Contents

4 Construction Strategy

4.1 Introduction

This chapter provides an outline of the general activities associated with the construction of the proposed development. The design, operation and decommissioning of the proposed development are described separately in **Chapter 3**.

This chapter of the EIAR has been prepared in accordance with Part 1 of Annex IV of the EIA Directive (2014/52/EU, amending 2011/92/EU). This section therefore provides the following information:

- The duration and phasing during the construction period;
- Land use requirements to support the construction of the proposed development;
- The activities required to prepare the site and undertake the enabling works to support the construction of the proposed development;
- An overview of employment numbers, hours of working and construction safety measures which will be enforced during the construction of the proposed development;
- An overview of site, materials and environmental management measures associated with the construction of the proposed development; and

The Construction Environmental Management Plan (CEMP), which describes the minimum requirements that will be required to be implemented, is provided in **Appendix 4.1**.

This chapter has been prepared by Simon Grennan and Dan Garvey of Arup, with input from GIL's engineering consultants, WSP, and Arup's civil engineers. A description of the authors' qualifications and experience is presented in **Appendix 1.1**.

4.2 Duration and Phasing

4.2.1 Indicative Construction Programme and Phasing

A large infrastructure project such as Greenlink takes several years from concept to construction, including technical design, obtaining the relevant permits and consultation with a variety of stakeholders.

Subject to obtaining planning approval and the relevant permits and licences, on-site construction of the proposed development will commence in 2021. Greenlink is expected to be fully operational in 2023.

The approach outlined below is considered to represent a reasonable worst-case scenario as to how the proposed development may be constructed in its entirety.

Whilst the general requirements detailed in this section will be followed, the Contractor, when appointed, will ultimately be responsible for the sequencing and implementation of the works in a safe and secure manner and in accordance with all statutory requirements. Notwithstanding this flexibility, Greenlink Interconnector Limited will ensure that the construction activities, and all associated environmental controls are carried out in compliance with the mitigation measures and best construction practice described in this EIAR.

The timeline in **Table 4.1** sets out the outline programme for the construction of the converter station and tail station. Construction will commence in May 2021.

Table 4.1: Outline Construction Programme – Converter Station and Tail Station

Activity	Timing
System design	0-6 months
Detailed design and equipment procurement	0-15 months
Manufacturing (converter equipment)	15-27 months
Early works (ground work and access)	14-20 months
Civil work	21-30 months
Installation	27-32 months
Commissioning	32-37 months
Trial operation	37-40 months

Cable detailed design and procurement will take up to six months. Cable manufacturing will take up to twelve months.

For the onshore cable route, the cable will be installed on a rolling basis. Where no obstacles or constraints exist within or near the cable route, it is expected that progress rates for the trench excavation and installation of ducts will be up to:

- 200 metres per day in farm land and on road sections with full road closure,
- 120m/day on road with single lane closure
- 70m/day on road maintaining two-way traffic.

These rates will reduce where obstructions and underground utility services are encountered.

The first section of the route from the converter station to east of Ramsgrange village is approximately 8.5km long. This runs across farmland, at the northern end, and then along a combination of regional and local roads. The third section from Templars Inn to the landfall site is approximately 5.9km long. This section runs along local roads. The central section from Ramsgrange to Templars Inn is approximately 8.5km long. It runs along the R733 regional road through Ramsgrange village, and on local roads thereafter.

Construction works at the landfall, and along public roads will not be carried out in the period from the first of July to the thirty first of August.

Construction activity in the vicinity of the Campile Estuary crossing, including the HDD, will not be carried out in the period from the first of October to the thirty first of March inclusive.

The current schedule envisaged that trench excavation and installation of ducts on the first and third sections will be undertaken concurrently between September and December 2021, to avoid the summer tourist season. The second section is currently programmed for trench excavation and duct installation after the other two sections, between December 2021 and March 2022. Cable pulling and jointing are currently programmed to be undertaken on the three sections between March and November 2022, but no works will be undertaken at the landfall or on public roads in the months of July and August.

The expected programme for each cable section (of up to one kilometre) is presented in **Table 4.2**.

Table 4.2: Outline Construction Programme - Onshore Cable Route (per cable section of up to one kilometre)

Excavation/Ducting	2 to 3 weeks Or, a typical HDD crossing requires 4 to 6 weeks to install.
Cable and Fibre Optic Pulling	1 day per cable length.
Cable and Fibre Optic Jointing	To excavate and prepare joint-bay: 5 days To pull cables into joint-bays: 4 days Jointing activities: 5 days Back fill joint bay and re-surface road: 5 days
Total	A minimum of 7 weeks per 1km cable section of trench. Or, at least 10 weeks if there is an HDD within the section.

The HDD at the Campile River estuary is currently scheduled to take circa 25 days and is planned to be undertaken between March and May 2022. The landfall HDD at Baginbun Beach is currently scheduled to take a total of 3 months and is planned to be undertaken between January and March 2022.

4.3 Land Use Requirements

4.3.1 Overview

Construction of the proposed development will require temporary land take to accommodate construction activities in addition to the permanent land take required to accommodate the above ground elements of the proposed development. Land will be temporarily required to accommodate construction compounds and temporary on-site activities. Provision will be made at Great Island for continuous access to the site of the consented battery storage facility located to the north of the converter station site. Small areas of additional land will be required where the cable route goes off-road. These are described in **Section 4.5.7** below.

4.3.2 Cable Contractor Compounds

Three construction compounds/lay down areas for the cable contractor will be provided. One cable contractor's compound will be located to the north of the SSE Great Island power station and the EirGrid 220kV substation, at the Great Island end of the route. This site was used as a contractor's compound for the construction of the SSE Great Island power station and the EirGrid substation and is an existing hardstand area. A second cable contractor's compound will be located at the landfall site close to Baginbun Beach. The third cable contractor's compound will be located in the townland of Lewistown, along the onshore route. **Figure 4.1** shows the location of the cable contractor's compounds. **Figures 4.2, 4.4 and 4.5** illustrate the Baginbun, Lewistown and Great Island construction compounds, respectively.

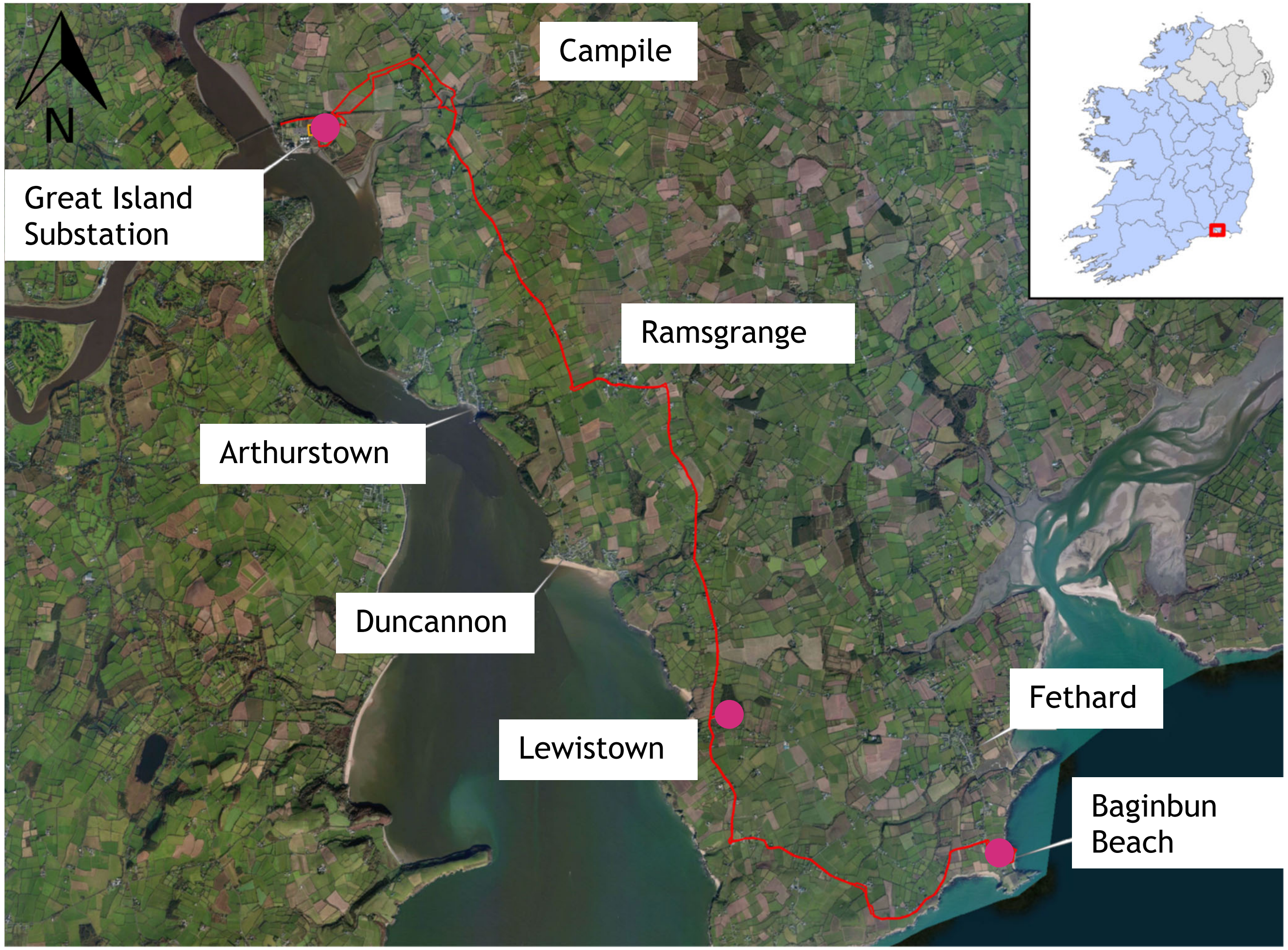


Figure 4.1: Locations of Construction Compounds (indicated thus: ●) (not to scale | background mapping from Bing © Microsoft 2020)

The cable construction compounds/lay down areas will provide the following:

- Space for materials lay down;
- Road access;
- Securely fenced site;
- Space for parking;
- Wheel wash, through which all trucks exiting the construction compounds will be required to pass. All water from the wheel wash will be collected, fully contained, and dispatched for treatment and disposal off-site;
- Construction waste storage;
- Site Offices;
- Electricity supplied by mains at the three compounds;
- IT/telecommunication connection;
- Water supplied from the watermain at the Great Island compound, water supplied by a bowser at for Baginbun and Lewistown; and
- Welfare facilities at the three sites, with foul sewage disposed of by removal off-site.

The construction compounds/lay down areas will be used for the external storage of plant, ducts, protective tiles, warning tapes, duct surround materials etc.

Most deliveries will be made to the lay down areas, within the compounds, during normal working hours. The HVDC and HVAC cables and accessories will be held in the three cable compounds and will be delivered to the cable installation site on the day of the cable pull.

After the construction is completed, all structures and facilities will be removed, and the cable construction compounds/lay down areas will be reinstated to their original condition.

4.3.3 HDD Contractor Compounds

There will be a compound for the HDD contractor adjacent to Baginbun Beach. This compound, which is illustrated in **Figure 4.2**, will be close to the cable construction compound at Baginbun.

