue under 01-05-04 as freshwater drilling muds and wastes. The cuttings circulated from the bore can be classified under 17-05-04 as soil and stones not containing dangerous substances. The fluid and the cuttings are non-hazardous wastes and therefore suitable for disposal to landfill. MSDS (Material Safety Data Sheets) and COSHH (Control of Substances Hazardous to Health) Sheets for all materials will be kept on site.

Drilled cuttings are stored on site for disposal via a licensed waste contractor. The European Waste Catalogue reference is 17-05-04. Drilling fluid volumes will be minimised. Excess fluid disposal will be via a licensed waste contractor. The European Waste Catalogue reference is 01-05-04

The Contractor will provide a site office, mess and welfare facilities. These units will be powered by a bunded and silenced generator and water will be stored in on-site tanks. The units will be serviced on a weekly basis which includes removal of all wastewater by a licensed contractor.

Reinstatement of Site

On completion of the installation of the ducts, disposal of material and backfilling of trenches, the site will be restored as agreed with the landowners while silt fences remain in place.

Geotextile and Clause 804 material used in construction of access tracks and site compound will be removed and disposed of to a licensed facility. Topsoil will be imported, where necessary and the area reseeded.

5.7 Project Specific Methodology – Trenchless Watercourse Crossings

HDD will be employed to construct the crossing of the various rivers at the 6 No. locations identified in Table 2 below and **Volume 2, Figure 2A and 2B Construction Details.**

Table 2 Horizontal Directional Drilling Locations

Location	**River**	**Description**
S13	Garrane River	Entry/exit pits located in green field and unfarmed mountain locations,15 m from river edge.
S21	Foherish River	Entry/exit pits located in mid mature forestry locations, 20 m from river edge. Minor removal of forestry trees required.
S43	Cappagh West River	Entry/exit pits located in grassland field locations, 20 m from river edge.
S44	Bohill River	Entry/exit pits located in grassland field locations, 30 m from river edge.
S49	Sullane River	Entry/exit pits located in grassland field locations, 20 m from river edge.
S67	Sullane River	Entry/exit pits located in unfarmed field locations, 15 m from river edge.

As identified in Plate 10 and 11 below, HDD is a well-contained trenchless technology, which can be undertaken in a relatively confined area, such as on or adjacent to a public road.

Aspects of this crossing method which could give rise to potential impacts will be addressed by best practice construction methods under the following headings: 1. bentonite preparation, injection and re-cycling, 2. bentonite blow-out.

Bentonite preparation, injection and re-cycling:

The area around the bentonite batching, pumping and re-cycling plants will be bunded using terram and sandbags in order to contain any spillages. One or more lines of silt fences will be interposed between the works area and the river on both banks to prevent solids laden runoff from the works areas reaching the watercourse. Spills of bentonite or bentonite contaminated with drill arisings from any aspect of the bentonite handling process will be cleaned up immediately and transported off site for disposal at a licensed facility. In addition, as stated above it is proposed to locate any bentonite pits a minimum of 15 m from streams and rivers to prevent any possibilities of bentonite entering these watercourses. If arisings are being temporarily stored on site they will be held in adequately sized skips with adequate freeboard to accommodate intense rainfall during the storage period without overflowing.

Bentonite blow-out:

A number of geologies are considered unsuitable for HDD because they increase the chances of bentonite being lost and eventually breaking up through the overburden into the watercourse. A typical example is fissured or fractured rock. A thorough geotechnical assessment of the crossing locations will be undertaken to determine the suitability of the site for this installation method. The drilling process will be constantly monitored to detect any possible leaking of bentonite into the surrounding geology and possible breakout. This can be gauged by monitoring pumping rates and pressures as well as observing for a bentonite plume. If any of these signs appear, then drilling and bentonite pumping will be stopped immediately and an attempt made to bypass the affected section by using a higher viscosity bentonite mix. Prior site investigation including detailed geotechnical investigations will ensure that HDD will only be employed where the soil and geological conditions are suitable. The possibility of any bentonite breaking through into the watercourse above during the HDD process is therefore negligible.

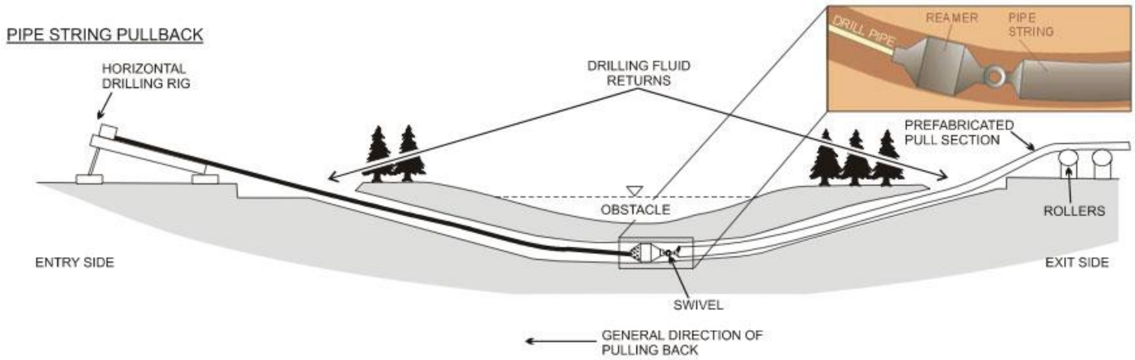


Plate 10: Typical HDD section drawing

Plate 10: HDD rig set up on regional road.

Plate 11: Typical HDD site on local road (Bridge parapet walls visible)

Annex A

Joint Bay Locations

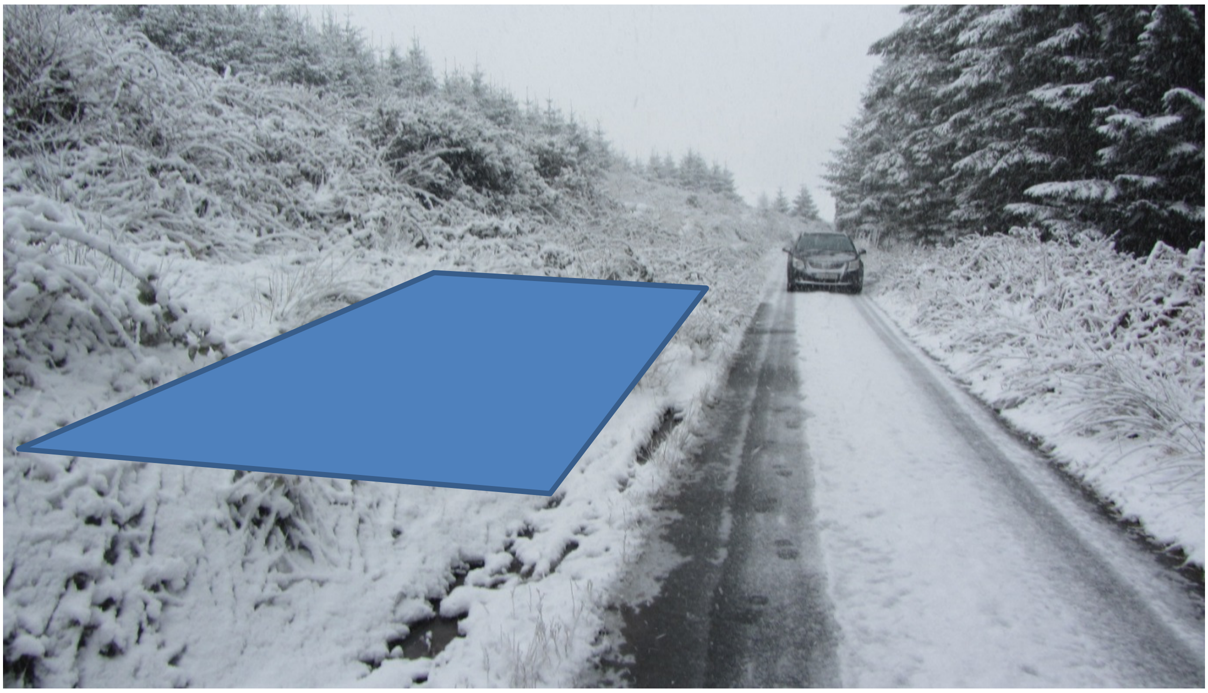
JB 1 Location	Passing Bay Location
In Road	On road / Margin

