OUTLINE CONSTRUCTION METHODOLOGY

Proposed Grangeford Solar PV Farm and Battery Storage System, 110kV Grid Connection

Document No: 05967-R02-02

Client: PRT Solar Limited c/o Malone O Regan

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1.0 Introduction

The purpose of this document is to outline and explain the construction techniques and methodologies which will be implemented during the construction of the proposed Grangeford Solar Farm 110kV grid connection to the Kellis 220kV Substation, Kellistown, Co. Carlow. The 110kV grid connection route will consist entirely of underground cables (UGC) which will be installed in the public road network and private lands.

The UGC works will consist of the installation of 6 No. ducts in an excavated trench to accommodate 3 No. power cables, 1 No. fibre communications cable to allow communications between the Grangeford Solar Farm Substation (Moanalow 110kV Substation) and Kellis 220kV substation 1 No. spare fibre communications cable and 1 No. earth continuity duct.

This document is intended to be used as an aid to understand the methodologies to be employed during construction. In addition, this document is in outline form only and will be revised and updated before the commencement of any construction activities. Detailed Method Statements will be prepared in respect of each aspect of the proposed development.

2.0 Grid Connection and Substation

2.1 Grid Connection Route

The grid connection utilises UGC with a route length of approximately 7.9 km in total. A UGC will exit the Kellis 220kV Substation Compound and turns south-west onto the L-30535. The UGC then turns south-east onto the L-3053 for 500 m before entering the L-3046, at the Kellistown Cross Roads, and thereafter veering north-east.
Close to Rathoe Village, the UGC route encounters Rathoe Bridge. This is a multiple arch bridge spanning the river Burren. It is proposed to utilise Horizontal Directional Drilling (HDD) method to cross beneath the bridge within the public road boundaries. After, Rathoe Bridge, the UGC continues along L-1024.
At Rathoe village the UGC turns north on the L-6113. On the L6113, the UGC route encounters two stone built bridges. The first is at Kellistown East on a tributary of the Burren River and the second in Rathnashannagh on the Aghalona River. It is proposed to utilise Horizontal Directional Drilling (HDD) method to traverse the bridges in both cases, within the curtilage of the road.
The UGC continues on the L-6113 before turning west onto the R725. At Grangeford Old, approximately 500 m along the R725 the UGC turns north-west into a private access route toward the solar farm substation which is approximately 1 km north of the R725 at Grangeford Old.

The exact location of the UGC will be determined following a further detailed assessment to be undertaken before construction and following consultation with Carlow County Council and all other relevant stakeholders, having regard for all environmental protection measures required.

Table 1 shown below gives a summary of the route composition and location. Figure 1 shows the grid connection route. The route is split into two sections and examined in detail in **Table 2**

Table 1 – UGC Route Location Summary			
Solar Farm Site	**Private Land**	**Public Road**	**Total**
975 m	0 m	6900 m	7875 m

Table 1: Kellis 220kV Substation to Grangeford 110kV Substation – UGC Route Location Summary

Figure 1 - Proposed Grid Connection Route

Table 2 below describes the specific construction features along the routes described above and identifies access routes to the work areas. All plant and equipment employed on the proposed works will be subject to good site organisation and hygiene, particularly during construction activities.

Table 2 - Summary of Features along Grid Connection Design Route	
Section	**Description**
110kV UGC Route **Section 1** **3750m**	**Kellis 220kV Substation to the townland of Inchisland** A UGC will exit the Kellis 220kV Substation Compound and turn south-west onto the L-30535. The UGC then turns south-east onto the L-3053 for 500 m before entering the L-3046, at the Kellistown Cross Roads, and thereafter veering north-east. Close to Rathoe Village, the UGC route encounters Rathoe Bridge. This is a multiple arch bridge spanning the river Burren. It is proposed to utilise Horizontal Directional Drilling (HDD) method to cross beneath the bridge within the public road boundaries. After, Rathoe Bridge, the UGC continues along L-1024. At Rathoe village the UGC turns north on the L-6113. On the L6113, the UGC route encounters a stone built bridge located at Kellistown East on a tributary of the Burren River. It is proposed to utilise Horizontal Directional Drilling (HDD) method to traverse this bridge, within the curtilage of the road. **Features** This section contains 6 No. joint bays. The Joint Bays will be located below ground and finished within the existing carriageway and reinstated as per Purple Book specifications whilst adhering to the ESBN functional specification. Every joint bay will have an associated communication chamber which will have a surface access hatch that will match existing ground levels. The location of the joint bay is shown on the Site Layout Plans. • Joint Bay 01 (JB-01) will be located at the entrance of Kellis 220kV Substation compound within ESB property. • Joint Bay 02 (JB-02) will be located approx. 525m subsequent to the location of JB-01. It is proposed that this Joint Bay will be installed within the L-3053. • Joint Bay 03 (JB-03) will be located approx. 710m subsequent to the location of JB-02. It is proposed that this Joint Bay will be installed within the L-3046. • Joint Bay 04 (JB-04) will be located approx. 715m subsequent to the location of JB-03. It is proposed that this Joint Bay will be installed within the L-3046. • Joint Bay 05 (JB-05) will be located approx. 700m subsequent to the location of JB-04. It is proposed that this Joint Bay will be installed within the L-6113. • Joint Bay 06 (JB-06) will be located approx. 825m subsequent to the location of JB-05. It is proposed that this Joint Bay will be installed within the L-6113. This section of the route contains **2 No. HDD Crossings**. The UGC encounters the Rathoe Bridge (Bridge 1 in drawings) on the L- 3046 between JB04 and JB05. This is a large stone built bridge, with tripe arch substructure, spanning the Burren River. It is proposed to utilise Horizontal Directional Drilling (HDD) method to cross beneath the river and bridge structure. It will be necessary to cross this bridge using HDD as there is insufficient cover within the bridge deck to facilitate the power and communication duct while maintaining sufficient cover over the ducts (450mm cover required). See drawing 05967-DR-130 for reference.

	The UGC encounters a second bridge (Bridge 2 in drawings) at Kellistown East on the L-6113 between JB05 and JB06. This is a small stone built bridge with a single arch substructure, spanning a tributary of the Burren River. It is proposed to utilise Horizontal Directional Drilling (HDD) method to cross beneath the river and bridge structure. It will be necessary to cross this bridge using HDD as there is insufficient cover within the bridge deck to facilitate the power and communication duct while maintaining sufficient cover over the ducts (450mm cover required). See drawing 05967-DR-131 for reference. **Section 1** of route is shown in Site Layout Plan Drawings 05967-DR-101,102.
110kV UGC Route **Section 2** **4125m**	**Inchisland to Moanalow 110kV Substation** Section 2 of this route begins at Inchisland on the L-6113. There is a small stone built bridge,at Inchisland on the Agahalona River, between joint bay 06 and joint bay 07. A HDD method will be employed to cross beneath this bridge. The UGC continues on the L-6113 before turning west onto the R725. At Grangeford Old, approximately 500 m along the R725 the UGC turns north-west into a private access route toward the solar farm substation which is approximately 975m within the solar farm boundary. **Features** This section contains 5 No. joint bays. The Joint Bays will be located below ground and finished/reinstated to the specification of the required road. Each joint bay will have an associated link box chamber which will have a surface access hatch that will match existing ground levels. The location of the joint bay is shown on the Site Layout Plans. • Joint Bay 07 (JB-07) will be located approx. 815m subsequent to the location of JB-06. It is proposed that this Joint Bay will be installed within the road L-6113. • Joint Bay 08 (JB-08) will be located approx. 825m subsequent to the location of JB-07. It is proposed that this Joint Bay will be installed within the road L-6113. • Joint Bay 09 (JB-09) will be located approx. 770m subsequent to the location of JB-08. It is proposed that this Joint Bay will be installed within the road L-6113. • Joint Bay 10 (JB-10) will be located approx. 775m subsequent to the location of JB-09. It is proposed that this Joint Bay will be installed within the road R-725. • Joint Bay 11 (JB-11) will be located approx. 765m subsequent to the location of JB-10. It is proposed that this Joint Bay will be installed within a private access path at Grangeford Solar Farm. This section of route contains **1 No. HDD Crossing**. The UGC encounters a Bridge watercrossing on the L-6113 between JB06 and JB07, on the Aghalona River. This is a Bridge (Bridge 3 in drawings) with stone built arch. It is proposed to utilise Horizontal Directional Drilling (HDD) method to cross beneath the waterway and bridge structure. It will be necessary to cross this bridge using HDD as there is insufficient cover within the bridge deck to facilitate the power and communication duct while maintaining sufficient cover over the ducts (450mm cover required). See drawing 05967-DR-132 for reference. **Section 2** of route is shown in Site Layout Plan Drawings 05967-DR-102,103,104.