The planning application includes two similar HDD compounds at Campile, one at either end of the Campile River Estuary HDD crossing. **Figure 4.3** illustrates the two compounds at the Campile River estuary. The environmental effects of the two compounds have been assessed in this EIAR. The location of the respective entry or exit compound is not known at this stage. The HDD construction contractor will decide which compound location suits its construction strategy.

The HDD compounds will provide the following:

- Space for materials and equipment lay down;

- Space for two HDD rigs aligned with the cable;
- Road access;
- Securely fenced site;
- Space for parking;
- All trucks exiting the construction compounds will be required to pass through a wheel wash. All water from the wheel wash will be collected, fully contained, and dispatched for treatment and disposal off-site;
- Construction waste storage;
- Site Offices;
- Electricity supplied by a generator;
- IT/telecommunication connection;
- Water supplied by a bowser; and
- Welfare facilities, with foul sewage disposed of by removal off-site.

4.3.4 Great Island Converter Station and Tail Station Construction Compound

The converter station and tail station contractor's compound will be established to the north of the Great Island 220kV substation, to the west of the converter station site at Great Island. This compound will be in two adjacent sections. This area was used for the construction of the SSE Great Island power station and the Eirgrid substation. The eastern of the two areas is within the licence boundary of the SSE industrial emission licence P606-03. **Figure 4.5** is a plan of the cable contractor and converter station contractor's compounds at Great Island.

The compound will provide facilities and lay down areas for the construction of the converter station and tail station. It will have similar facilities to the cable contractor's compound at Great Island, described in **Section 4.3.2** above, but will be on a larger scale.

Following the commissioning of the converter station and tail station, the ground of the converter station construction compound will be restored to its original condition.

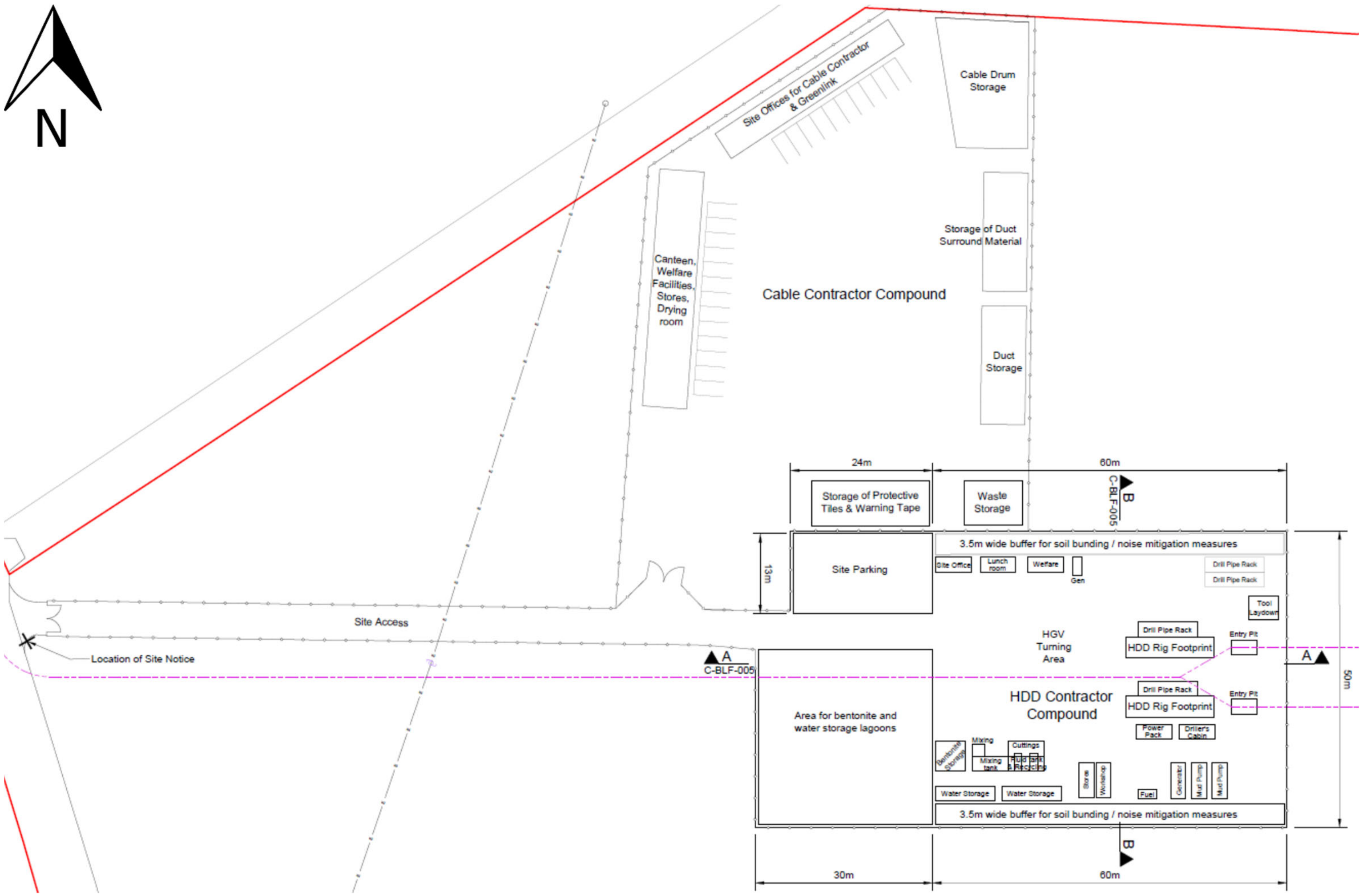


Figure 4.2 Contractors' Compounds near Baginbun Beach | not to scale [cable route shown in magenta]

Figure 4.3 HDD Compounds at Campile Estuary | not to scale [mapping: Bing Maps (c) Microsoft 2020]

Figure 4.4 Contractor's Compound at Lewistown | not to scale

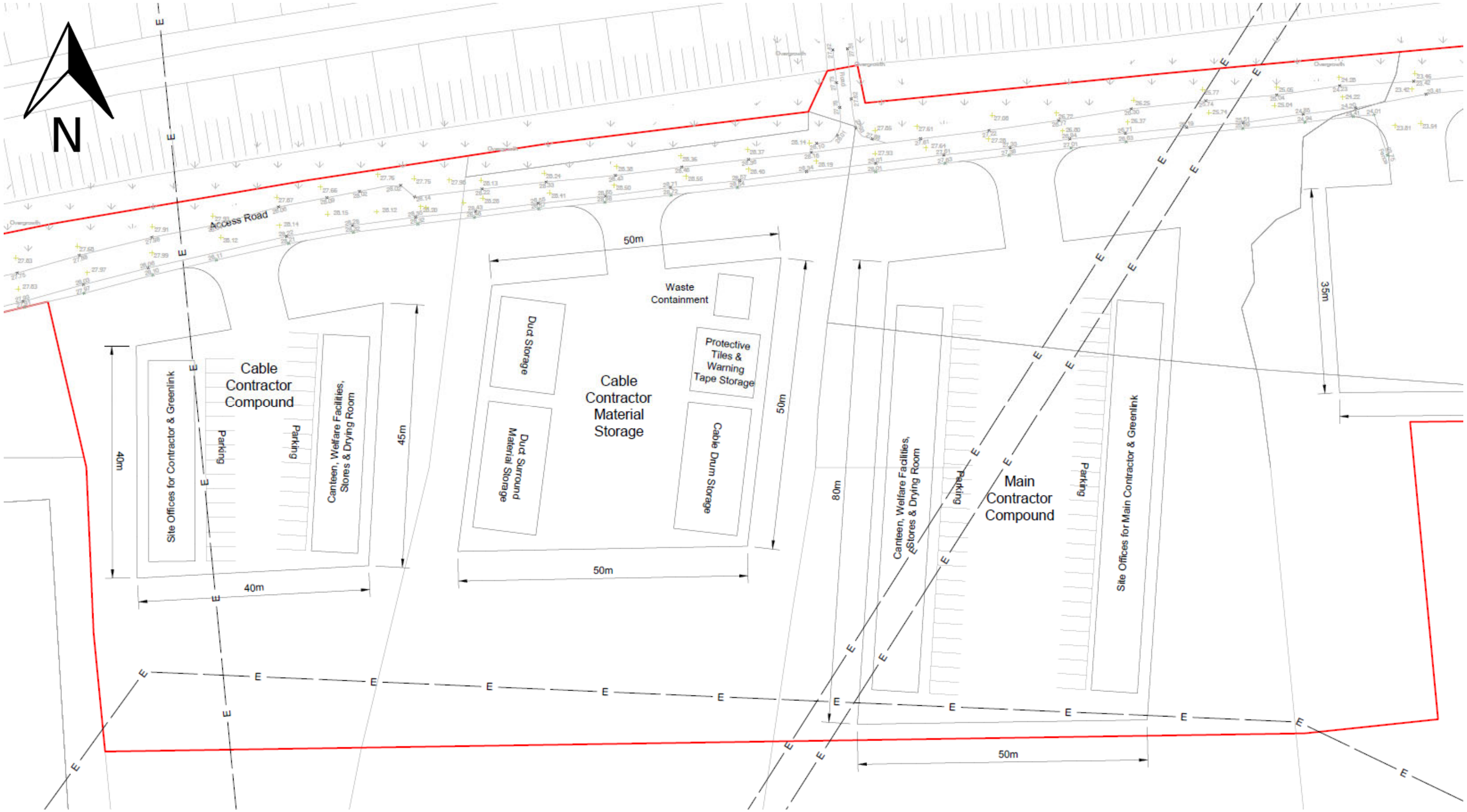


Figure 4.5 Contractors' Compounds at Great Island | not to scale

4.4 Construction Methods

The following sections outline the planned methodology for the main construction elements of the proposed development. The tail station perimeter will be contiguous with the converter station perimeter and they will be constructed at the same time. In the text below, reference to converter station should be read to include the tail station.

4.4.1 Enabling Works and Site Clearance

Enabling works, which will be undertaken at the HDD compounds and Lewistown and Baginbun cable compounds, will be as follows:

- Establish a construction traffic management plan for each construction compound. **Chapter 6** *Traffic and Transportation* provides the details;
- Establish and implement the surface water management strategy at each compound. **Chapter 13** *Water and Hydrology* provides the details;
- Construct temporary site access from the existing road network; the Lewistown cable compound will use the existing yard entrance, which will be upgraded;
- Install secure hoarding or fencing (2.4 metres in height as a minimum) around each of the compounds that will remain in-situ for the duration of the construction works;
- Remove vegetation and strip and store topsoil, ensuring any stockpiles are covered and surrounded with silt fencing;
- Create a reasonably level platform using crushed stone.
- Install vehicle set down and material storage areas as shown on the layout drawings in each of the construction compounds;
- Install the site offices and welfare facilities.
- Undertake all required utility services connections and diversions.

Advantage will be taken of the fact that the Great Island construction compounds were used previously to support construction projects. Enabling works at these compounds will be as follows:

- Establish a construction traffic management plan for each construction compound. **Chapter 6** *Traffic and Transportation* provides the details;
- Reinstate the surface water management strategy at each compound. **Chapter 13** *Water and Hydrology* provides the details);
- Reinstate fencing (2.4 metres in height as a minimum) around each of the compounds that will remain in-situ for the duration of the construction works;
- Minor works to existing crushed stone platform;
- Install vehicle set down and material storage areas as shown on the layout drawings in each of the construction compounds;

- Install the site offices and welfare facilities.
- Undertake all required utility services connections and diversions.