JB 2 Location	Passing Bay Location
In Road	On Private Land

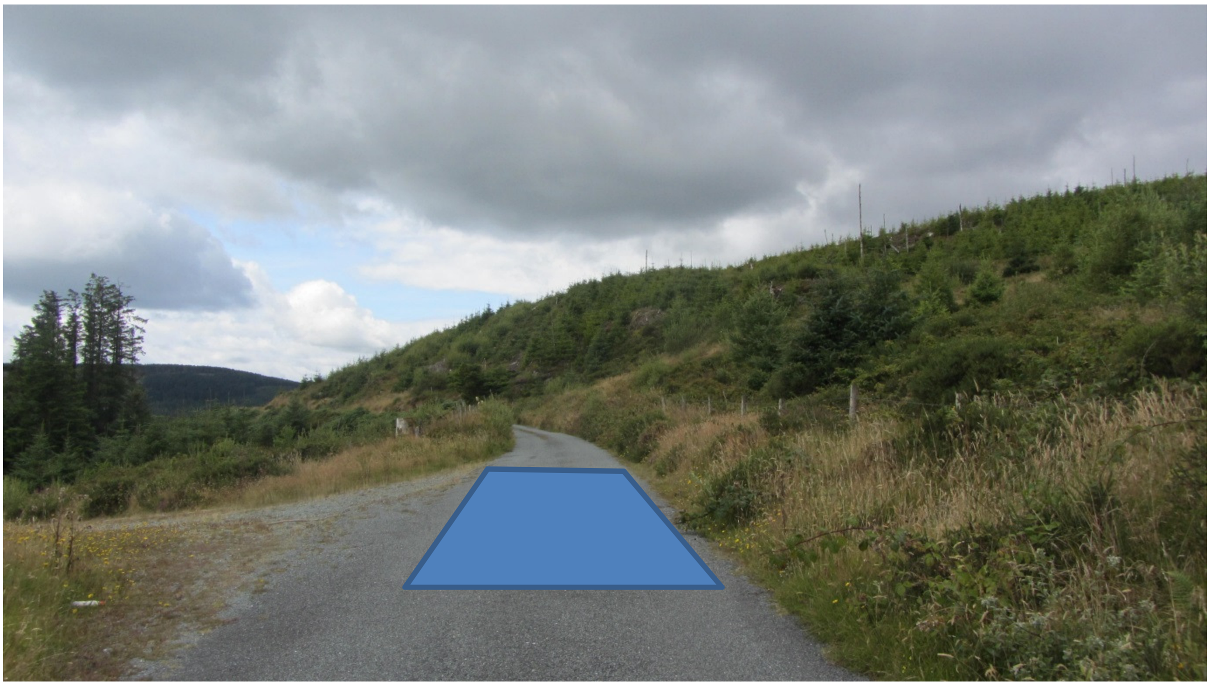
JB 3 Location	Passing Bay Location
In Road	On Private Land

JB 4 Location	Passing Bay Location
In Private Land	On road

JB 5 Location	Passing Bay Location	Right of Way Required
In Road	In Private Land	Yes



JB 6 Location	Passing Bay Location
In Private Land	In Road



JB 7 Location	Passing Bay Location
In Road	On Private land

JB 8 Location	Passing Bay Location
In Road	In Private Land

JB 9 Location	Passing Bay Location
In Private Land	On road

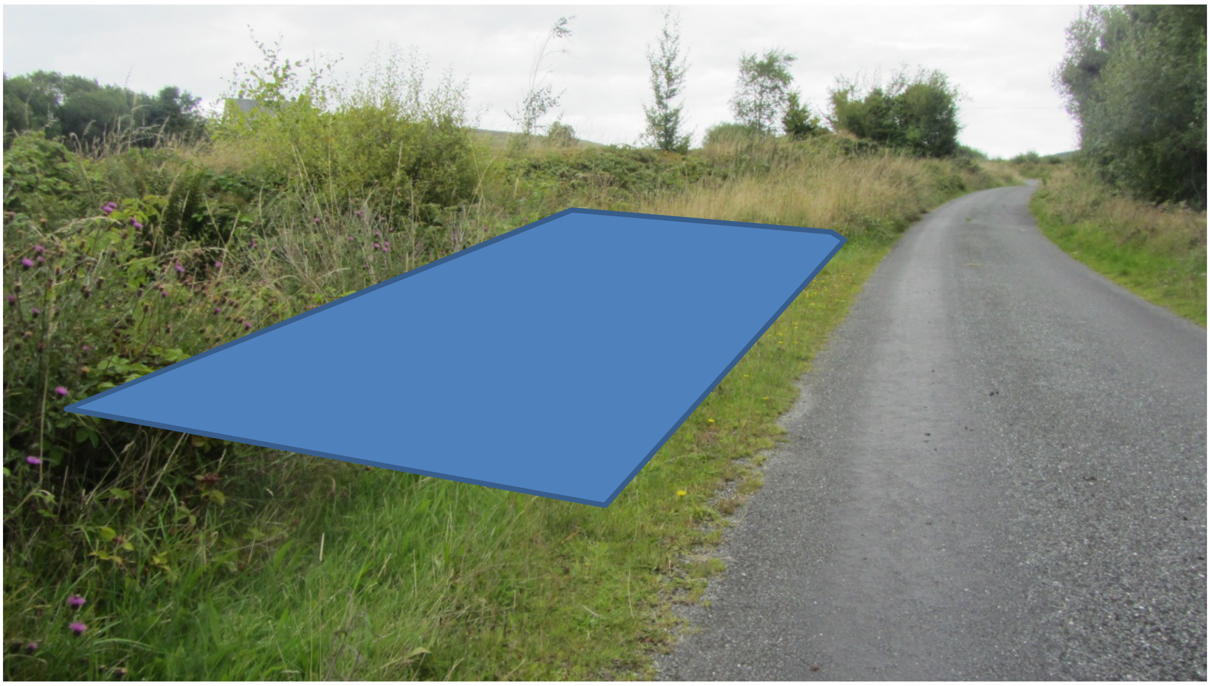
JB 10 Location	Passing Bay Location
In Private Land	On road

JB 11 Location	Passing Bay Location
In Private Land	On road

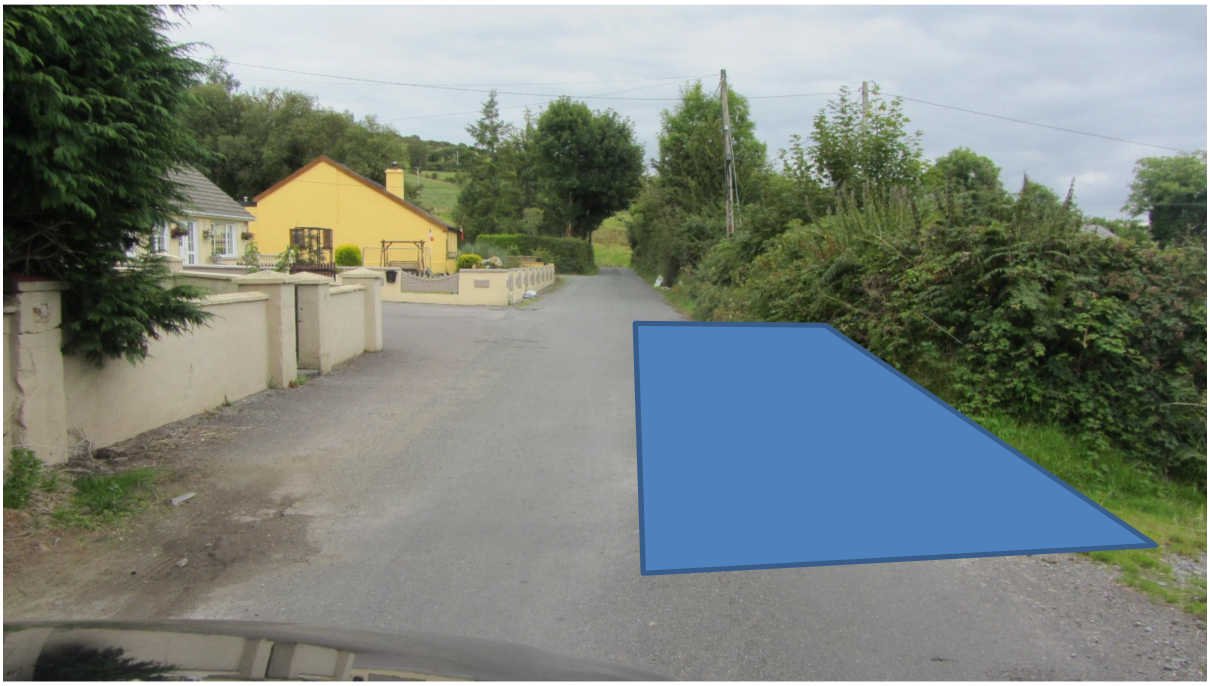
JB 12 Location	Passing Bay Location
In Private Land	On road