Table 2: Summary of Features along Grid Connection Design Routes

2.2 Proposed Moanalow 110kV Substation

Moanalow 110kV Substation at Grangeford Old, Co Carlow will connect to the electricity grid by means of a tail fed connection to Kellis 220kV Substation located approximately 8km southwest of Moanalow Substation. The Substation is designed to the very latest Eirgrid Standard comprising a 110kV AIS 2 Bay Station extendable to 4 Bay and 8 Bay configuration. Eirgrid recommends this design as it facilitates future expansion and improving the overall availability of renewable energy on the grid. This design optimises resources in the initial substation development and reduces the downtime and impact on the grid over its lifecycle thus facilitating future grid connections and improving the effectiveness of the substation. This substation design will improve the availability of customer renewable energy connections on the system and enhance the integration of renewable sources thus supporting the industry's collective goal of a sustainable energy future.

The proposed 110kV substation will be designed and constructed to meet all the required EirGrid standards. An area will be levelled and built to the required level with stone fill material, capped by high quality compacted stone. Two control buildings will be constructed using traditional techniques for constructing small buildings (i.e. concrete block walls, timber and slate tile roof). Foundations will be built for all of the proposed electrical infrastructure. All the electrical equipment will be installed to EirGrid requirements. Perimeter fencing will be constructed around the substation compound for security and safety purposes.

This substation will connect via UGC circuits to accommodate a grid connection to Kellis 220kV Substation. Moanalow 110kV Substation will be made up of 1 No. Control building, 1 No. Independent Power Producer (IPP) Medium Voltage (MV) Switch room, transformer compound and busbar compound.

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

The expected duration of works is expected to be approximately 12 months.

The following section outlines the methodology to be followed during construction works of the new Moanalow 110kV substation.

1. This new substation will be in a compound of circa 100.75m x 126.8m plan area secured by a 2.6m high palisade fence.
2. The substation compound and drainage will be marked out by a qualified engineer.
3. A drainage system will be excavated and installed around the compound area.
4. Topsoil and subsoil will be removed from the footprint of the compound using an excavator. The excavated material will be temporarily stored in adjacent berms for later use during reinstatement works.
5. A layer of geotextile material will be laid over the footprint of the compound.
6. Using an excavator, a base layer of Clause 804 material will be laid followed by a 6F2 capping layer which will provide the finished surface.
7. Each layer will be compacted using a vibrating roller.
8. Earthing cable will be laid underground around the substation for connection to the various electrical components during the electrical fit out phase.
9. The construction of a 12,861.7m² substation compound comprising of approximately 450m² single story 110kV substation control building, 300m² single story MV building and associated outdoor electrical

equipment, including 1 no. 33/110kV transformer, associated internal access road, including 2.6m high station perimeter fencing will be built.

10. Permanent access road will be constructed to allow site vehicular activity in and out of construction area.
11. Adequate lighting will be installed around the compound on the lighting masts within the compound.
12. 110kV cable sealing ends and associated accessories will be required to link the Moanalow to Kellis 110kV UGC into the substation. The support structures will be located outdoors.
13. Transformers will be installed in bunded enclosures within the substation compound.

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

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

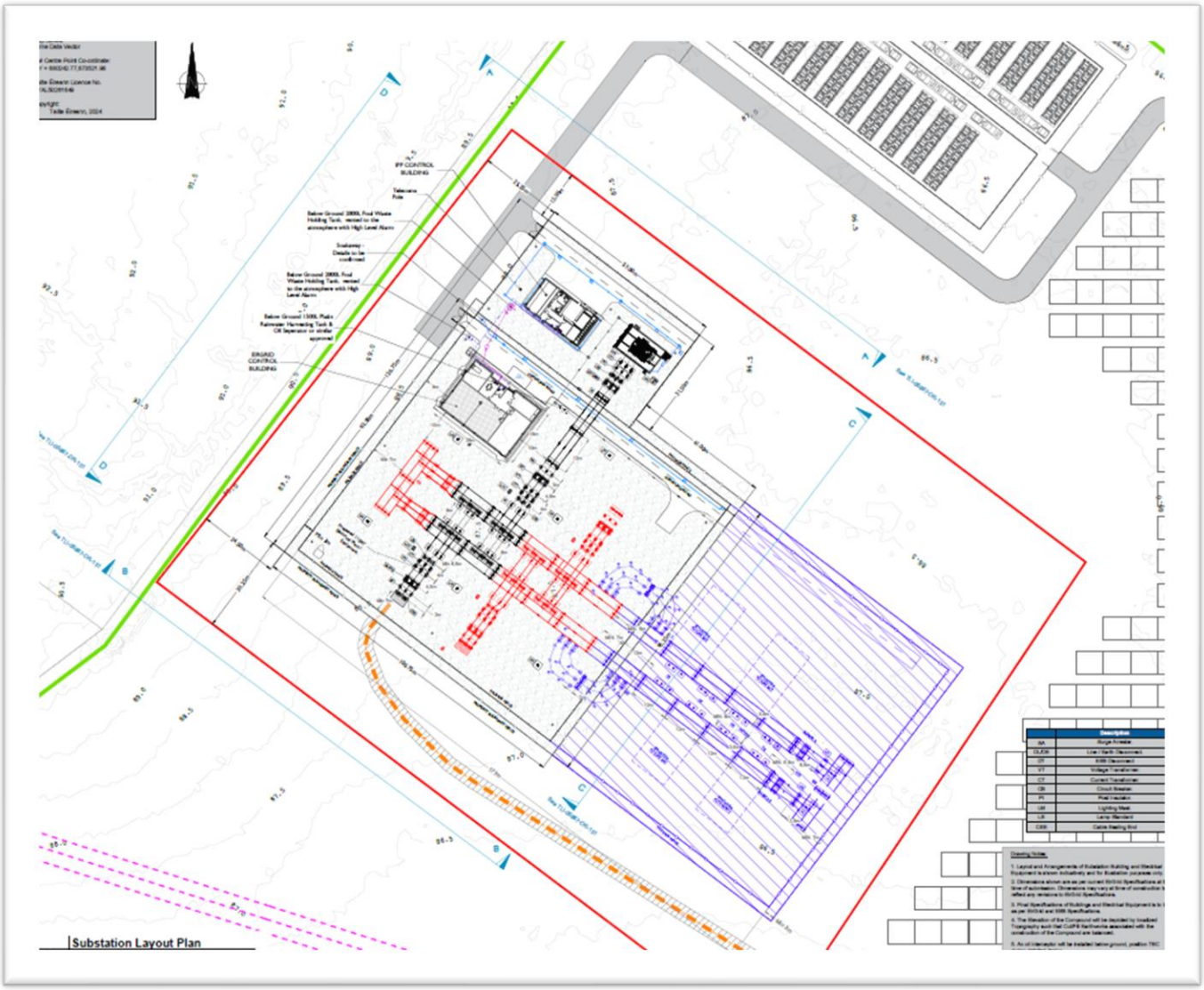

Figure 2 - Moanalow 110kV Substation

3.0 Preliminary Construction Considerations

3.1 Preliminary Works

It may be proposed to carry out Preliminary site investigations along the cable route before construction to confirm design assumptions.

The following items may be carried out:

Slit trenches at locations of major service crossings (Half road width).

Boreholes at specified HDD locations either side of obstacle to assert ground composition

7 No. trial holes along the route to ascertain ground conditions and thermal resistivity of the soil.

Traffic Management – Single road closure for public local road network.

Equipment:

- 4x4 vehicle
- Concrete vibrator
- Wheeled dumper
- Soil compactor
- 360° tracked excavator (only rubber-tracked machines will be allowed on public roads)

3.2 Access Routes to Work Area

The majority of the proposed underground cable will be installed within the public road network and therefore will be accessed via the existing road network. Where the cable route is located on private lands, such as at the solar farm, the contractor(s) will be required to access these from the local public road network in the vicinity of the work area and from there, traverse the consenting and permitted, predominantly within the permitted solar farm site.