Minor enabling works will also need to take place at locations along the route where trees/hedges need to be removed, suitable access points will be constructed and haul roads installed where applicable. Removal of walls will also be required; however these will be reinstated following the construction works.

4.4.2 Permanent Access Road and Converter Station Construction Compound

The construction of the permanent access road to the converter station site and setting up the construction compounds and converter station site, will be early tasks in the construction schedule. The works will include:

a. Protection of existing services

- Mobile welfare – either mobile welfare vans, towed units, or self-contained units will be used, until the facilities in the construction compound have been established.
- Initial works will be carried under temporary traffic management (lane closure under traffic signal control).
- Any area to be excavated will be subject to utilities searches, GPR (ground penetrating radar) survey and CAT (cable avoidance tool) scanning.
- Services – if any, subject to utilities searches and investigation during design, will be exposed using intrinsically safe excavation methods i.e. vacuum excavation. Protection methods (subject to design and agreement with service owner, such as steel plating, concrete slab etc.) will be installed.
- A 25 tonne 360° tracked excavator, with nine tonne forward tipping dumpers, and ride-on twin rollers will typically be used for earthworks. Similar plant will be used for compound construction and construction of the temporary access road.
- Topsoil and arisings will be segregated. The design intent is that all material will be reused on-site.
- Segregated walking routes will be established and maintained.
- Permanent signage will be installed, prior to the removal of temporary traffic management.
- Permanent access gates will be installed to ensure access control.
- Vehicle movements on site will be controlled by a Plant and Vehicle Marshal(s) (PVM).

b. As stated above, the converter station construction compound will be located on an area used for the construction of the power station.

- Segregated pedestrian access routes from the compounds to the converter station site will be established and maintained.

- Site security will be maintained by a combination of: the gate being permanently staffed during working hours; random out of hours security patrols; remotely monitored "smart" security.
- Foundations will be constructed for temporary accommodation.
- Secure bunded areas will be constructed for fuel storage and chemicals, and generators. Permanent connections for site services (electricity, water, telecoms) to mains will be established.
- Welfare facilities with holding tank, which will be emptied by disposal off-site.
- Temporary cabins will be placed using a loader crane or mobile crane.
- Asphalt surfacing to the car park area will be placed. The equipment required for this includes an asphalt paving machine, ride-on rollers, floor saw and planers.
- Surfacing will be provided to the converter station site entrance and first 50 metres of road.
- Signage, fencing, compound lighting, and services to cabins will be installed.

c. Converter Station Site Temporary Access Road

To provide initial access to the converter station site along the route of the permanent access road, a temporary road will be constructed.

- Topsoil and subsoil will be stripped, and soft spots excavated. Soils will be separated and stockpiled. All stockpiles will be covered and surrounded with silt fencing in a designated area.
- Capping and geotextile reinforced sub base layers will be placed and compacted.
- All plant movements will be controlled by a qualified supervisor; works will be zoned by barriers ensuring segregation.
- Temporary signage will be installed at intervals (speed limits, passing places, overhead services, etc). Warning "goal posts" will be provided where overhead services cross the route.

d. Converter Station Permanent Access Road

- Ducts located under permanent road, for future medium-voltage cables to be pulled through.
- The top surface of the temporary road will be graded off, and excess material will be retained as general fill material.
- The sub-base layers will be topped up and trimmed.
- Road drainage will be installed.
- The kerb raft will be constructed with in situ concrete, and precast concrete (PCC) kerbs and place backing will be installed. Mechanical lifting will be used to lift and place the PCC kerbs.

- Verge fill will be placed behind kerbs, with the batters trimmed and shaped.
- Surfacing to roads will be placed: the construction will be base/binder/surface course to a total depth of between 200 and 300mm. The surface course will be omitted at this stage. The equipment used will include an asphalt paving machine, ride-on rollers, floor saw, and planers.

e. Finishing the permanent access road

- Lines, and permanent signage will be installed.
- The surface course will be placed prior to handover to the client on completion of construction, when use of the road for site construction traffic has finished.

4.4.3 Earthworks on Converter Station Site, Haul Roads, Piling

A level platform circa 2.04ha in area, on which the converter station and tail station will be located, will be created by bulk excavation and filling. The platform will require the excavation of circa 23,000m^3 of rock which will be crushed on site and reused, insofar as is possible. Up to an additional 20,500m^3 of crushed stone structural fill will be imported for the converter station and tail station site.

Precast concrete piles will be used for the building foundations.

These works will be undertaken as follows:

a. Haul roads and access routes and bulk excavation

- Suitably graded imported stone will be delivered to site and stockpiled until required for haul roads and access routes.
- The converter station site will be excavated in a cut and fill manner to eliminate the requirement for bulk removal of excavated material from site. Rock will be excavated using either rock splitting or blasting, or a combination of both techniques. Rock crushing may be required to reuse the excavated material. The noise levels associated with blasting (if it is deemed necessary) will not exceed those predicted for rock-breaking, and specific mitigation measures will be implemented, as set out in **Section 8.5.1** of **Chapter 8** *Noise and Vibration* to ensure that adverse effects on the Gas Networks Ireland transmission pipeline are avoided.
- Topsoil will be removed and stockpiled within the site to be reused during the landscaping phase. All stockpiles will be covered and surrounded by silt fencing. Stone will be placed using a dozer or excavator.
- Rock will be excavated, ripped or broken out as required, to achieve the required levels.
- Where required, the stone blanket will be reinforced with geotextile materials.

- Access roads will be designed and installed to ensure that water is dispersed into drainage channels.
- Segregated pedestrian routes will be provided.

b. Installation of precast piling

- Precast piling will be installed.
- Piles will be delivered to site on articulated trucks and offloaded using the piling rig or a mobile crane and stored as required.
- Piles will be installed using a piling rig.
- It is expected that there will be up to three piling rigs operating simultaneously during the scheme.
- To minimise the effect of noise, the piling rigs, where practical, will be situated with the rear of the rig towards any sensitive receptor. Timber packers will be used between the pile and the hammer to reduce the noise level.

4.4.4 Converter Station Site Perimeter

The earthworks to the footprint of the converter site will be completed within a perimeter secured by temporary fencing – Heras-type or similar. The permanent fencing will be installed following completion of earthworks.

The permanent internal roads, temporary roads and pedestrian access routes will be established within the site perimeter, ensuring ongoing safe and efficient access. Temporary routes will be reviewed regularly as construction progresses and changed and developed as required. Temporary safety and information signage will be provided. Pedestrian routes and designated crossing points will be well marked. Permanent road construction will be built up to and including asphaltic layers, but surface course will be omitted until completion of site construction vehicles and plant. The equipment required will include an asphalt paving machine, ride-on rollers, floor saw, and planers.

4.4.5 Converter Station Site Drainage, Temporary Drainage, Interceptors, Ducts, Troughs, Earthing Grid

For the construction phase, temporary drainage will be installed to control silt run-off. The permanent drainage will be installed later in the construction sequence. The converter station and tail station will each have an earthing grid. This will be installed at the same time as the permanent drainage.

a. Temporary drainage including silt busting/interception

- Measures will be provided to ensure only clean surface water run-off is discharged from site during the construction phase i.e. de-silting and temporary oil interceptor. These will be subject to daily inspection to ensure they remain adequate and effective. The discharge will be to the same watercourse as the permanent drainage.

b. Permanent Drainage: attenuation tanks, interceptors, oil dump tanks

- The proposed attenuation pond will be formed by excavating material from the existing embankment to the south of the converter station platform. The excavation will be carried out using a 35-tonne 360 degree tracked excavator, to a depth of approximately two metres.
- The base of the excavation will be formed and proof-rolled by small plant machinery.
- A HDPE liner and protective geotextile will be included in the pond build-up.
- the precast concrete inlet and outlet headwalls and associated pipework will be positioned into place and the pond excavation landscaped prior to decommissioning.

c. Carrier Drains, filter drains, manholes including penstock chambers.

- Ground Support will be by trench sheets/trench boxes/manhole boxes.
- Excavation will be by a 360° tracked excavator, sized to suit the drainage being carried out, typically 13 to 25 tonnes.
- An excavator will be used to place pipes.
- Safe access into excavations will be maintained.

d. Storm water drainage, road gullies

- Below ground drainage will be installed prior to erection of the building superstructure/roof drainage. Final connection will be made when down pipes are installed to ensure accurate positioning.

  Road gullies and connections to carries will be installed during road construction, prior to trimming sub base, and surfacing. Gullies will be finished once the binder course has been installed.

e. Installation of earthing grid

- The earthing grid will be progressed in conjunction with drainage/ducts/troughs and foundations to ensure it is progressed safely and efficiently. As far as possible open excavations will be avoided and will be backfilled the same day. Any open excavations will be barriered.
- Ground will be tested for resistivity and pH levels to ensure the grid works efficiently.
- Joints and connections will be carefully recorded.
- A small tracked excavator will be used.

f. Duct and trough Installation

- A small tracked excavator will be used.
- The sequence of installation will be carefully planned with the drainage and foundations installation to ensure that it can be carried out safely and efficiently.
- Ducts and chambers will be installed in shallow excavations. As far as possible open excavations will be avoided and will be backfilled the same day. Any open excavations will be barriered.

- Excavations for cable troughs will be benched to avoid the need for additional ground support. Base of excavation will be prepared to design detail, typically mass concrete. Precast concrete trough units will be placed using mechanical lifting – using a small tracked excavator (lift plan required). Excavations will be backfilled as soon as possible. Precast covers will be placed progressively to avoid fall hazard of open troughs. Whenever covers are removed or omitted, edge protection/barriers will be provided.

4.4.6 Converter Station and Tail Station Reinforced Concrete Foundations and Slabs

The converter station and tail station will have reinforced concrete pile caps and floor slabs. There will be miscellaneous reinforced concrete foundations. The works will be undertaken as described below.