JB 13 Location	**Passing Bay Location**
In Private Land	On road

JB 14 Location	**Passing Bay Location**
In Private Land	On Road



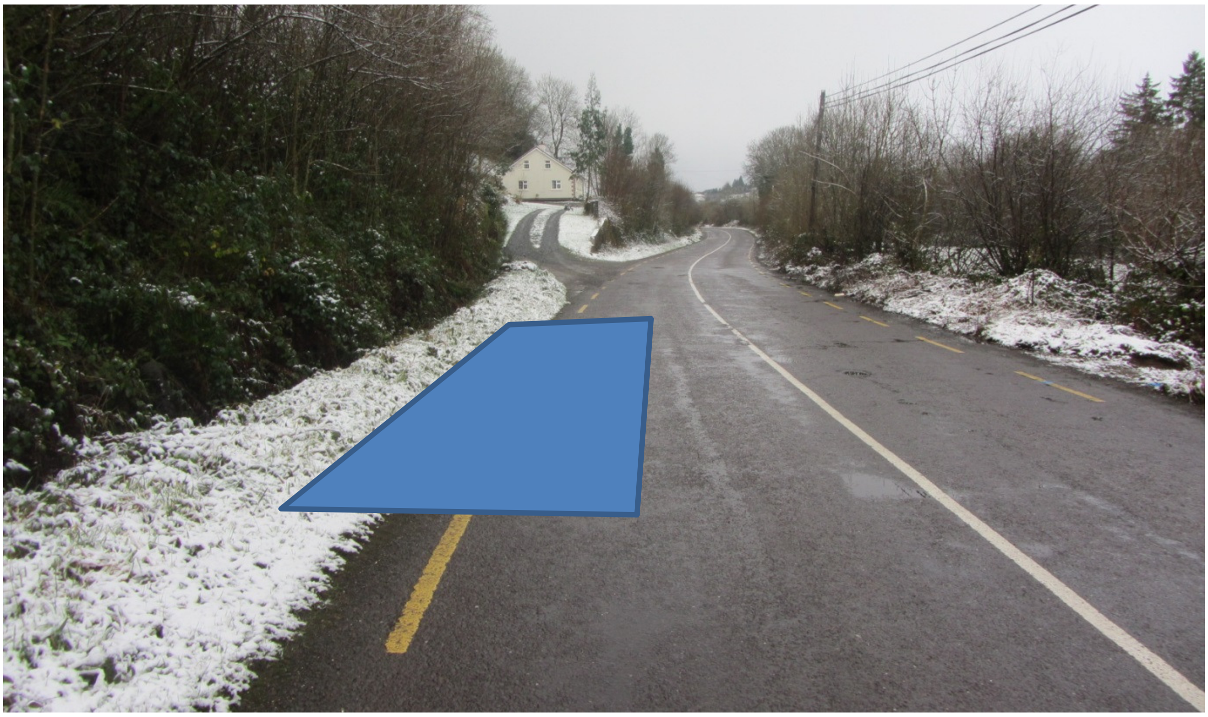
JB 15 Location	**Passing Bay Location**
In Private Land/Margin	On road



JB 16 Location	**Passing Bay Location**
In Road/margin	On Road

JB 17 Location	Passing Bay Location
In Private Land	On road

JB 18 Location	Passing Bay Location
In Private Land/Margin	On road



JB 19 Location	Passing Bay Location
In Road	On road

JB 20 Location	Passing Bay Location
In Road	On road

JB 21 Location	**Passing Bay Location**
In Road	On road

JB 22 Location	**Passing Bay Location**
In Road	On road

JB 23 Location	Passing Bay Location
In Road	On road

JB 24 Location	Passing Bay Location
In Road	On road/margin

JB 25 Location	Passing Bay Location
In Road	On road

JB 26 Location	Passing Bay Location
In Road	On road & Private Land

JB 27 Location	Passing Bay Location
In Road	In Private Land

JB 28 Location	Passing Bay Location
In Road	On Private Land

JB 29 Location	Passing Bay Location
In Margin / Private Land	On road

JB 30 Location	Passing Bay Location
In Margin / Private land	On road

JB 31 Location	Passing Bay Location
In Road	On road

JB 32 Location	Passing Bay Location
In Road	On hard Shoulder

JB 33 Location	Passing Bay Location
In Private Land	On road

JB 34 Location	Passing Bay Location
In Road	In Private Land

JB 35 Location	**Passing Bay Location**
In Private Land	On road

JB 36 Location	**Passing Bay Location**
In Road	On Private land

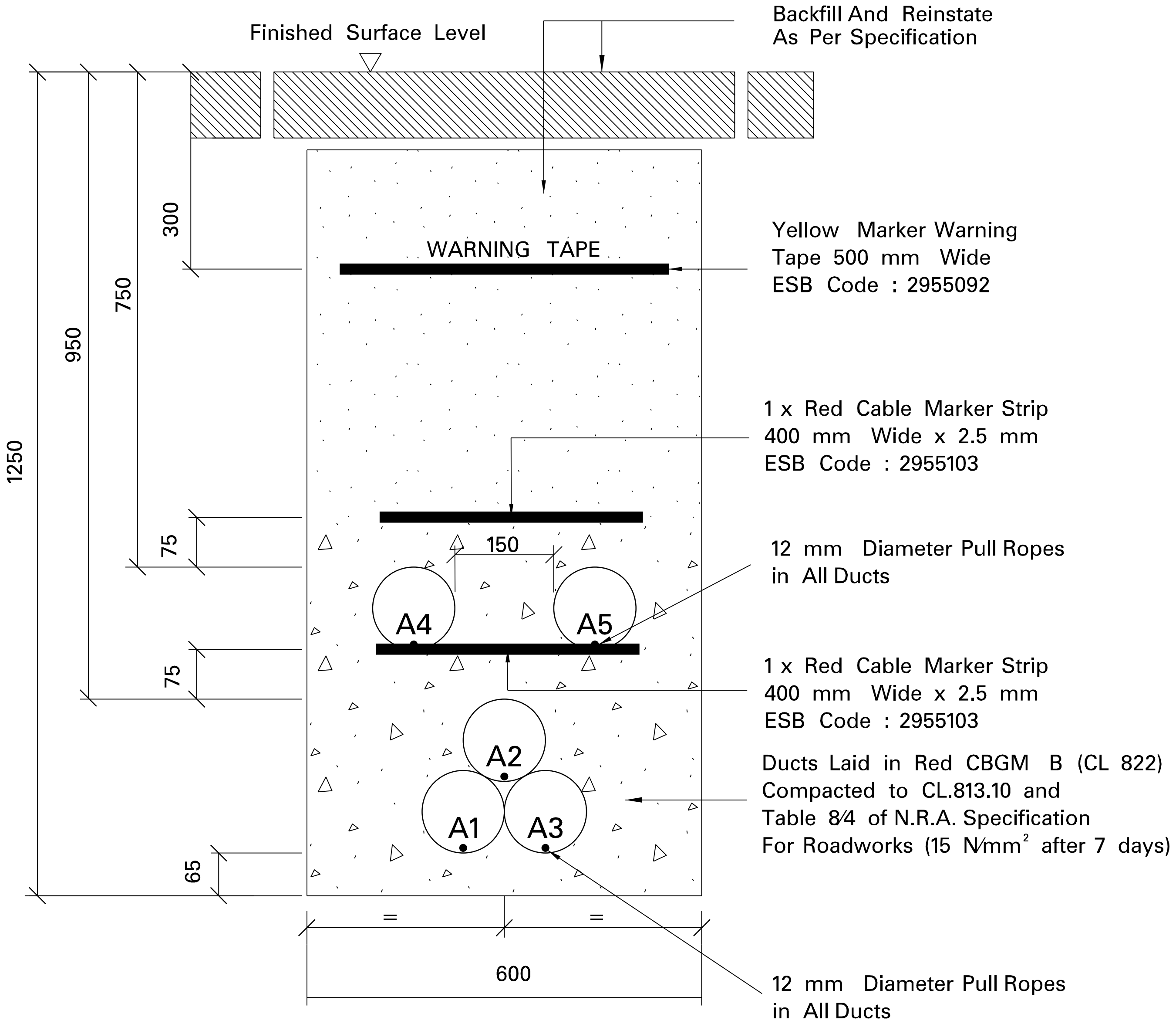
JB 37 Location	Passing Bay Location
In Private Land	On Road