A detailed Traffic Management Plan will accompany this planning application. In the event that planning consent is granted for the proposed development, the TMP will be updated prior to commencement of development to address the requirements of any relevant planning conditions, including any additional mitigation measures, which are conditioned and will be submitted to the planning authority for written approval.

Careful and considered local consultation has been carried out, to minimise the amount of disturbance caused during works. Prior to the commencement of construction, the contractor will assess all access routes and determine any additional access requirements which will be incorporated as part of the method statement. All plant and equipment employed during the proposed works (e.g. diggers, tracked machines, footwear etc.) will be inspected prior to arrival on site and on leaving site and cleaned where necessary to prevent the spread of invasive aquatic / riparian species.

3.3 Traffic Management

Traffic management and road signage will be in accordance with the Department of Transport: Traffic Signs Manual - Chapter 8: Temporary Traffic Measures and Signs for Road Works and in agreement with Carlow County Council. All work on public roads will be subject to the approval of a road opening license application. The contractor will prepare detailed traffic management plans for inclusion as part of the road opening applications. Where road widths allow, the UGC installation works will allow for one side of the road to be open to traffic at all times by means of a ‘Stop/Go’ type traffic management system, where a minimum 2.5m roadway will be maintained at all times. Where it is not possible to implement a ‘Stop/Go’ system a full road closure will be required. Temporary

traffic signals will be implemented to allow road users safely pass through the works area by channelling them onto the open side of the road. Typically, the UGC will be installed in 100m sections, and no more than 100m will be excavated without the majority of the previous section being reinstated. Where the construction requires the crossing of a road, works on one carriageway will be completed before the second carriageway is opened, to maintain traffic flows.

All construction vehicles will be parked within the works area so as not to cause additional obstruction or inconvenience to road users or residents. The traffic signals will be in place prior to the works commencing and will remain in place until after the works are completed. The public road will be checked regularly and maintained free of mud and debris. Road sweeping will be carried out as appropriate to ensure construction traffic does not adversely affect the local road condition.

In the event of emergency, steel plates, which will be available on site, can be put in place across the excavation to allow traffic to flow on both sides of the road.

All traffic management measures will comply with those outlined in the accompanying Traffic chapter of the EIAR and in the event that planning consent is granted for the proposed development, the TMP will be updated prior to commencement of development to address the requirements of any relevant planning conditions, including any additional mitigation measures, which are conditioned and will be submitted to the planning authority for written approval.

3.4 Road Opening Licences

The proposed underground grid connection works will require a road opening licence under Section 254 of the Planning and Development Act 2000-2015 from Carlow County Council. A Traffic Management Plan (TMP) will be agreed upon with Carlow County Council before the commencement of the development. In the event that planning consent is granted for the proposed development, the TMP will be updated prior to commencement of development to address the requirements of any relevant planning conditions, including any additional mitigation measures, which are conditioned and will be submitted to the planning authority for written approval.

The TMP will outline the location of traffic management signage, together with the location of any necessary road closures and the routing of appropriate diversions. Where diversions are required, these will be agreed with Carlow County Council in advance of the preparation of the TMP.

3.5 Construction Hours

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

4.0 UGC Construction Methodology

The UGC will consist of 3 No. 160mm diameter HDPE power cable ducts, 2 No. 125mm diameter HDPE communications duct and 1 no. 63mm diameter earth continuity duct to be installed in an excavated trench, typically 825mm wide by 1,315mm deep, with variations on this design to adapt to bridge crossings, service crossings and watercourse crossings, etc. The power cable ducts will accommodate 1 No. power cables per duct. The communications duct will accommodate a fibre cable to allow communications between the Grangeford Solar Farm Substation and Kellis 220kV substation. The inclusion 1 No. earth continuity conductor duct will also be required.

The ducts will be installed and the trench reinstated in accordance with the local road's authority within Carlow County Council where installed on public roads and reinstated in accordance with the landowner's requirements where installed on private lands. The installation of the electrical cabling/fibre cable will be pulled through in some sections. Construction methodologies to be implemented and materials to be used will ensure that the UGC is installed in accordance with the requirements of the Council and private landowners.

4.1 Trenching Methodology

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

- The Contractor, and their appointed Site Manager, will prepare a targeted Method Statement concisely outlining the construction methodology and incorporating all mitigation and control measures included within the planning application and accompanying reports and as required by planning conditions where relevant;
- All existing underground services shall be identified on site prior to the commencement of construction works;
- At watercourse crossings, the contractor will be required to adhere to the environmental control measures outlined within the planning application and accompanying reports, the detailed Construction Environmental Management Plan (CEMP),
- Where the cable route intersects with culverts, the culvert will remain in place (where possible) and the ducting will be installed either above or below the culvert to provide minimum separation distances in accordance with ESB and Irish Water specifications;
- In the event that culverts require removal for ducting installation, it is proposed that a suitable method of damming the water source and pumping the water around the work area would be set out in a method statement and agreed with the relevant stakeholders. Once the ducts are installed the culvert will be reinstated to match existing levels and dimensions. If works of this nature are required, the contractor will liaise with Inland Fisheries Ireland in advance of works;
- Traffic management measures will be implemented in accordance with those included in the Traffic Management chapter, and detailed Traffic Management Plan
- Excavated material will be temporarily stockpiled onsite for re-use during reinstatement. Stockpiles will be restricted to less than 2m in height. Stockpiles will be located a minimum of 50m from surface water features and all stockpiling locations will be subject to approval by the Site Manager and Project Ecological Clerk of Works (ECoW);
- Excavated material shall be employed to backfill the trench where appropriate and any surplus material will be transported off site and disposed at a fully authorised soil recovery site;
- Any earthen (sod) banks to be excavated will be carefully opened with the surface sods being stored separately and maintained for use during reinstatement;

- The excavated trench will be dewatered if required, from a sump installed within the low section of the opened trench. Where dewatering is required, dirty water will be fully and appropriately attenuated, through silt bags, before being appropriately discharged to vegetation or surface water drainage feature;
- Where required, grass will be reinstated by either seeding or by replacing with grass turves;
- No more than a 100m section of trench will be opened at any one time. The second 100m will only be excavated once the majority of reinstatement has been completed on the first;
- The excavation, installation and reinstatement process will take on average of 1 no. day to complete a 100m section;
- Where the cable is being installed in a roadway, temporary reinstatement may be provided to allow larger sections of road to be permanently reinstated together;
- Following the installation of ducting, pulling the cable will take approximately 1 no. day between each joint bay, with the jointing of cables taking approximately 1 week per joint bay location.

Figure 3 - 110kV Underground Duct Installation

4.2 Ducting Installation Methodology

Trenching and ducting works, shall employ the following step by step methodology:

1. Grade, smooth and trim trench floor when the required 1315mm depth and 825mm width have been obtained.
2. Place bedding layer of Cement Bound Granular Mixture B (CBGM B) material in accordance with the specification and compact it so that the compacted thickness is as per the drawings.
3. Lay the bottom row of ducts in trefoil formation as detailed on the design drawings. Use spacers as appropriate to establish horizontal duct spacing. Fit a secure cap / bung to the end of each duct run to prevent the ingress of dirt or water.
4. Carefully surround and cover ducts with CBGM B in accordance with the design drawings and specifications and thoroughly compact without damaging ducts.
5. Place cable protection strips on compacted CBGM B directly over the ducts.
6. Lay the top row of ducts onto the freshly compacted CBGM B including the cable protection strips above the bottom row of ducts. Place a secure cap at the end of each duct to prevent the ingress of dirt or water.

7. Carefully surround and cover ducts with CBGM B material in accordance with the drawings and thoroughly compact without damaging ducts.
8. Place red cable protection strip on top of compacted CBGM B over each set of ducts as shown on the drawings.
9. Place and thoroughly compact CBGM B material or Clause 804 backfill or soil backfill as specified and place warning tape at the depth shown on the drawings.
10. For 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.
11. Clean and test the ducts in accordance with the specification by pulling through a brush and mandrel. Install 12 mm polypropylene draw rope in each duct and seal all ducts using robust duct end seals fitted with rope attachment eyes in preparation for cable installation at a later date. All the works should be witnessed by ESBN Clerk of Works (CoW) as required.