- The equipment to be used will include a tracked excavator, mobile crane/crawler crane/tower crane/pedestrian tower crane, and concrete pumps.

b. Excavation, blinding, pile trimming

- All excavations will be barriered and fenced.
- Excavations will be by appropriately sized excavator – typically 20 or 25 tonnes for larger structures, and 13 tonnes for smaller structures. Excavations will be benched or battered, and temporary stairs will be provided for safe access into excavations. Formation will not be left open in poor weather: blinding will be placed as the excavation progresses over several days, or a protective surcharge will be left for final trim.
- Blinding will be placed using a machine bucket, or crane and skip, or by concrete pump.
- Hydraulic crushers/mounted excavators will be used to break down piles, final trim using hand held breakers.

c. Deep structures: foundations, Control Building basement

- The sheet piled ground support system will be installed.
- The foundation will be excavated from outside the footprint.
- The Control Building basement will be excavated from inside the footprint, leaving an earth ramp for access, which will be removed as the excavation is completed.

d. Steel Fixing

- Where possible cages will be prefabricated.
- Where fixed in situ, reinforcement will be craned onto the blinding.
- Reinforcement will be fixed progressively across the blinding, using tying wire and hand tools. Strips of rubber matting will be placed to provide safe access to reduce trip hazard on reinforcement mats. Protection will be provided to starter bars and any projecting steel.

e. Shuttering and preparation for pour

- Prior to erection, panels will be inspected to ensure they are clean and free from damage. Shutter oil will be applied.
- Panels will be placed using mechanical lift assistance. Kickers and bolt hanging jigs etc. will be completed in timber and ply.
- Cast in bolts and ducts will be installed during shutter erection.
- Prior to placement of concrete, the pour will be checked, and debris will be blown out or removed by hand.

f. Placement, compaction, finishing and curing for concrete

- Concrete will be placed by crane and skip, or by concrete pump, working progressively across the pour in layers, to ensure the working front is kept “live”.
- Concrete will be compacted using portable vibrating poker units.
- Unformed surfaces will be tamped off to the required level, before being floated to the required finish. Some slabs may require a power float finish. Curing will be achieved by polythene covers or by sprayed on curing membranes. Protection from rain or cold may be required in adverse weather.

g. Striking formwork, finishing works

- The sequence for striking will be planned, and temporary propping for stability will be provided.
- Formwork will be stuck when the concrete is sufficiently cured and has gained sufficient strength.
- On striking formwork, defects and tie holes will be made good, and any rubbing up/finishing will be carried out. Surface treatments (if any) to surfaces will be applied, and foundations will be backfilled as soon as possible.

4.4.7 Converter Station and Tail Station Steel Superstructure Erection, Wall Cladding, Roof Installation, Gutters and Rainwater Pipes

The superstructure of the buildings in the converter station and tail station will be structural steel. The structural steel will be erected, once the foundations have been completed. The wall and roof metal cladding will be fixed, making the buildings weather-tight, when the structural steel frames are in place.

a. Structural Steel Erection

- Equipment to be used will include: 200 or 250 tonne crawler cranes, 120 or 160 tonne mobile cranes. Mobile Elevated Work Platform (MEWP) access.
- The sequence of operations will be carefully planned, ensuring that the structures are built progressively to maintain access, and ensuring temporary stability. Temporary bracing may be required to ensure stability.
- Large span roof trusses will be assembled at ground level in two parts, which will be connected by an “air splice” to avoid tandem lifts.

b. Wall Cladding and Roof installation

- Equipment to be used will include: mobile cranes. MEWP access, scissor lifts, scaffold and tower access, fall arrest netting.
- The sequence of operations will be carefully planned to ensure the installation is progressed safely and efficiently.

4.4.8 Converter Station and Tail Station Fit Out

Once the buildings are weather-tight, the fit-out will be undertaken.

a. Floor screeds and finishes

- Floor Screeds and finishes will comprise a pumped floor screed and specialist concrete floor paints.

b. Internal walls and partitions

- Once the building envelope is water tight, internal walls will be constructed using a metal stud partition system. Plywood patresses will be installed where items are to be fixed to the walls. All walls will be painted. First and second fix joinery will be installed. Electrical equipment and instrumentation will be installed.
- A specialist subcontractor will install fire stopping which will undergo a very stringent monitoring system.

4.4.9 Converter Station and Tail Station Site Finishes and Surfacing

When site construction traffic is no longer a risk to finished surfaces and prior to the completion of the development, road surfacing will be completed, permanent site signage will be erected, unpaved areas within the converter station and tail station permanent fences will be surfaced with stone chippings. The surrounding areas will be landscaped.

a. Road Surfacing

- Top surface of binder will be thoroughly cleaned, and tack coat will be applied to the binder layer, prior to placing the surface course by the surfacing contractor.

b. Lining and Signage

- Road markings will be applied as soon as possible after the surface course has been placed. Equipment to be used will include an asphalt paving machine, ride-on rollers, floor saw, and planers.
- Permanent Road Signage will be installed.

c. Tail station Surfacing “chippings”

- The sub-base will be placed as structures are completed and backfilled.
- When areas are no longer subject to site traffic, the sub base will be trimmed and tail station surfacing – chippings – will be placed and compacted.

4.5 Onshore Cable Construction

4.5.1 Cable Construction Along a Road

4.5.1.1 Duct Installation in Roads, Footpaths and Verges

Schematics of HVDC and the HVAC trench dimensions and details are provided in **Chapter 3** in **Section 3.4**.

A section of route (road) approximately 100 metres long will be fenced-off at the start of a week, the road excavated, the ducts installed, and the trench backfilled with duct surround material (cement-bound sand or concrete, and compacted aggregate) each day. At the end of the week, the road base and wearing courses will then be reinstated over the completed trench.

Typical plant used will be:

- Road saw(s);
- Excavator, with hydraulic 'pecker' to break the road courses;
- 4-axle lorry, for removing excavated material; and
- Dumper(s), to take the excavated material to the 4-axle lorry, if it is not possible to locate the lorry at the end of the trench, and to deliver trench backfill materials.

A mobile welfare unit will be located nearby.

In general, because the full-depth trench will only be open for less than 24 hours, and the ground is well-compacted, internal supports will not be required.

Where possible, the construction easements will consist of the trench, safe clearance on either side, and a 5m corridor for the lorry and dumpers.

The spoil from the road courses will be disposed of, if it is not suitable for reuse. Likewise, the material excavated from the trench, which will be replaced by the ducts and surrounds will be removed. It may be possible to reinstate some of the crushed stone aggregate material that will be excavated from the trench, provided it is suitable. The excavated material will be stored adjacent to the trench, while the trench is open. Unsuitable material will be stored separately. Once the trench has been backfilled, any surplus or unsuitable material will be removed by truck, in a planned operation, in which the truck will be summoned to collect a load and will depart immediately, once loaded.

4.5.1.2 Installation of Ducts

Ducts are usually delivered to site in 6m sections. The ducts can be forced into bends, typically of 10m diameter, after they have been connected, but care will be taken to ensure that local over-bending does not occur at the connections. Pre-formed bends are available, at 3900mm radius for ducts of diameters suitable for this development, and bends at other radii may also be custom-made, if required.

Due to the way push-fit ducts are connected, with a considerable length of interference (i.e. the ‘male’ part is inserted at approximately 175mm) the ducts will be installed in a continuous process. Trying to insert ducts in gaps in the route e.g. at road crossings, requires a considerable length of duct to be lifted in order to provide the spare length to accommodate the interference, and there is a risk of disturbing good duct connections at either side of the gap.

For this reason, it is essential that the whole of each cable section is available and accessible before duct installation commences, and that one crew works from one end to the other. Multiple crews working on the same section is not practicable and will not be carried out.

The push-fit joints are designed to present minimum interference to the cable when pulled in one direction through the joint, from the ‘male’ end of one duct into the ‘female’ part of the next duct. Therefore, the installation of the cables will be planned before the ducts are installed, to ensure that the orientation suits the proposed pulls.

Cables can be pulled in the opposite direction, but additional scuffing of the cable oversheath, and increased pulling tensions, could occur.

A rope, usually a 6mm or 12mm nylon rope, will be left in each section of duct to enable cleaning equipment and the pulling bond to be pulled into the duct. The ducts will then be sealed.

4.5.1.3 Duct Proving after Completion of Cable Section

The ducts will be installed in such a manner to ensure the cables can be pulled into them without serious damage. Some scuffing of the oversheath is to be expected during any cable installation. The purpose of this part of the cable is to provide mechanical protection to the metallic sheath and the cable core.

A small excavation, typically two square metres, will be left open at each end of a cable section, i.e. at joint bay locations.

The ducts will be cleaned of any debris and water by a series of brushes and rubber discs, usually pulled trough as a ‘train’.

The pulling tension will be recorded for two reasons:

1. Validating assumptions regarding coefficients of friction between the bond wire and the unlubricated duct; and
2. Increases in pulling tension, compared with calculated values, can indicate local obstructions, ovality (caused by ducts being crushed during installation) or deviations from the designed route.

As the ducts will be proved immediately after installation, to allow time for any remedial works, the excavation of the joint bays and the installation of the cables will not happen immediately afterwards. The two square metre pits will therefore be re-instated.

4.5.1.4 Cables and Ducts Trench Construction Off-Road

A schematic of the arrangement of the construction activities, within the working width, which will be used for the construction of the portions of the cable route which traverse farmland is presented in Figure 4.6. A 30m construction working width (centred on the permanent wayleave) has been agreed with the landowners. As shown in **Figure 4.6**, the 30m temporary working width will give sufficient area for the excavation of the trench, storage of topsoil and subsoil arisings plus a temporary haul road for the movement of the excavation equipment and general installation vehicles for the delivery of materials such as ducting, protective covers and bedding.

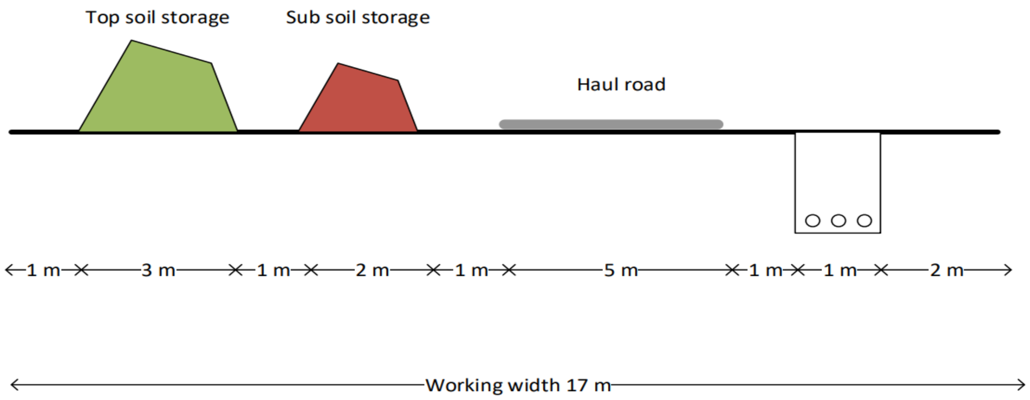


Figure 4.6: Working Corridor for Cables (source: WSP | not to scale)

Existing fences, hedgerows and/or walls will be removed as required for construction and replaced, on completion of the works, with appropriate materials in agreement with the landowner. It is recommended that the vegetation be removed outside of the breeding season. The temporary working areas will be fenced for protection of the public and livestock and to prevent trespass. The fencing will remain in place for the duration of the works and until reinstatement of the land to its original condition has been completed.

Where excavations cross existing farm tracks or roadways, obstruction will be minimised, and arrangements will be made for the safe passage of persons, farm machinery and livestock across the working width, as required by the landowner. All permanent farm tracks and roadways will be restored to their original condition.

Land drains, open drains or water courses, affected by the works, will be maintained until completion of the works and restored to their original condition. Water mains, affected by the works, will be reinstated as soon as is feasible, or an alternative supply provided on a temporary basis until the permanent supply can be reinstated. Where access to drinking troughs for animals are severed by the works, an alternative supply will be provided for the duration of the works.

Farmland will be reinstated to its original condition. Prior to the replacement of the topsoil, the subsoil will be ripped to below the depth of compaction, if possible, and levelled, and any roots, stones, shale and rock will be removed. Topsoil will be replaced, and additional topsoil provided, if required. Grassland will be reseeded, in consultation with the landowner. Vehicle traffic over the land, on which the topsoil has been replaced, with equipment heavier than a standard tractor and trailer, will be avoided.