JB 38 Location	Passing Bay Location
In Road	On private Land

JB 39 Location	Passing Bay Location
In Road	On Private Land

Annex B

Trench Cross Section



A=125 mm: Outer Diameter HDPE ESB Approved Duct, SDR=17.6, ESB Code : 9317552

All Dimensions in Millimetres

Note:
The Contractor shall provide test certificates confirming that the thermal resistivity of CBGM B is maximum 1 K.m/W

ESB INTERNATIONAL

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Email: marketing@esbi.ie **Web:** www.esbi.ie
ESB International is a trading name of ESBI Engineering & Facility Management Limited.
Registered Office: as above **Registered in Ireland No.** 155249

Rev	Date	Revision Description	Drn	Prod	Ver	App
9	08/14	ESB warning tape type revised	—	—	—	—
8	06/13	Bedding and surround revised to Red CBGM B	RD	RD	MA	RD
7	02/13	Backfill material revised + general revision	RD	RD	MA	RD
6	10/11	New revision	JD	JD	JD	JD
5	4/11	Trench width changed to 600 mm	JM	JM	JD	JD

Purpose of issue - Preliminary unless indicated
Tender ☐ Client Approval ☐ Construction ☐ As-built ☐ Revised ☐

Drawn	Produced	Verified	Approved	Approval date
J.Dillon	R.Doyle	E.Butler	T.Sheridan	22/08/2014

Client Ref: TC200007 | No. of Shts: 1/1 | Size: A4 | Scale: NTS

Drawing Number: PE424-D7001-001-003-009 (SHEET 003, REV 009)

Client: ESB NETWORKS

Project: HV Cables Standards

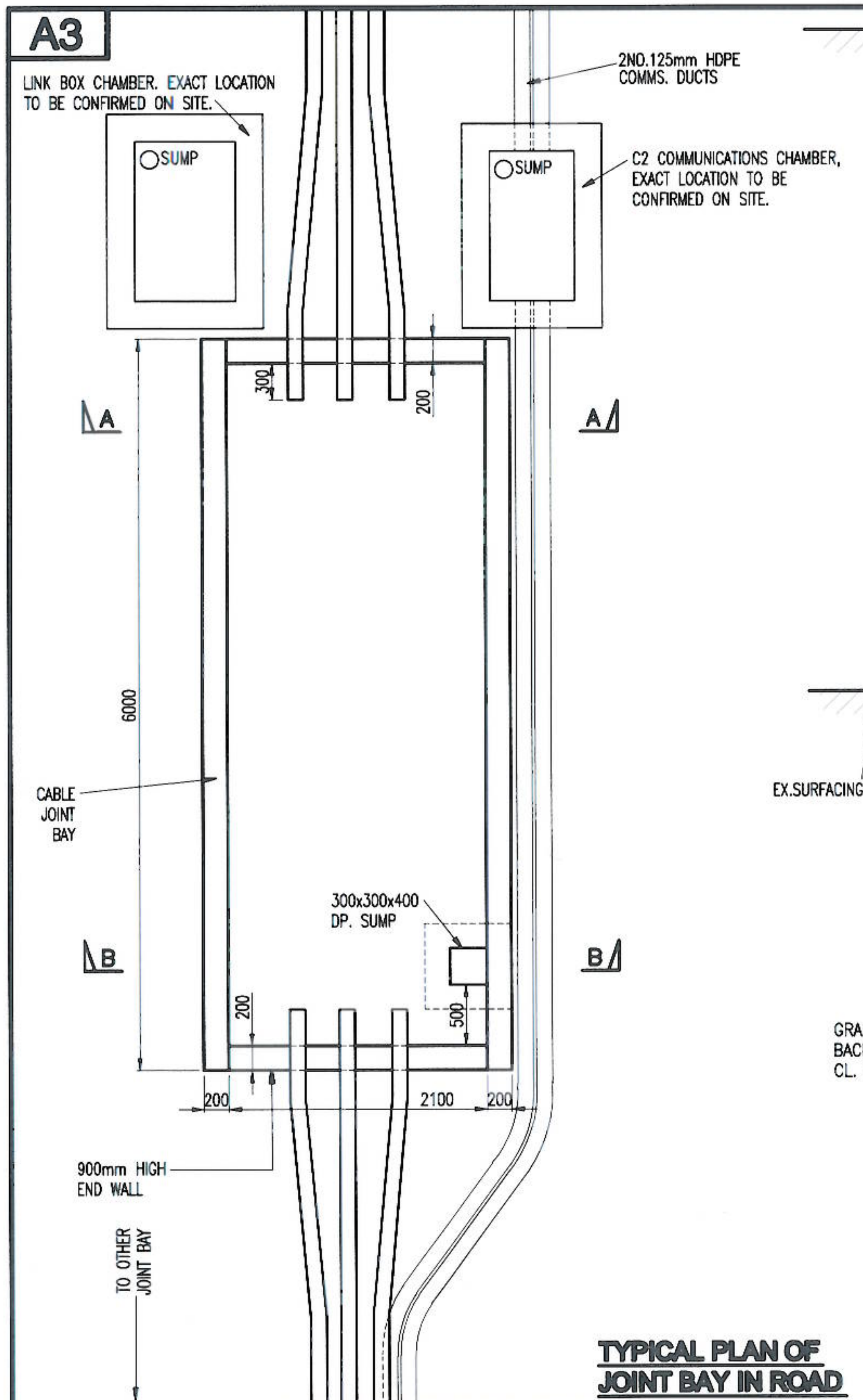
Drawing Title: TRENCH CROSS SECTION
110 kV SINGLE CIRCUIT
TREFOIL 5 WAY DUCT FORMATION