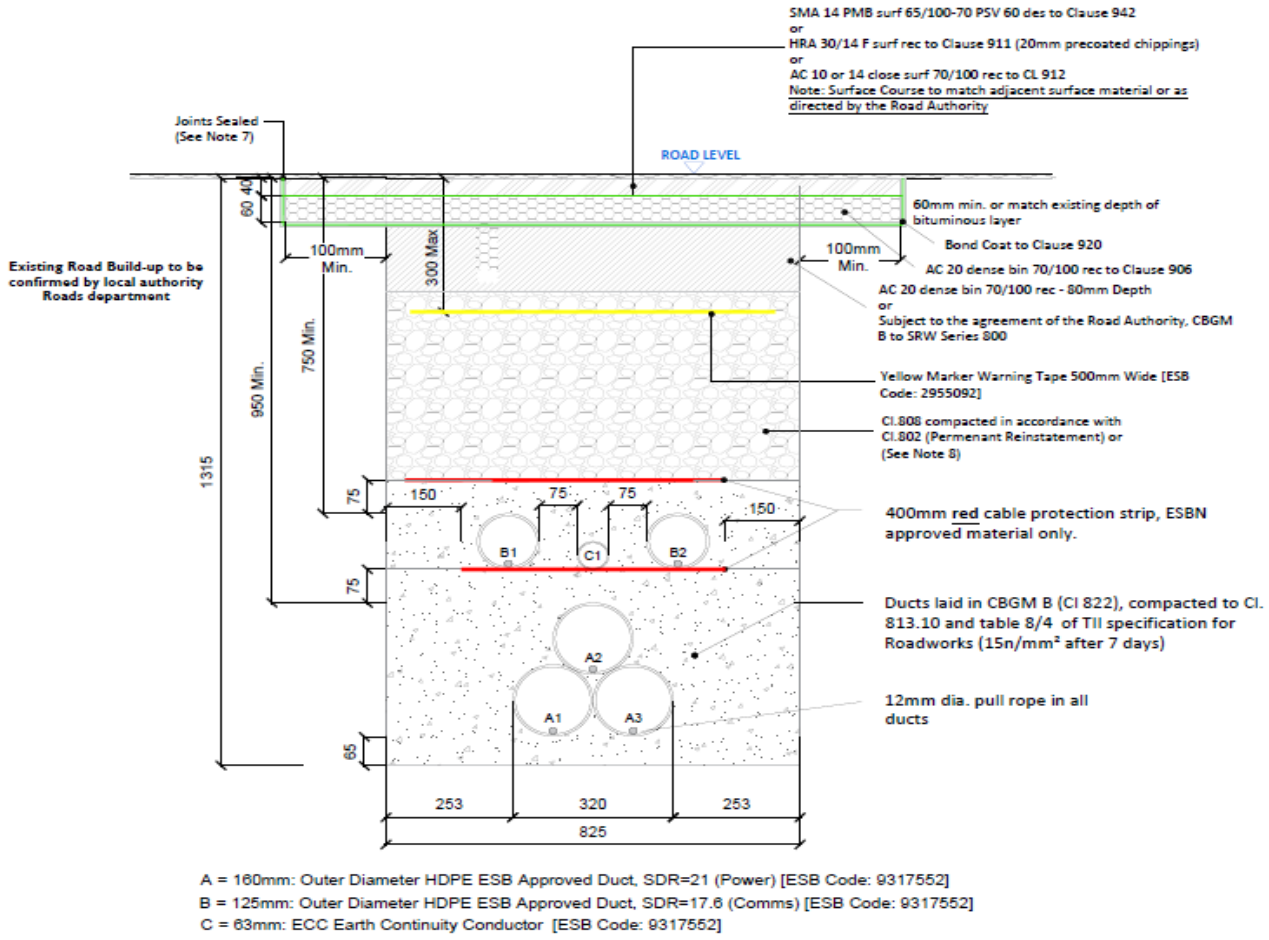

Figure 4 - Typical Trench in Road Section

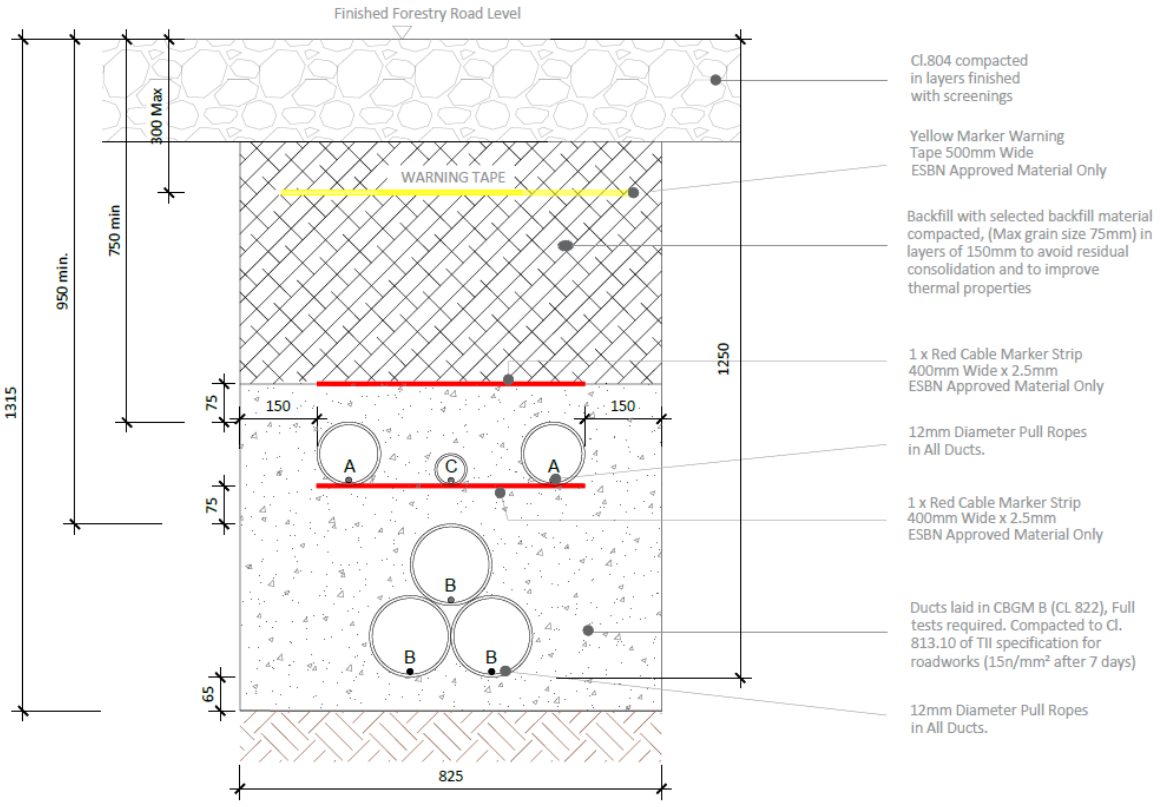

Figure 5 - Typical Trench in Off-Road Section

4.3 Marker Posts

Surface cable markers will be placed along the route where cable depth is unavoidably shallow, due to constraints such as existing services, to indicate the precise location of the UGC. These markers will be metallic plates in accordance with ESB standards.

Marker posts will be used on non-roadway routes to delineate the duct route and joint bay positions. Corrosion-proof aluminum triangular danger signs, with a 700mm base, and with centered lightning symbol, on fluorescent yellow background shall be installed inadequately sized concrete foundations. Marker posts shall also be placed if burial depth is not to standard. The precise siting of marker posts will be dictated by ESBN as part of the detailed design process.

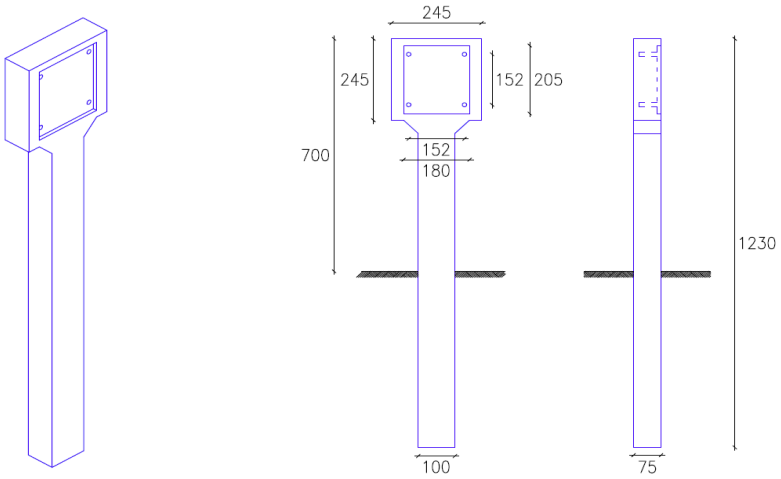

Figure 6 - ESB Marker Posts

4.4 Managing Excess Material from Trench

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

4.5 Storage of Plant and Machinery

All plant, machinery, and equipment will be stored on-site within the works area or within the temporary construction compound to be located within the permitted Solar Park sites. Oils and fuels will not be stored on-site and will be stored in an appropriately bunded area within the temporary storage compound.