On completion of the works all temporary buildings, fences, roadways, surplus materials debris, and materials not naturally belonging on the land will be removed.

4.5.2 Duct Installation by Horizontal Directional Drill

HDD is the method of installation of the cable which will be used at the landfall at Baginbun Beach, and the cable crossing of the Campile River Estuary. HDD is the preferred method for the cable crossing of the gas pipeline and the Kilmannock Stream. HDD is a technique whereby a hole is drilled under a feature so that the cable installation avoids disturbance of the feature. At a landfall these features could include sea defences, cliffs, dune systems or sensitive habitat. HDD can also be used to cross features such as railways, motorways or rivers. In the case of a landfall constructed by HDD, the bore would extend to a point at a suitable distance offshore, usually several hundred metres. A pipe is inserted into the drilled hole which is then used as a duct into which the cables are installed. Sufficient space is required behind the HDD bore to string out the HDD ducts to enable a direct feed into the boreholes.

Lengths of cables in HDDs can be limited by the maximum pulling tension of the cable and this will vary depending upon the cable mass, conductor cross-section, conductor material and, for the submarine cables, the design of the cable armouring. Also, the length of cable that can be delivered to the HDD location is another limiting factor.

Horizontal drilling rigs can be classified into three equipment sizes based on their capability: mini-rigs, midi-rigs and maxi-rigs. For HDD lengths exceeding 150m Maxi HDD rigs are required and for HDD lengths in the range 40m to 150m mini-rigs can be used. A maxi-rig will be required for the Campile River Estuary and landfall installation. A mini-rig would be used as the preferred method for the crossings of the gas pipeline and the Kilmannock Stream.

For on-shore cables, a typical maximum length for cables in HDDs will be in the range 700m - 1000m.

For offshore cables, a typical maximum length at the sea/land interface will be in the range of 1000m - 1500m. Very long HDDs (i.e. in excess of 1500m) at the sea/land interface could require cables with a special armouring design (i.e. a double layer of armour wires).

Typical burial depths for HDDs will be in the range of 5m - 10 m. As explained in **Chapter 3**, when cables are installed at a greater depth, then to maintain the rating of the cables, it will be necessary to increase the cable spacing. Typically, the axial spacing between ducts will be in the range of 5m – 10m. The depth of the HDD will be dependent on the ground profile and the cable spacing will be dependent upon the cable ratings.

For the Campile River Estuary crossing, the expected outer diameter of the HDD bore will be in the range of 200mm to 250mm.

The expected outer diameter of the HDD at the sea/land interface will be in the range of 350mm to 450mm.

The typical space required for a maxi-rig HDD entry set-up is up to 50m x 50m, providing room for the drilling rig, bentonite pumping plant and drill sections. **Figure 4.2** above shows the plan of the HDD contractor’s compound at the landfall at Baginbun. **Figure 4.7** shows a maxi-rig HDD drill rig.

For HDD works that have both the entry and exit on land, the space requirement for the exit compound is reduced as it only requires space for storage of the HDD pipe and welding equipment during the pipe fabrication process including the plant and welfare facilities.

Figure 4.7: Photo of Typical maxi-rig HDD Drill Rig

A schematic of a HDD at a typical landfall is shown in **Figure 4.8**. (Note there are no sand dunes at Baginbun). **Figure 4.9** illustrates the stages in a typical HDD duct installation at a landfall. The stages of duct installation will be similar at the Campile River Estuary HDD.

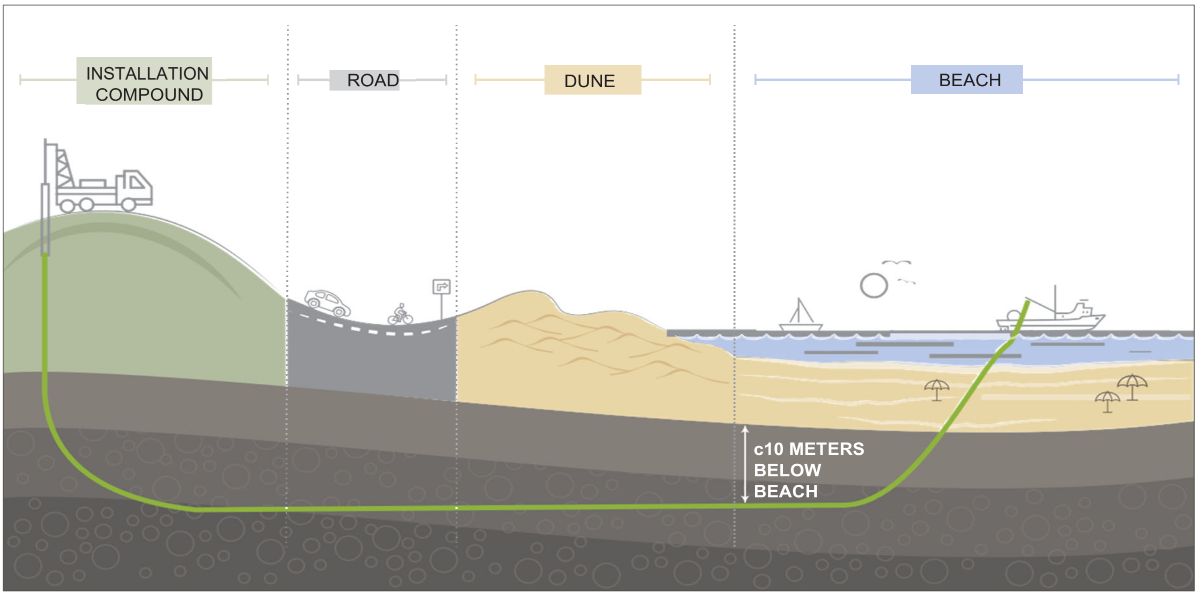
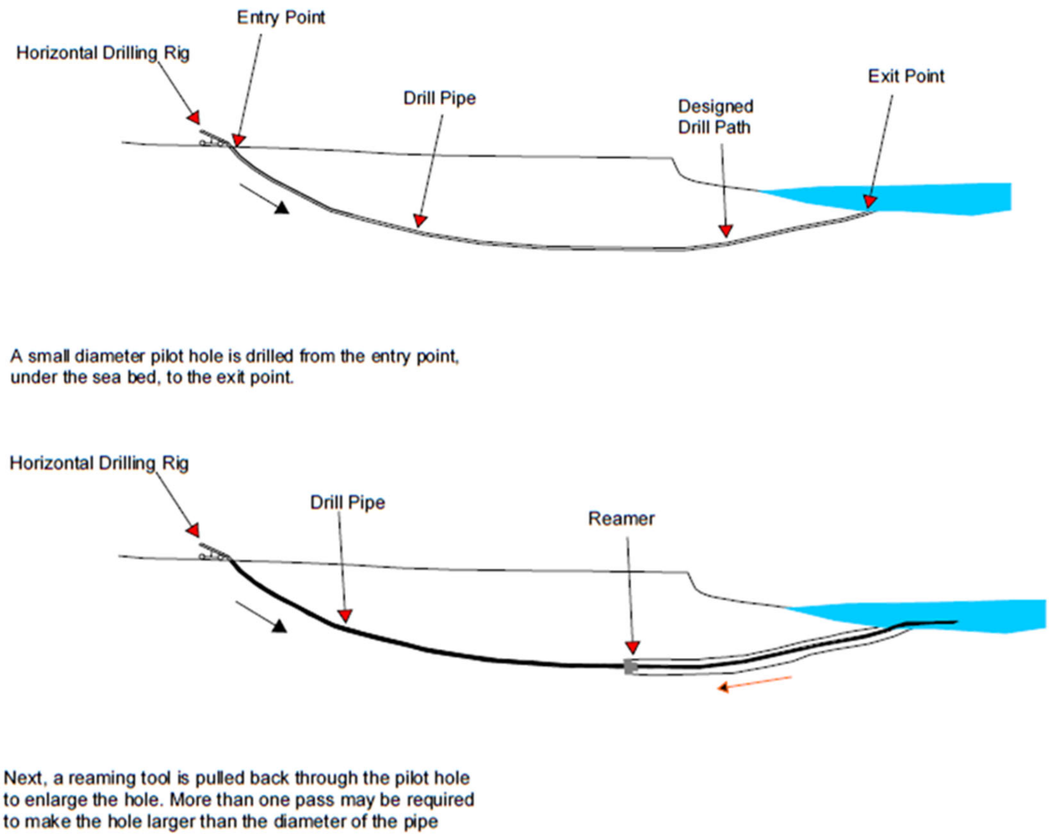


Figure 4.8 Typical HDD Installation at a Typical Landfall | not to scale



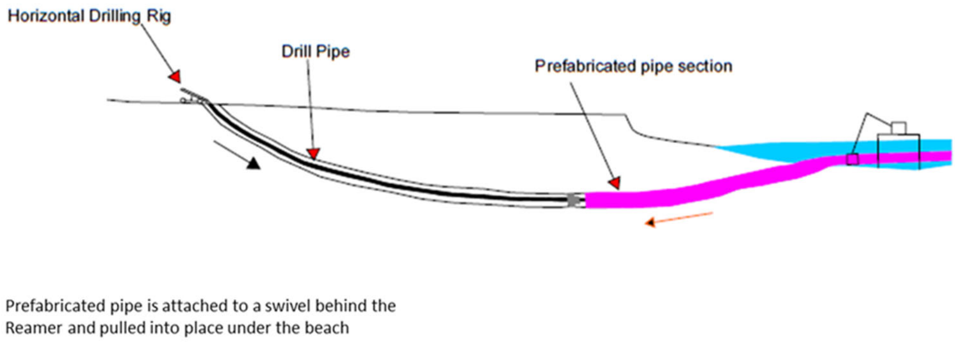


Figure 4.9 Typical Stages in HDD Installation at a Landfall

The drilling of the pilot bore may be performed by a specialist sub-contractor, working for the HDD contractor, using wire-guiding techniques to set the profile of the crossing.

The space required at the drilling exit point is small, as the HDD drill can be guided to within 0.5m. An area of 10m x 10m will be adequate. The bore will then be reamed to the required diameter.

The ducts are welded together and laid in a single length at one end of the crossing, to be pulled in a continuous process.

Once commenced, the HDD activity may operate continuously over a 24-hour period until each bore is complete. Consequently, lighting will be provided to provide a safe working area. Directional lighting will be employed to minimise light spill onto residences and adjacent areas and lighting configured to a minimum to meet health and safety requirements.

The HDD may require a drilling fluid to cool and lubricate the drill head. Typically, bentonite is used, which comprises 95% water and 5% bentonite clay which is a non-toxic, natural substance. The bentonite effectively seals the bore maintaining a closed system throughout the drill. The bentonite drilling fluid is circulated down through the drill rods and back up the outside the rods in the annulus of the borehole.

While the bentonite drilling fluid is non-toxic, if sufficient quantity enters a watercourse it can potentially settle on the bottom, smothering benthic flora and affecting faunal feeding and breeding sites. In saltwater environments the smothering effect is less problematic because seawater degrades the bentonite fluid, causing it to flocculate and allowing faster dispersal. Every endeavour will be made to avoid a breakout (loss of drilling fluid to the surface) and it will be remediated quickly if one occurs.