Contract: CABLE SERVICES TO ESB

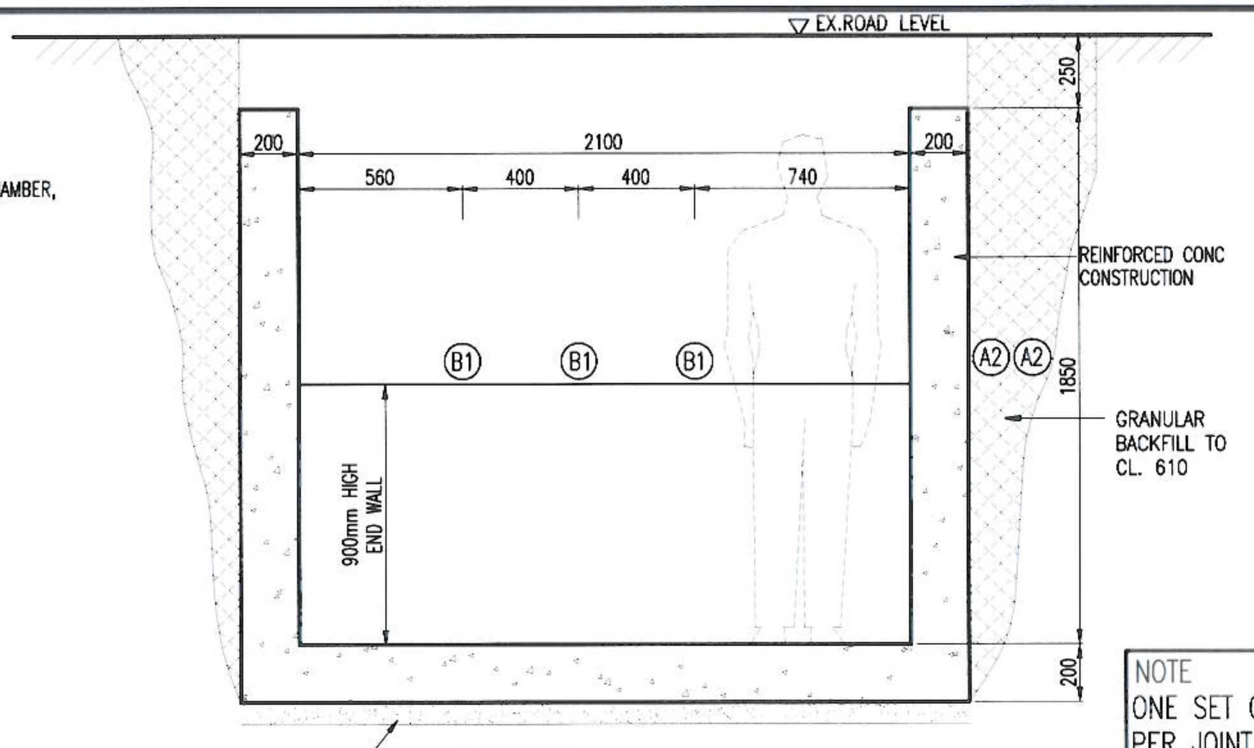
Production Unit: High Voltage Engineering

Annex C

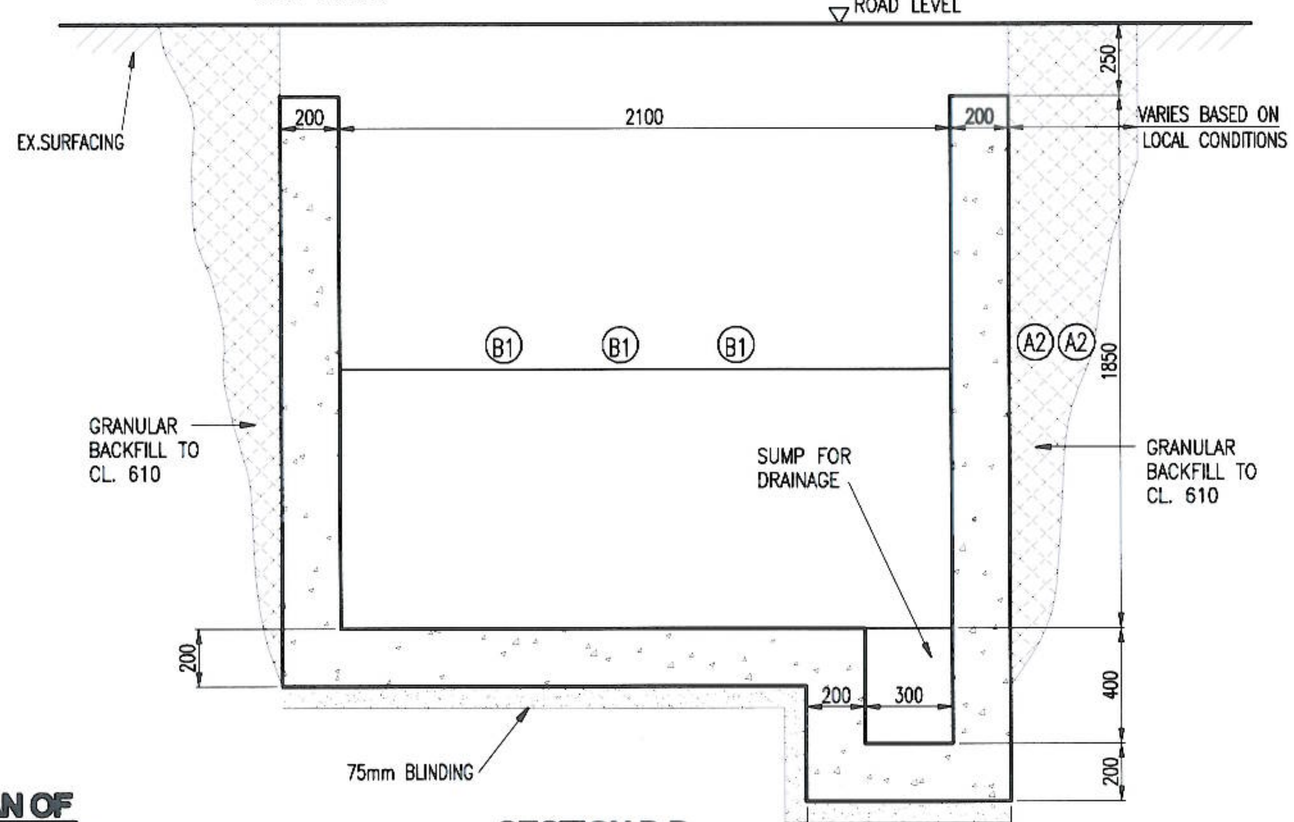
Cast in - Situ Joint Bay General Arrangement



TYPICAL PLAN OF JOINT BAY IN ROAD



SECTION A-A



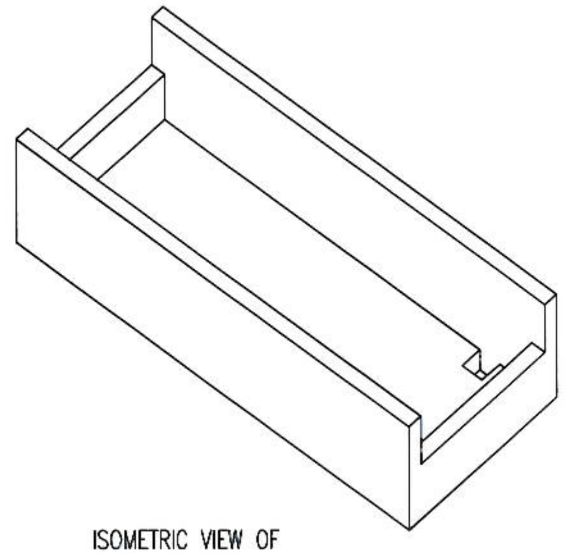
SECTION B-B

NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEER'S, ARCHITECT'S AND ESBI DRAWINGS & SPECIFICATIONS.
2. ALL DIMENSIONS ARE IN mm.
3. DO NOT SCALE DIMENSIONS.
4. THE CONTRACTOR SHALL CHECK ALL DIMENSIONS PRIOR TO CONSTRUCTION, ANY DISCREPANCIES TO BE NOTIFIED TO THIS OFFICE IN WRITING IMMEDIATELY.
5. CONCRETE GRADE C28/35.
6. CONCRETE COVER TO REINFORCEMENT TO BE 40mm.