4.6 Joint Bays and Associated Chambers

Joints Bays are to be provided approximately every 750-850 m along the UGC routes to facilitate the jointing of 2 no. lengths of UGC. 110kV Joint Bays are typically 6 m x 2.5 m x 2.05 m pre-cast concrete structures installed below the finished ground level. Joint Bays will be located in the non-wheel bearing strip of roadways, however given the narrow profile of local roads this may not always be possible.

In association with Joint Bays, Communication Chambers are required at every joint bay location to facilitate communication links between Grangeford Solar Farm Substation and the existing 220kV substation at Kellis, Co Carlow. Communication Chambers are located close to Joint Bays and will typically be pre-cast concrete structures with an access cover at the finished surface level. Earth Sheath Link Chambers are required at every joint bay along the cable route. Earth Sheath Links are used for earthing and bonding cable sheaths of underground power cables, so that the circulating currents and induced voltages are eliminated or reduced. Earth Sheath Link Chambers and Communication Chambers are located in close proximity to Joint Bays. Earth Sheath Link Chambers and Communication Chambers will typically be pre-cast concrete structures with an access cover at finished surface level.

The precise siting of all Joint Bays, Earth Sheath Link Chambers and Communication Chambers is subject to approval by ESBN. Marker posts will be used on non-roadway routes to delineate the duct route and joint bay positions. The marker posts will consist of a corrosion-proof aluminum triangular danger sign, with a 750mm base, and with a centered lightning symbol, on an engineering grade fluorescent yellow background. They will be installed inadequately sized concrete foundations and will also be placed where the cable has not been buried to the standard depth, due to existing road conditions. Drawings of the joint bays and communication chambers are included within this planning package.

Equipment:

- 360° tracked excavator (wheeled excavator where required)
- 1 no. tracked dumper or tractor and trailer

Materials:

- Sand for pipe bedding
- Ready-mix Concrete where necessary (delivered to site);
- Trench backfilling material (excavated material and aggregates) to relevant specifications;
- Precast Chamber Units / Construction materials for chambers
- Cable ducting