For landfall projects exiting below sea level, the pilot hole is usually stopped short of the exit point, within the bedrock, so that drilling fluid returns are not lost to the sea. The pilot hole is then enlarged using forward reaming; the reamer / hole opener being advanced from entry towards exit. The drilling fluid is pumped down through the drilling rods onto the cutting face of the reamer and then carries the cuttings back up the hole to the entry pit. From the entry pit the fluid is passed through the recycling unit to remove the cuttings before being pumped downhole again. It is expected that forward reaming will be suitable for Baginbun.

Any bentonite will be managed and removed by the specialist drilling contractor. Either tanked or piped water (local supply or farm water storage) will be utilised for lubrication of the bore, or alternatively suitably bunded settlement ponds may be installed within the site compound to provide the requisite volumes of water. The water used will be non-potable, if a supply is available.

The water or bentonite drilling fluid will be circulated down through the drill rods and back up the outside of the rods in the annulus of the borehole. Exiting into the entry pit, the fluid will then be pumped to the mud recycling unit where hydro-cyclones and shaker screens will remove cuttings. The cuttings will accumulate beneath the shakers and will disposed of at a landfill site as inert fill. The cleaned drilling fluid will be transferred to the active tank ready for circulation through the hole.

Figure 4.10 shows a HDD mini-rig, which would be used as the preferred method for crossing the gas pipeline and the Kilmannock Stream.

Figure 4.10: HDD Mini-Rig

The operation of mini-rigs is similar to that described above. However, mini-rigs utilise a small volume of cutting fluid which is located within a self-contained and small mobile vessel. The HDD mini-rig ancillary equipment is easily mobile on a small footprint with setup significantly quicker than the static equipment used by maxi-rigs. The mini-rig will be set-up and will operate within the normal working width and a separate HDD compound is not required. The trench will provide 1.5m separation between the bed of the watercourse and the cables. In addition, extra cable protection will be provided in the form of a concrete duct block.

For the crossing under the gas pipeline, a Gas Networks Ireland inspector will be present for the duration of the pipeline crossing works, to ensure adherence to Gas Networks Ireland procedures.

4.5.3 Joining of Cables

Typically, up to 1.8km of HVDC cable can be carried on a single reel. This results in one jointing bay being required every 1.8km of a cable installation, at a minimum. However, jointing bay locations depend on the geometry of the cable route. It is expected that there will be joint bays at circa 1km centres. Any works within private land will be agreed with landowners in advance of the works. The provisional locations of these joint bays are indicated in **Figure 4.11.**

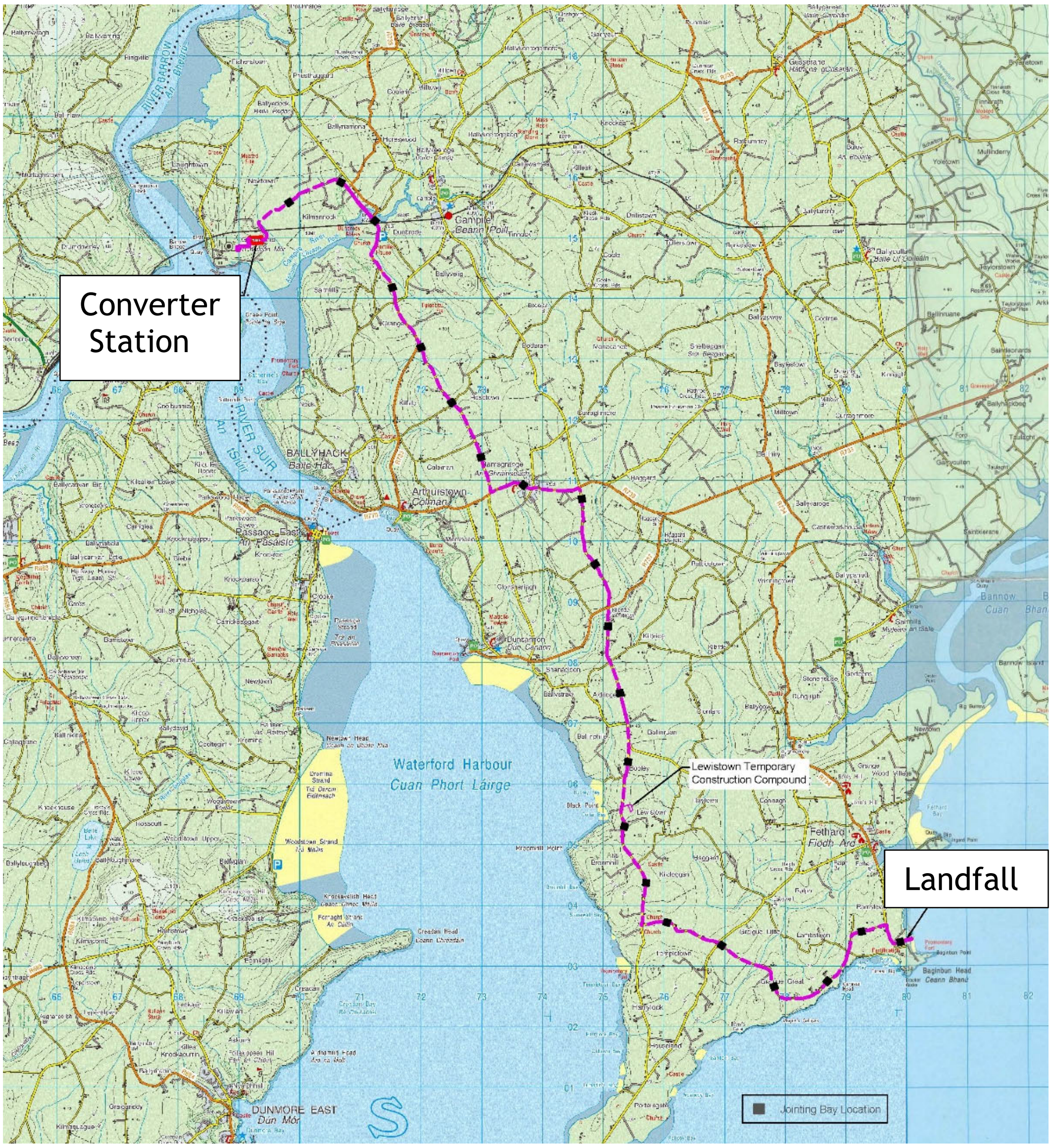


Figure 4.11: provisional Jointing Bay Locations | not to scale

A jointing bay provides a temporary safe and clean environment for an engineer to work in while connecting two cable ends during the installation process. A jointing bay can take many forms from a small tent to a shipping container. The form a jointing bay takes will depend on the amount of space available to work in, ground conditions and the type of joint being made. Once the joint has been made the cable will be buried in the same manner as the rest of the underground cable.

Typical joint-bay dimensions for one 320 kV HVDC circuit are shown in **Figure 4.12.**

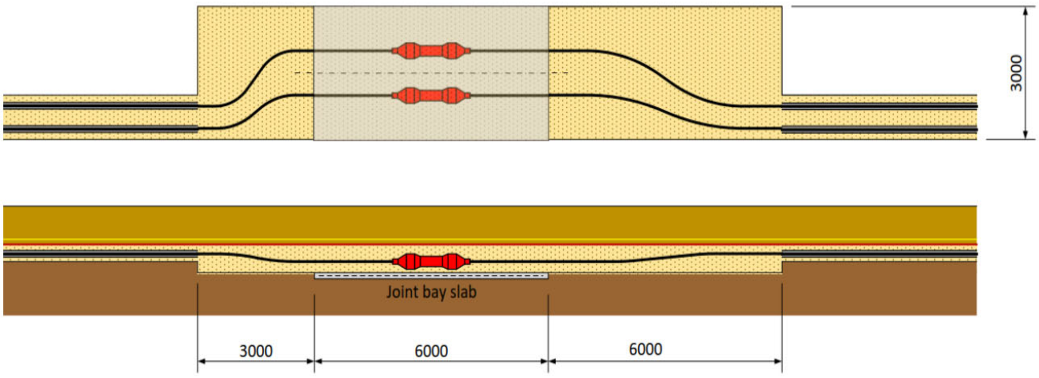


Figure 4.12: Typical Joint-Bay Dimensions (source: WSP | not to scale)

Adequate room will be provided in front and behind each joint-bay location to accommodate cable drums and pulling equipment. **Figure 4.13** shows a cable drum at a joint-bay location. Typical dimensions of the cable drum are 4.5m high and 3m wide, and the typical mass is 20 – 30 tonnes.

Figure 4.13: Cable Drum at Joint-bay location

The arrangements shown in **Figure 4.13**, where the cable is being pulled directly from the low loader, will be used. This arrangement will minimise the space required at each joint-bay location because no additional space would be required to off-load from the low loader and to manoeuvre the cable drum on to drum stands.

The joint-bays locations along a road will:

- Be positioned on a straight section of road;
- Not restrict access to properties;

- Provide adequate road width to accommodate the joint-bay width and have a minimum gap of 1.5m between traffic flow and the edge of any excavation (i.e. 3m + 1.5m = 4.5m);
- Provide adequate road width to limit road closures;
- Provide adequate road width to allow cable pulling;
- Provide adequate space along the road for parking, welfare facilities, generator etc.; and
- Provide adequate space for locating and accessing link-pillar (only at certain joint-bays).

Joint-bay locations will be chosen so that:

- Joint-bays will be kept away from access points e.g. driveways, entrances etc.;
- Adequate room will be provided in front of and behind each joint-bay location to accommodate cable drums and pulling equipment (i.e. winches);
- The ground conditions at all joint-bay locations will be proven by trial trenches;
- The selection of joint-bays will take account of the maximum calculated pulling forces and tensions in the cables being pulled;
- Joint-bay positions will avoid unnecessary road closures and traffic management;
- Associated communication chambers and link boxes will be installed off the carriageway where possible;
- There is adequate space along the road for parking cars, temporary welfare facilities, generator, fuel etc. This required space will be located along the road within the secured construction area; and
- For joint-bays located in road-ways, a clearance of at least 1.5 m will be allowed for between the edge of the excavation and an active lane with traffic, for safety and to protect the excavation from surcharges.

4.5.4 Landfall Transition Jointing Bay

The onshore cables, which will be to a different specification, will be connected to the marine cables at the Transition Jointing Bay (TJB) to be located below ground level in the HDD contractor’s compound adjacent to Baginbun Beach. The TJB at the sea-land interface will contain the following:

- 2 no. armour clamps (fixed to a concrete block);
- 2 no. HVDC cables joints;
- A fibre joint;
- A link-box or link-pillar; and
- There will be an earthing strip around the periphery of the joint-bay.

The dimensions of the sea/land TJB will be larger than a standard joint-bay (to allow for the additional space required for the armour clamps. Typically, the dimensions of the TJB will be 20 m long, 3 metres wide and 2 metres deep.

Following completion of the HDD and jointing activities, all cabling and jointing infrastructure will be below ground. The construction compounds at Baginbun will then be reinstated whereupon it can be returned to arable use.

4.5.5 Watercourse Crossing

The cable corridor crosses a watercourse, Kilmannock Stream, northeast of the converter station. The preferred method to cross the stream is a HDD using a mini-rig. The non-preferred alternative is an open-cut trench crossing.