NOTE
ONE SET OF DUCTS PER JOINT BAY

A2=125mm DIA HDPE DUCT (COMMS)
B1=125mm DIA. HDPE DUCT (110kV)
B1=200mm DIA. HDPE DUCT (220kV)



ISOMETRIC VIEW OF JOINT BAY

Rev.	Date	Revision description	Drn.	Prod.	Ver.	App.
1	18.11.11	DEPTH OF PIT INCREASED & MINOR REVISIONS	CJ	MA	TS	JD
0		ISSUED FOR —	AB	AB	AB	AB

Purpose of issue - Preliminary unless indicated
Tender ☐ Client approval ☐ Construction ☐ As-built ☐ Revised ☐

International
ESBI Energy Innovation

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Email: marketing@esbi.ie Web: www.esbi.ie
ESBI Engineering Solutions is a trading name of ESBI Engineering & Facility Management Limited.
Registered Office: as above Registered in Ireland No. 155249

Client

Project: HV Cables Standards

Contract: HV CABLES STANDARDS

Drawing title: GENERAL ARRANGEMENT OF 6m x 2.5m JOINT BAY

Production unit: Civil & Structural Engineering

Drawn	Produced	Verified	Approved	Approved date
C.Jordan	M.Amst	T.Sheridan	J.Daly	30/11/2011

Client ref.	No. of sheets	Size	Scale
TC201191	5	A3	N.T.S

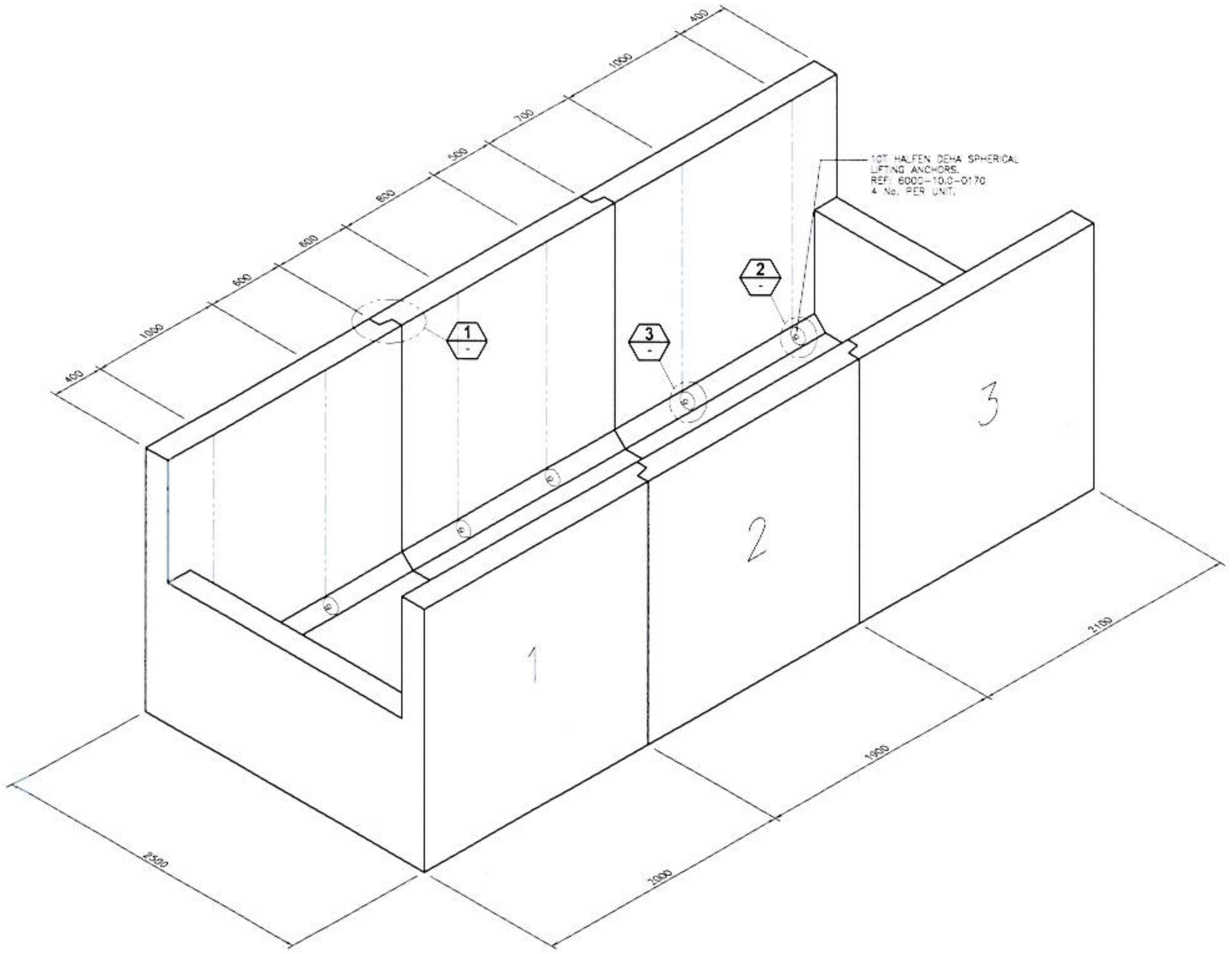
Drawing number: PE424-D7001-008-002-001

BF-DRG-013-004-001

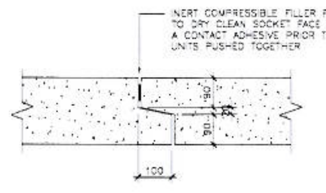
\\virtapp172s\am\vault.d-high voltage\drawings\pe424 hv cables\7001 - hv cables standards\pe424-d7001-008-002-001.dwg

Annex D

Pre – Cast Joint Bay Cross Section

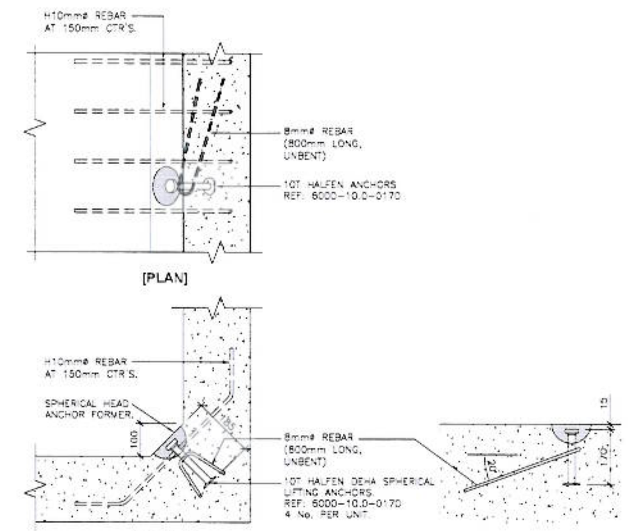


ISOMETRIC: JOINT BAY ARRANGEMENT
SCALE 1:25



DETAIL 1
SCALE 1:10

[TYPICAL SOCKET & SPIGOT DETAIL IN WALL & FLOOR]



DETAIL 2
SCALE 1:10

[LIFTING EYE DETAIL]
[DETAIL 3 HANDED]

GENERAL NOTES:

1. ALL PRECAST CONCRETE ELEMENTS TO BE MANUFACTURED TO B.S.EN 13369:2004 "COMMON RULES FOR PRECAST CONCRETE PRODUCTS".

2. LIFTING INSERTS TO BE DESIGNED & INSTALLED TO PD CEN/TR 15728:2008 "DESIGN AND USE OF INSERTS FOR LIFTING AND HANDLING OF PRECAST CONCRETE ELEMENTS".

3. SPECIFIED LIFTING INSERTS HAVE A S.W.L. OF 10 TONNE.

4. LOCATION & SPECIFICATION OF LIFTING INSERTS ARE ASSUMED TO FACILITATE DEMOULDING AND HANDLING IN PRECAST MANUFACTURING FACTORY. IT IS THE RESPONSIBILITY OF THE PRECAST MANUFACTURER TO NOTIFY THE ESBI ENGINEER IF THESE ARE UNSUITABLE FOR HIS MANUFACTURING METHODOLOGY. ESBI ENGINEER TO BE INFORMED OF ANY ALTERNATIVE LIFTING LOCATIONS FOR FACTORY HANDLING & DEMOULDING.