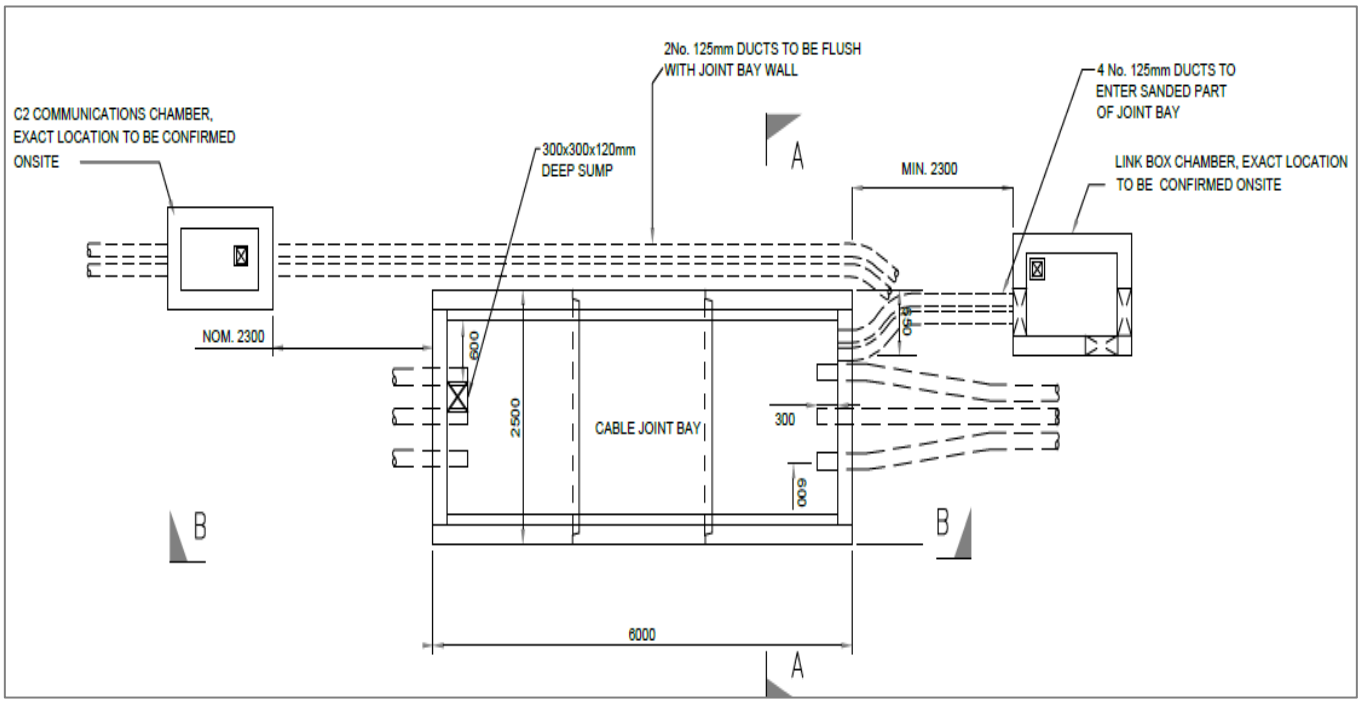

Figure 7 - Typical Joint Bay Plan Layout

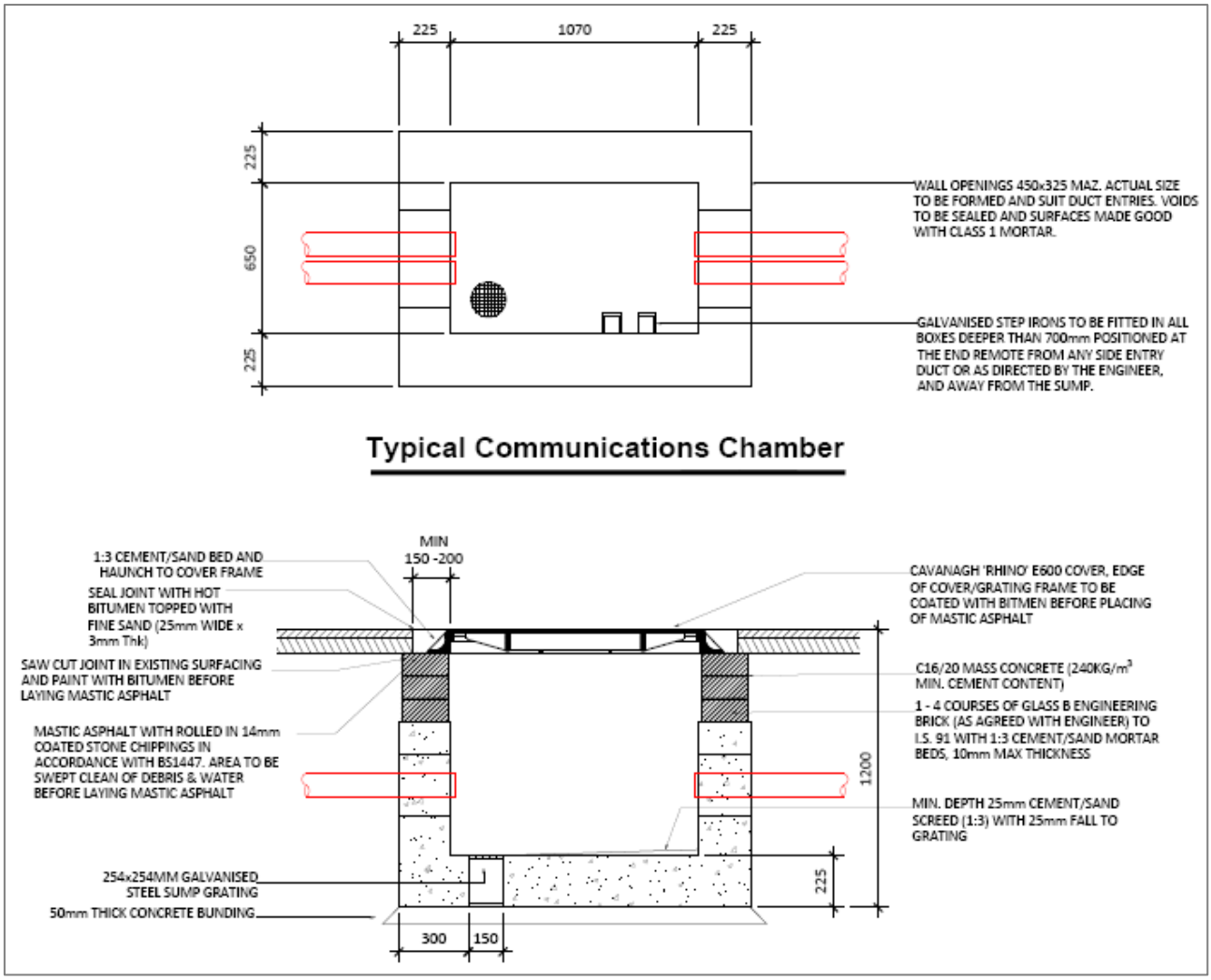

Figure 8 - Typical Communications Chamber

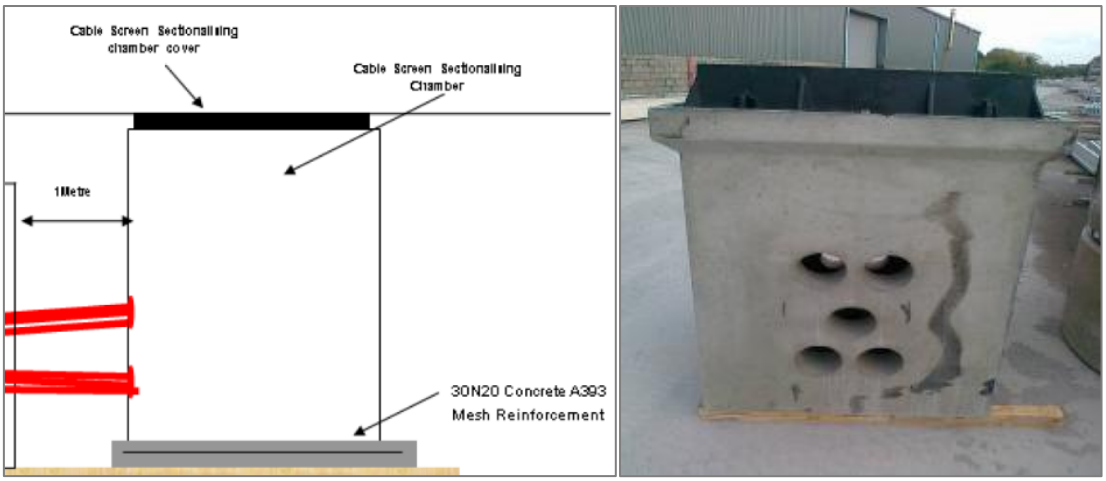

Figure 9 - Typical Section through Comms Chamber

4.7 Methodology for Joint Bay Construction and Installation

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

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

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

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

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

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

1. The contractor will excavate a pit for joint bay construction, including for a sump in one corner.
2. Grade and smooth floor; then lay a 75 mm depth of blinding concrete (for in situ construction) or 50 mm thick sand (for pre-cast concrete construction) on 200 mm thick Clause 804 granular material.
3. In situ construction. Construct 200 mm thick reinforced concrete floor slab with sump and starter bars placed for walls as detailed on the drawings.
4. In situ construction. Construct 200 mm thick reinforced concrete sidewalls as detailed on the drawings. *(Figure 9)*

Figure 10 - Typical joint bay under construction (in-situ)

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

Figure 11 - Completed joint bay prior to cable installation (in-situ)

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

Figure 12 - Typical joint bay under construction (pre-cast)

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

Figure 13 - HV cable pulling procedure (Typical drum set-up)

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

Figure 14 - HV cable jointing container

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

Equipment:

- 2-3 General Operatives
- 1 Excavator Operator
- 360˚ tracked excavator (13 ton normally, 22 ton for rock breaker)
- 1 no. tracked dumper or tractor and trailer.

Materials:

- Sand for pipe bedding
- Blinding Concrete where necessary
- Clause 804 Material
- 160mm diameter HDPE ducting
- 125mm diameter HDPE ducting
- 63mm diameter HDPE ducting
- Precast Chamber Units
- Earth Sheath Link Box

4.8 Horizontal Direction Drilling (HDD)

Horizontal Direction Drilling (HDD) is a method of drilling under obstacles such as bridges, watercourses, existing UG infrastructure, etc. This method is employed where installing the ducts using standard installation methods is not possible and is implemented to install cable ducts under the obstacle. There will be a requirement to drill beneath three obstacles in this underground grid connection route. These consist of 3 No. Bridges.

The proposed drilling methodology is as follows:-

- A works area of circa 40m^2 for the HDD entry side, and circa 20m^2 on the HDD exit side, will be required for the HDD equipment and vehicles. These areas will be fenced off during the HDD implementation.
- The drilling rig and fluid handling units will be located on the entry side and will be appropriately bunded using sandbags, which will contain any fluid spills and stormwater run-off.
- Entry and exit pits (approximately 2m (w) x 3m (L) x 1m deep) will be excavated using an excavator, and the excavated material will be temporarily stored within the works area and used for reinstatement or disposed of to a licensed facility.
- The HDD pilot bore will be undertaken using a wireline guidance system. Assembly will be set up by the drilling team and steering engineer.
- The pilot bore will be drilled to the pre-determined profile and alignment under the watercourse crossings.
- The steering engineer and drill team will monitor the drilling works to ensure that modeled stresses and pressures are not exceeded.
- The drilled cuttings will be flushed back by drilling fluid to the entry and exit pits and re-cycled for re-use.
- Once the first pilot hole has been completed a hole-opener or back reamer will be fitted in the exit side which will then be pulled back to the entry side as part of the pre-reaming/hole opening process to enlarge the hole to the correct size.
- When the pre-reaming/hole opening/hole cleaning has been completed, a reamer of a slightly smaller diameter than the final cut will be installed on the drill string to which the ducts will be attached for installation.
- The drilling fluid will be disposed of at a licensed facility.
- The ducts will be cleaned and proven and their installed location surveyed.
- The entry and exit pits will be reinstated to the specification of ESB Networks and any requirements of Carlow County Council.
- A joint bay/transition chamber/transition coupler will be installed on either side of the road following the horizontal directional drilling as per ESB requirements.

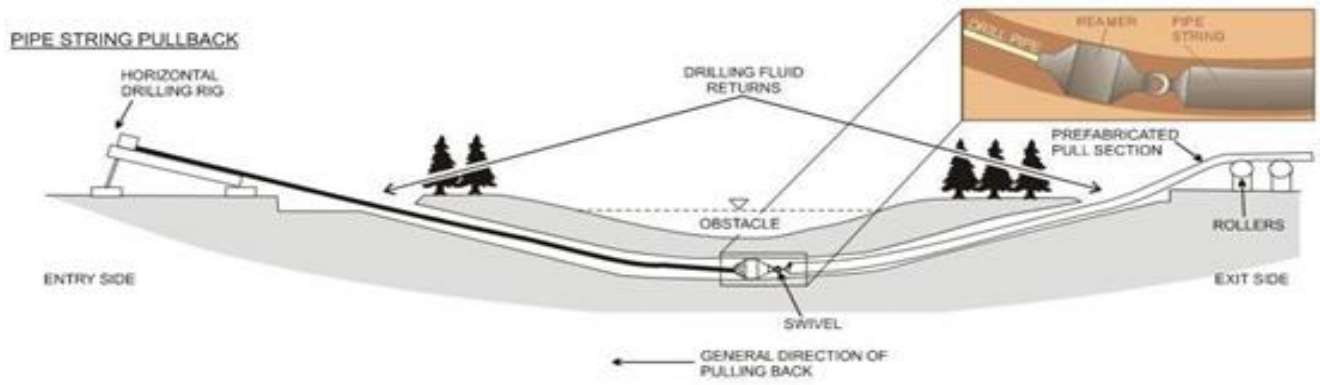

Figure 15 - Typical HDD Installation (not to scale)

5.0 Design, Construction & Environmental Management Methodology

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

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

- Inland Fisheries Ireland (2016) *Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters*. Inland Fisheries Ireland*, Dublin,*
- *National Roads Authority (2008) Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes*. National Roads Authority, Dublin;
- E. Murnane, A. Heap, and A. Swain. (2006) *Control of water pollution from linear construction projects.* Technical guidance (C648). CIRIA;
- E. Murnane et al., (2006) *Control of water pollution from linear construction projects*. Site guide (C649). CIRIA.
- Murphy, D. (2004) Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites. Eastern Regional Fisheries Board, Dublin;
- H. Masters-Williams et al (2001) *Control of water pollution from construction sites. Guidance for consultants and contractors* (C532);
- Enterprise Ireland (unknown). *Best Practice Guide (BPGCS005) Oil storage guidelines;*
- Law, C. and D'Aleo, S. (2016) *Environmental good practice on site pocketbook*. (C762) 4th edition. CIRIA;
- CIRIA *Environmental Good Practice on Site (fourth edition) (C741) 2015*.