With a trench crossing, the cable trenching detail at the stream crossing would not differ from the standard. However, the trench would be deeper to provide a 1.5 metre minimum separation between the cable protective measures and the bed of the watercourse. In addition, extra cable protection is required, in the form of a concrete duct block. Temporary works would be required to enable the cable duct installation. The watercourse would be temporarily dammed immediately upstream and downstream of the cable installation. Over-pumping would be employed to ensure continuous flow in the watercourse. Best practice pollution prevention measures, described in **Chapter 13**, would be installed to avoid any downstream siltation impacts. Once reinstatement of the cable trench would be complete, the temporary dams would be removed, and over-pumping ceased.

With the preferred HDD crossing, the stream would not need to be dammed, no instream works would take place and a duct block would not be required for extra cable protection.

No specific haul road is proposed at the watercourse crossing. Plant will utilise existing accesses used by landowners to avoid any potential impacts on the watercourse. Vegetation will not be significantly adversely affected as the access routes from each side of the watercourse will utilise existing gates, laneways and tracks.

If an open-cut trench crossing is required, the excavated material from this activity will be stored outside of the designated flood zone.

4.5.6 Gas Pipeline Crossing

The HVAC cable from the Loughtown tail station to the Eirgrid Great island 220kV substation will be laid under the Gas Networks Ireland high pressure gas pipeline in the SSE power station site. The pipeline is approximately 1.2m below ground level at this location. The pipeline will be located by hand-digging.

A HDD mini-rig, described in Section 4.5.2 above, is the preferred method to install the cables under the gas pipeline. The alternative is a trenched crossing, under the pipeline. In the case of a trenched crossing, once the pipeline had been located, it would be uncovered by hand digging. Protective timbers would be strapped around it. The trench would be deepened to allow the ducts to be installed under the pipeline.

The protective timbers would be removed as the trench would be backfilled carefully by hand. A HDD would install the cables well under the pipeline and hand digging, once the pipeline was located, would not be required.

A Gas Networks Ireland (GNI) inspector will be present for the duration of the pipeline crossing works, regardless of the cable installation method chosen, to ensure that the Gas Networks Ireland procedures are adhered to. GNI has been consulted on the crossing of this pipeline.

4.5.7 Off-Road Locations Along Cable Route

4.5.7.1 General

There are a number of special locations along the cable route, at which the cable diverts from the public road or at which a greater construction area is required. These are described below.

At each of these locations it will be necessary to remove the hedgerow or field boundary and install fencing to secure the area. **Section 4.5.1.4** above describes the measures which will be implemented in farmland during and after the construction phase.

4.5.7.2 Ramstown

In the townland of Ramstown, northeast of the landfall at Baginbun, the road, along which the cable is routed, goes through an almost right-angle bend. In order to facilitate construction, the working area will be extended into farm land on the eastern side of the road at the corner, with the agreement of the landowner. **Figure 4.14** shows the offline locations in Ramstown.

Figure 4.14 Offline Area in Ramstown | not to scale

4.5.7.3 Graigue Great Areas 1 and 2

At two locations in the townland of Graigue Great, in order to facilitate construction, the working area will be extended into farmland to the south and west of the road. **Figure 4.15** shows the offline locations in Graigue Great.

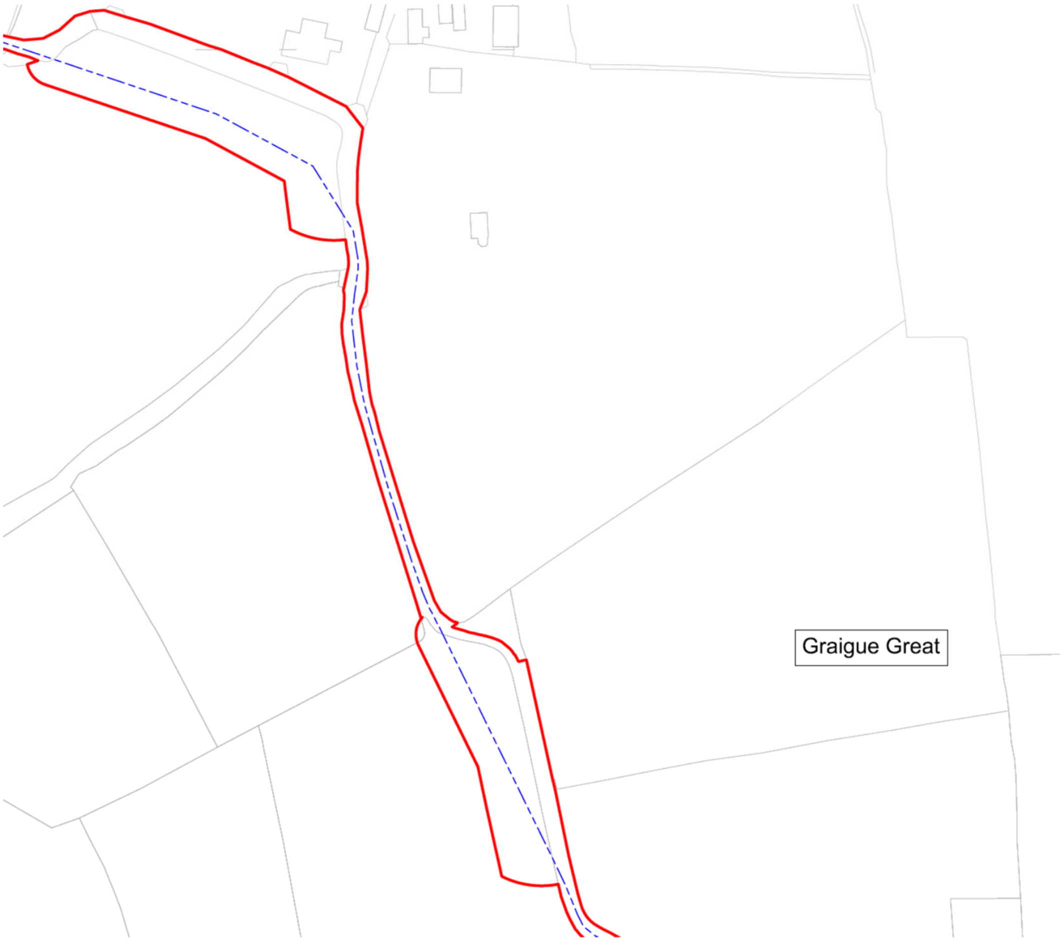


Figure 4.15 Offline Areas in Graigue Great | not to scale

4.5.7.4 Templars Inn

At Templars Inn in the townland of Templetown, the road, along which the cable is routed, goes through an acute angle bend. In order to facilitate construction, the working area will be extended into farm land on the southern side of the road at the corner, which will include the temporary removal and reinstatement of a low level concrete wall, with the agreement of the landowner. **Figure 4.16** shows the offline location in Templetown.

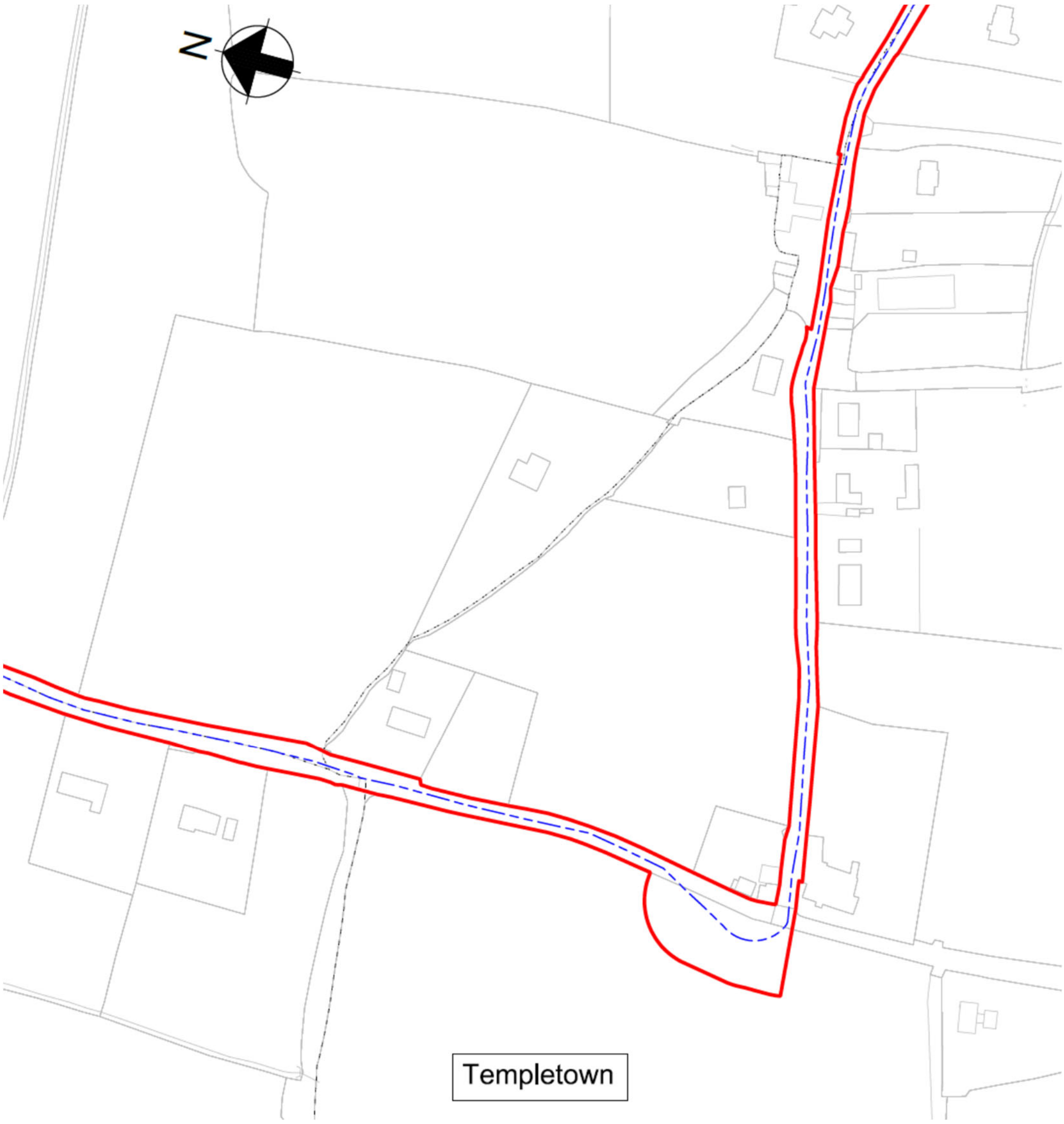


Figure 4.16 Offline Area in Templetown | not to scale

4.5.7.5 Ramsgrange

In the townland of Ramsgrange, on the eastern outskirts of Ramsgrange Village, the cable route goes through an almost right-angle bend. In order to facilitate construction, the working area will be extended into farmland on the southwestern side of the road at the bend, with the agreement of the landowner. **Figure 4.17** shows the offline location at Ramsgrange.