5. CONCRETE TO HAVE A MINIMUM STRENGTH OF 30 N/mm² PRIOR TO HANDLING OR DEMOULDING.

6. MAIN CONTRACTOR TO ENSURE THAT A METHOD STATEMENT AND RISK ASSESSMENT INCLUDING A LIFTING PLAN, IS PRODUCED FOR INSTALLATION AND ARE AVAILABLE TO ESBI ENGINEER FOR REVIEW IF REQUESTED. LIFTING PLAN TO INCORPORATE REQUIREMENTS OF LIFTING INSERTS AND LIFTING LOOP EYES.

7. A MINIMUM LIFTING SLING ANGLE OF 50° TO THE HORIZONTAL IS REQUIRED.

8. A LIFTING SYSTEM WHICH ENSURES ALL LIFTING POINTS TAKE ON AN EQUAL LOAD IS REQUIRED.

9. HALFEN DEHA SPHERICAL LIFTING ANCHORS TO BE USED AS SPECIFIED. ANY DEVIATION FROM THIS MUST BE NOTIFIED TO ESBI ENGINEER BY PRECAST MANUFACTURER. LIFTING INSERTS TO BE INSTALLED AS PER MANUFACTURER'S GUIDELINES AND IN ACCORDANCE WITH PD CEN/TR 15728:2008.

10. FORMWORK FOR PRECASTING TO BE OF A MINIMUM STANDARD OF VARNISHED WOODEN MOULD WITH PLANED BOARDS.

11. COVER TO REINFORCEMENT TO BE 40mm.

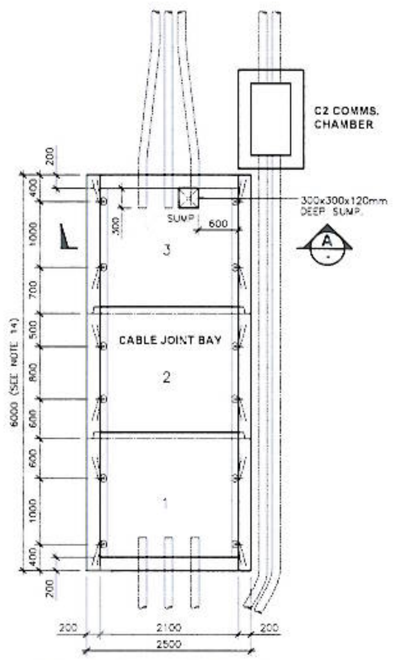
12. CONCRETE TO BE GRADE C30/37 AS SPECIFIED IN TABLE 1.

13. ALL CONCRETE TO BE IN ACCORDANCE WITH I.S. EN 206-1: 2002 WITH THE MIX DESIGNS SHOWN IN TABLE 1.

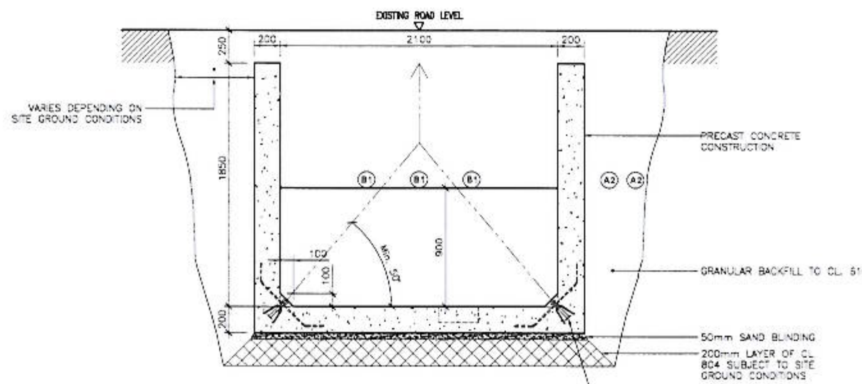
14. FOR 7.9 m JOINT BAY INSERT 1 No. ADDITIONAL PRECAST SECTION 2. FOR 9.8 m JOINT BAY INSERT 2 No. ADDITIONAL PRECAST SECTIONS 2

REFERENCE DRAWINGS

SECTION No. 1 : PE424-D7001-003-003-003
SECTION No. 2 : PE424-D7001-003-004-003
SECTION No. 3 : PE424-D7001-003-005-003



TYPICAL PLAN OF JOINT BAY
SCALE 1:50



SECTION A
SCALE 1:25

(A2) ø125mm HDPE DUCT (COMMS)
(B1) ø125mm HDPE DUCT (110kV ≤ 1000mm sq CONDUCTOR)
(B1) ø200mm HDPE DUCT (220kV AND 110kV > 1000mm sq CONDUCTOR)

TABLE 1

CONCRETE SPECIFICATION TO I.S. EN 206-1				
	BLINDING & MASS CONCRETE, DRAINAGE PIPE & MANHOLE SURROUNDS	FOUNDATIONS & WALLS	INTERNAL SLABS	EXTERNAL SLABS
EXPOSURE CLASS	X0	XC2	XC1	XC4
MIN. CEMENT CONTENT (kg/m³)	240	300	300	320
MAX. WATER/CEMENT RATIO	-	0.60	0.60	0.55
CEMENT TYPE TO I.S. EN 197-1	CEM 1 N	CEM 1 N	CEM 1 N	CEM 1 N
CHLORIDE CONTENT CLASS	CL 1,0	CL 0,40	CL 0,40	Cl 0,40
MAX. AGGREGATE (mm)	10	20	20	20
MIN. COVER (CMin) (mm)	-	40	30	40
*COMPRESSIVE STRENGTH CLASS	C16/20	C30/37	C28/35	C30/37

NOTES: 1. *C16/20 to be read as follows: 16 - Refers to min. characteristic cylinder strength (N/mm²). 20 - Refers to min. characteristic cube strength (N/mm²).
2. Design working life to be 50 years minimum.

REV.	DATE	REVISION DESCRIPTION	DRN	PROD	VER	APP
4	25.07	NOTE 14	PO'L	RS	TS	MA
3	01.12	ANCHOR DETAILS & DIMS REVISED.	CJ	RS	TS	MA
2	04.08	NEW REVISION	JD	JD	KC	JD
1	02.09	NEW REVISION	JD	JD	KC	JD

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED
TENDER ☐ CLIENT APPROVAL ☐ CONSTRUCTION ☐ AS-BUILT ☐ REVISED ☐

Client: ESB NETWORKS

Project: HV Cables Standards

Contract: CABLES SERVICES TO ESB

Drawing Title: PRECAST JOINT BAY 110kV & 220kV GENERAL ARRANGEMENT AND DETAILS

Production Unit: Civil, Building & Environmental

ESB International

ESBI Engineering Solutions, Stephen Court, 18-21 St. Stephen's Green, Dublin 2, Ireland. Tel: +353 (0)1 703 8000 Fax: +353 (0)1 703 7186 Email: marketing@esbi.ie Web: www.esbi.ie