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

- All materials shall be stored at the temporary compound within the Solar Park sites and transported to the works zone immediately before construction;
- Where drains and watercourses are crossed with underground cables, the release of sediment will be prevented through the implementation of best practice construction methodologies.
- Weather conditions will be taken into account when planning construction activities to minimise the risk of runoff from the site;

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

6.0 Watercourse Crossings

There are three bridges encountered on the proposed underground cable route, Bridges 1,2,3. A site survey was carried in each case to determine the best method of crossing. Detailed measurements were taken as well as examination of the watercourse and examination of third party lands in the vicinity. In all three cases, there was inadequate cover for an in deck crossing solution and a Horizontal Directional Drilling (HDD) will be required. Further desktop analysis and design modelling was carried out to plot the trajectory of each HDD. In each case, HDD options were examined, being HDD from road to road or HDD within adjacent third party lands. The survey and design analysis which was carried out determined, that the optimum solution of crossing Bridges 1,2,3 was Horizontal Directional Drilling (HDD) within the curtilage of the public road.

Where the cable route intersects with existing watercourses, a detailed construction method statement will be prepared by the Contractor before the commencement of construction and is to be approved by the relevant environmental agency. Inland Fisheries Ireland has published guidelines relating to construction works along water bodies entitled 'Requirements for the Protection of Fisheries Habitats during Construction and Development Works at River Sites", and these guidelines will be adhered to during the construction of the proposed development.

6.1 Bridge 1 - Horizontal Directional Drilling [Chainage – 2005m]

Coordinates (ITM): 680710.90, 671380.60

This Bridge has insufficient cover to install the cable to ESB specification (450mm cover to the top of ducts) within the bridge deck. It is proposed to HDD a minimum of approximately 1500mm beneath the waterway. This depth is based on locating a suitable clay/silt formation for HDD and the required depth may increase subject to geotechnical investigations. All drilling and associated works will take place within the road corridor**.** The HDD process is outlined in Section 4.8 above. *See drawing 05967-DR-130 for reference.*

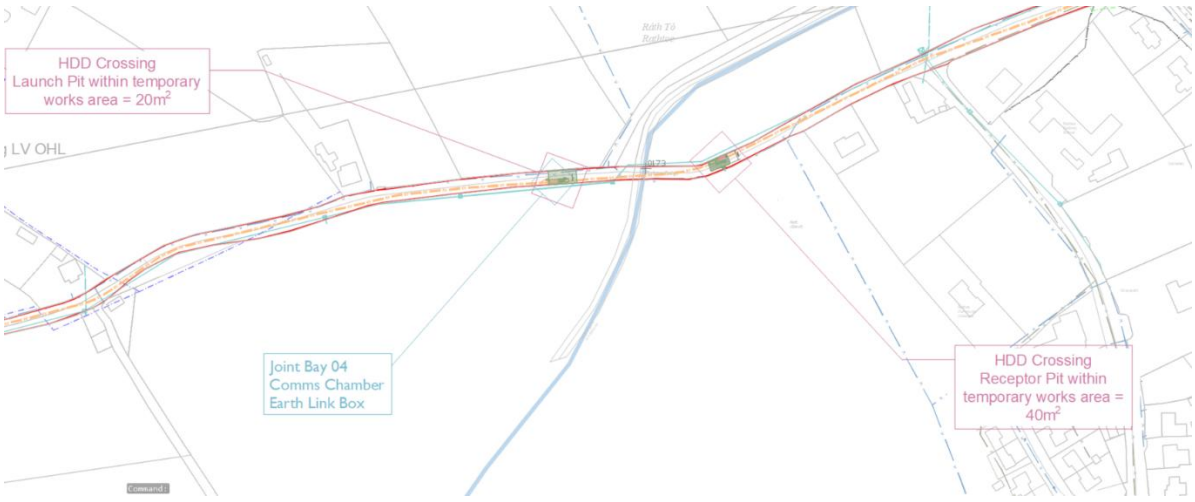

Figure 16 - Bridge 1 Rathoe Bridge with Tailte Eireann Background

Figure 17 - Bridge 1 Rathoe Bridge

6.2 Bridge 2 - Horizontal Directional Drilling [Chainage – 3110 m]

Coordinates (ITM): 680874.55, 672220.90

This Bridge has insufficient cover to install the cable to ESB specification (450mm cover to the top of ducts) within the bridge deck. This depth is based on locating a suitable clay/silt formation for HDD and the required depth may increase subject to geotechnical investigations. All drilling and associated works will take place within the road corridor**.**The HDD process is outlined in Section 4.8 above. *See drawing 05967-DR-131 for reference.*

Figure 18 - Bridge 2 on River Burren Tributary

Figure 19 - Bridge 2 HDD Crossing on with Tailte Eireann Background

6.3 Bridge 3 - Horizontal Directional Drilling [Chainage – 3800m]

Coordinates (ITM): 680845.76,672871.31

This Bridge has insufficient cover to install the cable to ESB specification (450mm cover to the top of ducts) within the bridge deck. It is proposed to HDD a minimum of approximately 1500mm beneath the waterway and bridge foundations. This depth is based on locating a suitable clay/silt formation for HDD and the required depth may increase subject to geotechnical investigations. All drilling and associated works will take place within the road corridor**.** The HDD process is outlined in Section 4.8 above. *See drawing 05967-DR-132 for reference.*

Figure 20 - Bridge 3 on Aghalona River

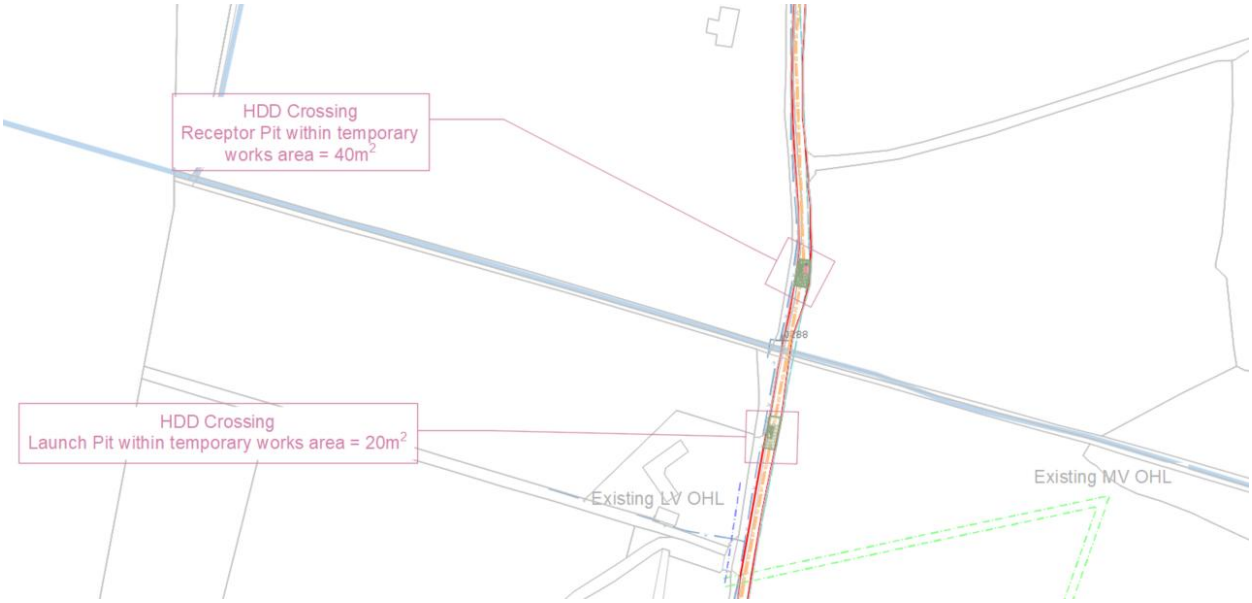

Figure 21 - Bridge 3 on Tailte Eireann Background

7.0 Drainage Management Plan.

The measures described in this section will be adopted during the construction phase in order to manage on-site drainage in accordance with current best practice and legislation.

The Site Manager shall contact:

- The Client;
- Environmental Protection Agency ("EPA") 24-hour emergency incident line 1890 33 55 99;
- Inland Fisheries 24-hour pollution line 1890 34 74 24. The pollution hotline number shall be referenced in the construction site rules and displayed in the Site Office, within the Grangeford Solar Farm facility, and in the Emergency preparedness & response plan.

Each Contractor working with controlled substances shall supply appropriate spill kits which shall be kept on site. The spill kits shall be made accessible at all times to all site personnel.

7.1 Silt Control

Silt-laden runoff should be expected from any areas of recently exposed soil. There is also potential for pollution to occur from machinery used in the construction.

The introduction or artificial materials required (e.g. silt fencing, straw bales, sand bags etc.) will need to be deployed onsite and will be removed on completion of the works. A suitable buffer and barriers (silt fences) will be provided between any excavated material and any surface water features to prevent sediment washing into the receiving water environment.

Discharge from the silt control measures will be discharged into an area of vegetation for dispersion or infiltration, in accordance with Sustainable drainage system (SuDS) techniques. Where drains or watercourses are crossed with underground cables the release of sediment will be prevented through the implementation of best practice construction methodologies.

7.2 Additional Mitigation Measures

- The contractor shall ensure that silt fences are regularly inspected and maintained during the construction phase.
- If very wet ground must be accessed during the construction process bog mats/aluminium panel tracks will be used to enable access to these areas by machinery. However, works will be scheduled to minimise access requirements during very wet periods and predominantly aiming to carry out works during the summer season.
- The contractor will carry out visual examinations of local watercourses from the proposed works during the construction phase to ensure that sediment is not above baseline conditions. In the unlikely event of water quality concerns, the Environmental Manager and ECoW will be consulted.
- Excavations will be left open for minimal periods to avoid acting as a conduit for surface water flows.
- Entry by plant equipment, machinery, vehicles, and construction personnel into watercourses or wet drainage ditches shall not be permitted. All routes used for construction traffic shall be protected against migration of soil or wastewater into watercourses.
- Cabins, containers, workshops, plant, materials storage, and storage tanks shall not be located near any surface water channels.

8.0 Access Routes to Work Area

The proposed grid route will consist entirely of UGC. Where the proposed underground cable will be installed within grassland, it will be accessed via the existing road network. A permanent access track will be required above the cable route to access the solar farm substation. This will consist of a 3m track with ten tonne axle weight bearing capacity.The contractor(s) will be required to utilise the local public road network in the vicinity of the work area and from there utilise private tracks, where appropriate. Before the commencement of development, precise access arrangements will be agreed upon with the respective landowners.

A detailed Traffic Management Plan will be prepared, and agreed upon with Carlow County Council, before the commencement of construction.

Temporary access roads on private land (if required due to ground conditions and/or landowner requirements) will consist of timber or aluminum bog mats (Figure 22) to spread the weight of machinery over a greater area to prevent damage to the ground. If necessary, a low ground pressure excavator may also be utilised. This machine is designed to spread its weight across a wider area thereby reducing the pressure exerted on the ground. No invasive works will be undertaken when placing the matting. Upon completion of the work, all mats will be removed immediately. Access routes will be carefully selected to avoid any damage to the land. Local consultation will be carried out with all relevant landowners to ensure that any potential disturbance will be minimised. Before the commencement of construction, the contractor will assess all access routes and determine the requirement for bog mats. Any such requirements will be incorporated into the relevant method statement.

Figure 22 - Temporary Aluminium Panel Tracks

9.0 Relocation of Existing Services

To facilitate the installation of the proposed UGC, it may be necessary to relocate existing underground services such as water mains, telecoms, or existing cables. In advance of any construction activity, the contractor will undertake additional surveys of the proposed route to confirm the presence or otherwise of any services. If found to be present, the relevant service provider will be consulted to determine the requirement for specific excavation or relocation methods and to schedule a suitable time to carry out works.

9.1 Underground Cables

If existing underground cables are found to be present, a trench will be excavated, and new ducting and cabling will be installed along the new alignment and connected to the network on either end. The trench will be backfilled with suitable material to the required specification. Warning strip and marking tape will be laid at various depths over the cables as required. Marker posts and plates will be installed at surface level to identify the new alignment of the underground cable, and the underground cables will then be re-energised.

9.2 Gas Networks

Consultation with Gas Networks Ireland must take place before starting works where gas pipes are present. Gas Networks Ireland will advise on the safety measures required and will arrange for the exact location of the pipe to be marked out on site.

9.3 Water Mains

Uisce Eireann will need to be consulted and advised on details of the project proposals in the form of a completed Building-over or Near an Irish Water Asset Application Form and associated technical information largely comprising drawings and schedules with details of proposed crossings etc with as much available information as possible. Uisce

Eireann will be involved in the early engagement on projects that may involve any infrastructure which may be located near their assets with the intention of identifying as early as possible, if bespoke design measures or diversions are necessary.

The water supply will be turned off by the utility so work can commence on diverting or crossing the service. The section of the existing pipe will be removed and will be replaced with a new pipe along the new alignment of the service. The works will be carried out in accordance with the utility standards.

10.0 Cable Pulling

Once the ducting is installed the electrical cables (situated on a drum) are pulled through the ducting by a specialised mechanical winch. The winch will also monitor the tension on the cables being pulled so as not to damage the cables. A guide rope is installed with the ducting to assist in the cable pulling process. The guide rope also is used for proving the ducts by attaching a mandrel, a sponge, or brush, for cleaning the duct installed. Cable lubricant is applied to the outside of the cables being pulled through the duct. The lubricant assists in the pulling process by removing friction between the cable and the rollers. This not only speeds up the process but also prevents snagging and therefore damage to the cable.

11.0 Reinstatement of Private Land

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

12.0 Emergency Response Plan

All site personnel will be inducted into the provisions of the Emergency Response Plan. The following outlines some of the information, on the types of emergency, which must be communicated to site staff (list not exhaustive);

- Release of hazardous substance - Fuel or oil spill
- Concrete spill or release of concrete
- Flood event – extreme rainfall event
- Environmental buffers and exclusion zones breach
- Housekeeping of materials and waste storage areas breach
- Stop Works order due to environmental issue or concern

The Emergency Response Plan must be completed by the appointed contractor before the project begins.

13.0 Invasive Species Best Practice Measures

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

- The contractor will prepare an Invasive Species Action Plan to be implemented during construction, and all personnel will be made aware of the requirements contained within;

- Plant and machinery will be inspected upon arrival and departure from site and cleaned/washed as necessary to prevent the spread of invasive aquatic/ riparian species such as Japanese knotweed *Fallopia japonica* and Himalayan Balsam *Impatiens glandulifera*. A sign off sheet will be maintained by the contractor to confirm the implementation of measures;
- Site hygiene signage will be erected in relation to the management of non-native invasive material.

14.0 Waste Management

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

15.0 Archaeology

The following are the mitigation measures that will be carried out during construction where required;

- If required a project archaeologist will be appointed to oversee the project.
- Demarcation of protective buffer zones around cultural heritage sites where there is a potential for disturbance during the construction phase and inclusion of the same in site induction.

16.0 Programme

Estimates for the duration of the construction works are included in the table below. Please note that some of the elements are likely to happen concurrently, therefore the overall start-to-finish duration is estimated to be six months.

Table 3: Estimated Construction Duration	
Development Element	**Estimated Construction Duration**
Cable route (not including HDDs)	6 Months
Moanalow 110kV Substation	12 months
HDD	2 Months

Table 3 - Estimated Construction Duration