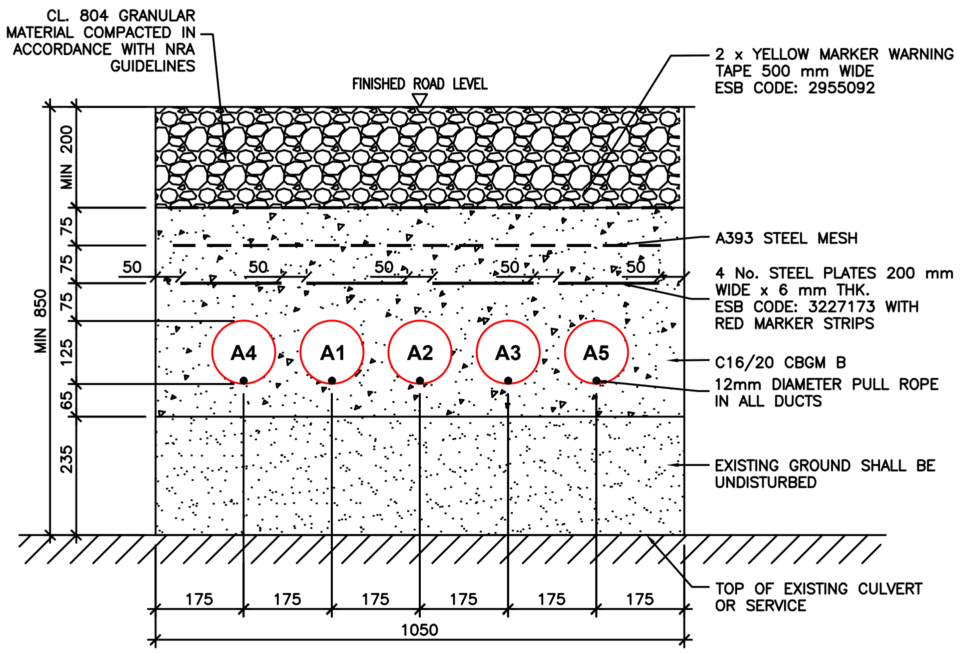
DRAWN	PRODUCED	VERIFIED	APPROVED	APPR DATE
P.O'Loughlan	P.O'Loughlan	T.Sheridan	M.Arnel	28/07/2014

CLIENT REF: TC200024 — REVISION: 6 — SIZE: A1 — SCALE: As Shown

DRAWING NUMBER: PE424-D7001-003-002-004

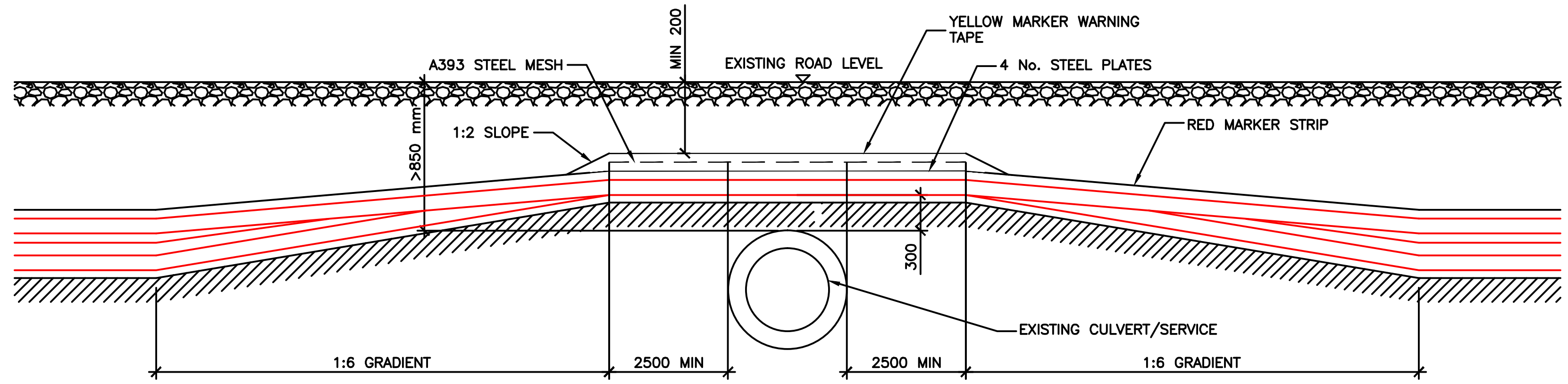
Annex E

Typical Trench Cross Section for Crossing Over Culverts or Services.

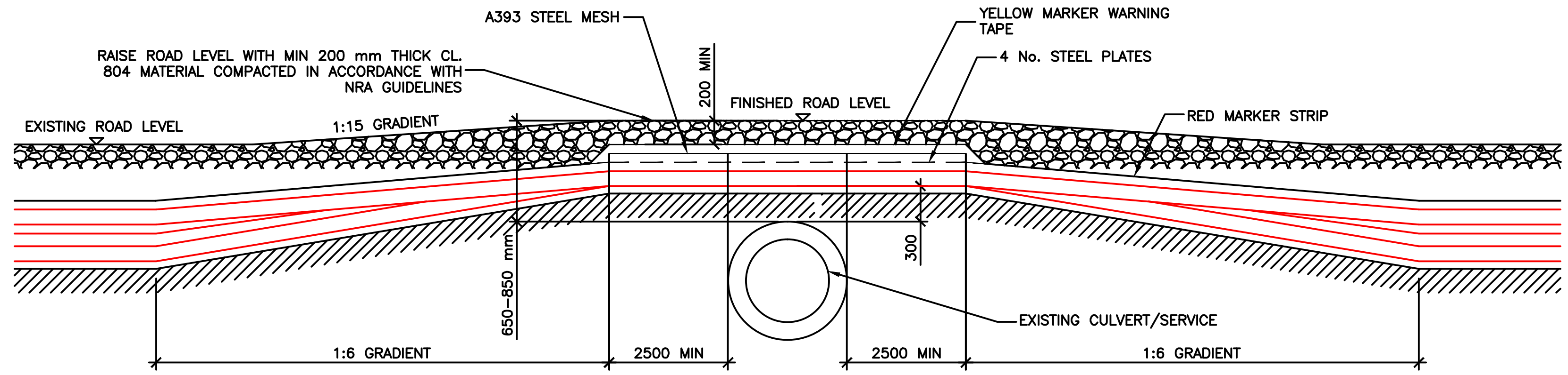


TYPICAL CROSS SECTION AT CULVERT CROSSING / SERVICE

NOTE:
1. REFER TO DRAWING PE424–D7001–001–003 (LATEST REVISION) FOR TYPICAL TRENCH CROSS SECTION DETAIL.
2. HAND DIG ONLY WITHIN 500 mm OF EXISTING CULVERT/SERVICE.
3. WHERE THE DEPTH TO COVER OF THE EXISTING CULVERT/SERVICE IS 650 mm TO 850 mm, THE FINISHED ROAD LEVEL SHALL BE RAISED WITH CL. 804 GRANULAR MATERIAL COMPACTED IN ACCORDANCE WITH NRA GUIDELINES. THE FINISHED ROAD LEVEL SHALL PROVIDE A MIN 200 mm COVER TO THE TOP OF CBGM B.
4. IF COMPACTING CBGM B COULD CAUSE DAMAGE TO THE CULVERT/SERVICE BELOW, RAPID HARDENING WET CONCRETE OF EQUAL STRENGTH SHALL BE UTILISED FOLLOWING ENGINEERS' PRIOR APPROVAL.
5. ALL CULVERTS/SERVICES SHALL BE SUPPORTED, SAFEGUARDED AND PROTECTED.



TYPICAL LONGITUDINAL SECTION AT CULVERT/SERVICE CROSSING



TYPICAL LONGITUDINAL SECTION AT CULVERT/SERVICE CROSSING WITH RAISED ROAD LEVEL

Rev	Date	Revision description	Drn.	Prod	Ver.	App
0	17.02.15	ISSUED FOR PLANNING				

Purpose of issue - Preliminary unless indicated

Tender ☐ Client approval ☒ Construction ☐ As-built ☐ Revised ☐

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Client: ESB WIND DEVELOPMENT

Project: BALLYVOUSKILL - COOMATAGGART

Contract: BALLYVOUSKILL - COOMATAGGART 110 kV CABLE

Drawing title: TREFOIL 5 WAY DUCT FORMATION 110 kV SINGLE CIRCUIT TYPICAL TRENCH CROSS SECTION FOR CROSSING OVER CULVERTS OR SERVICES

Production unit: Civil Building and Environmental

Drawn	Produced	Verified	Approved	Approved date
S.Rugero	S.Rugero	B.Allen	M.Hogan	27/02/2015

Client ref.	No. of sheets	Size	Scale
TC213825	1	A3	N/A

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