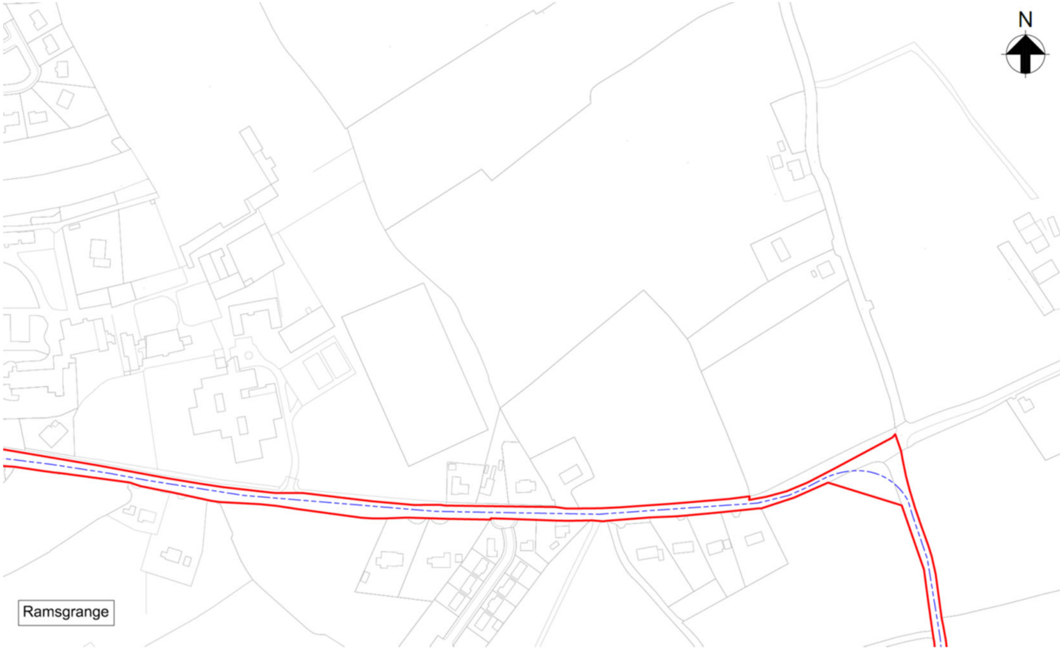


Figure 4.17 Offline Area in Ramsgrange | not to scale

4.5.7.6 Coleman

In the townland of Coleman, on the western outskirts of Ramsgrange Village, the cable route goes through an almost right-angle bend. In order to facilitate construction, the working area may be extended into farmland on the southern and western side of the road at the corner, with the agreement of the landowner. **Figure 4.18** shows the offline area in Coleman.

Figure 4.18 Offline Area in Coleman | not to scale

4.5.7.7 Railway Crossing at the Campile River Estuary

There is a railway line on the eastern side of the Campile River Estuary in the townland of Dunbrody. The railway is carried on a bridge over the road at this location. The cable will be installed in this road. Cable installation will be typical for cable installation in a road which is described in **Section 4.5.1**. Apart from complying with the head height restriction, no special construction issues are anticipated.

4.5.7.8 Campile River Estuary to the Great Island Converter Station Site

From the railway line on the eastern side of the Campile River Estuary to the converter station site at Great Island, the cable will be constructed off-road, across farmland. The Campile River Estuary will be crossed by HDD. As described above, the planning application is for two HDD compounds, one either site of the Estuary. However, it is expected that only one of these compounds will be required. The HDD receiving pit will require a much smaller area, as described in **Section 4.5.2** above. It will be necessary to take down some of the hedgerow on the eastern side of the estuary to access the land for

HDD compound. Access to the off-road working area south of the Campile River Estuary will be via an existing gated farm entrance immediately south of the Dunbrody Bridge. This farm gate may need to be widened to allow heavy goods vehicle access. The cable will be routed under an existing stone wall at this location. The stone wall will be removed and reinstated after completion of the trench works, with the agreement of the landowner.

Access to the off-road working area between Great Island and the western side of the Campile River Estuary will be via an existing farm entrance in the townland of Kilmannock, where the cable route turns onto a western alignment, to the west of the Campile river.

A disused railway line crosses the route in the townland of Great Island. The railway is carried on a bridge over a track at this location. The cable will be routed in this track. Cable installation will be typical for cable installation in a road. Apart from complying with the head height restriction, no special construction issues are anticipated.

4.5.8 Invasive Species Management

The non-native and invasive species Japanese Knotweed (*Fallopia japonica*), Rhododendron (*Rhododendron ponticum*) and Three Conered Leek (*Allium triquetrum*) were recorded within or in proximity to the proposed works area. All three species are listed on both the “Most Unwanted: Established Threat” and on the “High Risk: Recorded Species” list compiled by Invasive Species Ireland a joint initiative by the Northern Ireland Environment Agency and NPWS. The Amber listed species Winter Heliotrope was recorded within the works area and is ubiquitous along roadside verges in this area and was too prevalent to effectively map.

An Invasive Species Management Plan is included as **Appendix 9.6** to this EIAR and includes the following protocols for the management of the aforementioned species.

Japanese Knotweed

- All stands of Japanese Knotweed will be clearly delineated with hazard tape and fenced in a manner visible to machine operators prior to the commencement of works;
- Appropriate signage will be put in place to deter any entrance by people or machinery into the areas within which the Japanese Knotweed is growing;
- At each location a specialised wash down area will be created for machinery and footwear. All machinery and equipment (including footwear) should be power washed prior to leaving the contaminated works area within this wash down area. All water from the wheel wash will be collected, fully contained, and dispatched for treatment and disposal off-site. They will also be visually checked for clods of soil, bits of vegetation etc. and particular care is required with tracked machinery;
- This wash down area will be located in close proximity to existing stands and the wash down area will be included in the post-works treatment programme for Japanese Knotweed; and

- Should stockpiling of contaminated material be required, the areas will be clearly marked out on site. These areas will not be within 50m of the seashore or within a flood zone.

Rhododendron

- The exact treatment details will be outlined in a detailed management plant prepared by the treatment contractor and supervising ecologist will be finalized prior to the commencement of treatment. The following principles/guidelines will be implemented;
- The entire site and adjacent area will be surveyed and the level of infestation assessed and mapped prior to the commencement of treatment works;
- The age, condition and any previous treatments of all stands will be noted and mapped;
- Areas to be treated will be prioritized. However, the objective is complete removal within the works area; and
- An updated Rhododendron Management Plan will be prepared by the contractor with input from the supervising ecologist. The plan will encompass the entire site and include projections over a suitable timeframe. All work to be carried out in the area should be mapped and clearly dated and detailed in an accompanying schedule, along with a timeframe for follow-up work.

4.6 Commissioning Activities

Commissioning of the converter station and tail station will involve the following activities:

- Pre-commissioning;
- Sub-system testing;
- HV energisation;
- Performance testing;

As each item of equipment, sub-system and each system will be tested, it will be an intensive process and will take circa 8 months.

Cable acceptance testing and commissioning will take between one and two months.

4.7 Construction Access, Haul Routes and Abnormal Loads

4.7.1 Road Access, Haul Routes, Transport of Abnormal Loads by Road

Access to the construction compounds and working areas from the local road network, haul routes for equipment including cable drums and provision for the transport to the sites of abnormally large loads by road, are addressed in **Chapter 6**, *Traffic and Transportation*.

4.7.2 Transport of Abnormal Loads by Sea

A number of specialist components will require delivery to site. The largest individual items of equipment are expected to be the four single phase transformers. The maximum transformer dimensions are 8.5m x 5m x 5m. The transformers and other abnormally large loads may be transported by road. The potential impacts of transporting them by road are addressed in **Chapter 6**, *Traffic and Transportation,* **Section 6.5.1**.

During construction of the SSE power station, a number of abnormally large loads were delivered by sea, to a berth on the southern shoreline of the power station site. With the agreement of SSE, this method of delivering abnormal loads to site will be an option for the converter station contractor. A detailed assessment will be undertaken by a specialist logistics contractor during the construction phase; however the feasibility has been determined based upon the transport routes shown in **Figure 4.19**. The preferred route through the power station site is circa 1.6km in length. An alternative route around the perimeter of the site (also shown in **Figure 4.19**) has also been considered. A portion of both these routes is within the boundary of the site covered by SSE industrial emission licence, PO606-03.

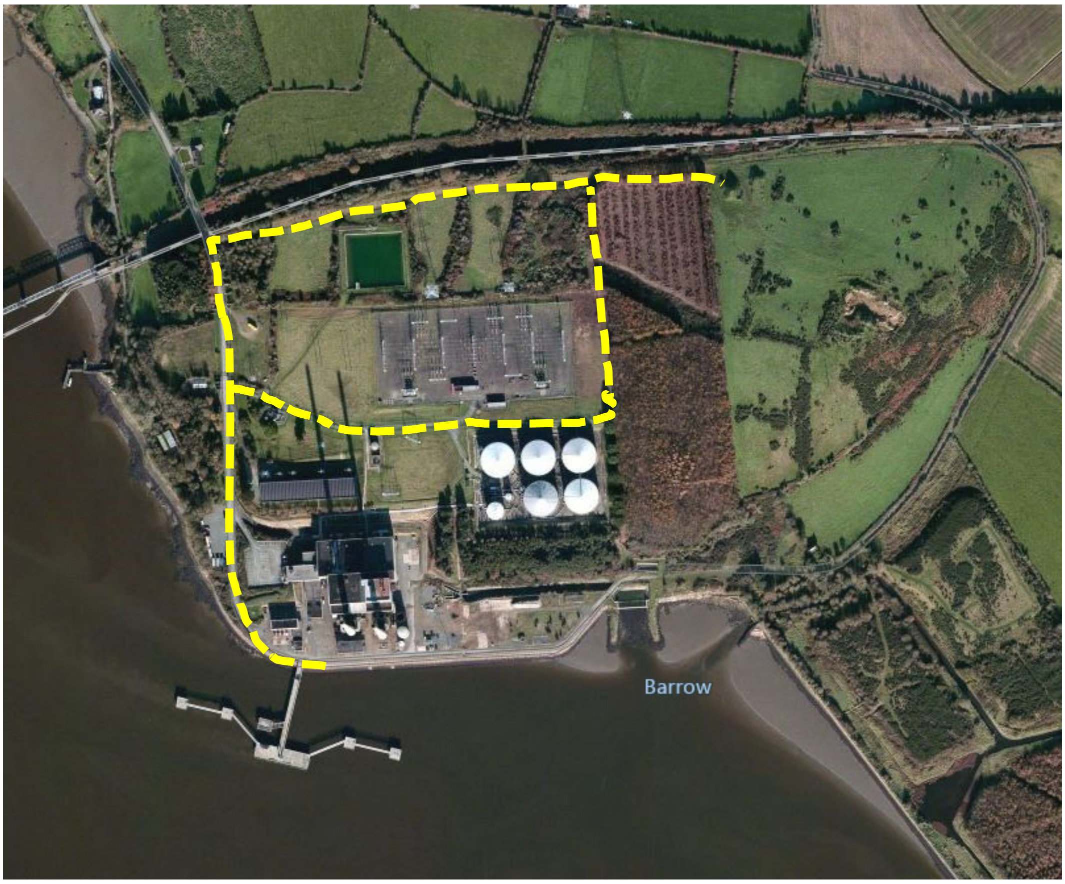


Figure 4.19 Transport Routes from SSE berth to Great Island Converter Station | not to scale [mapping © Microsoft Bing 2020]

The delivery vehicle which has been assessed is a 10 axle 2-file hydraulic trailer with one or two tractor units. An overview is shown in **Figure 4.20**.

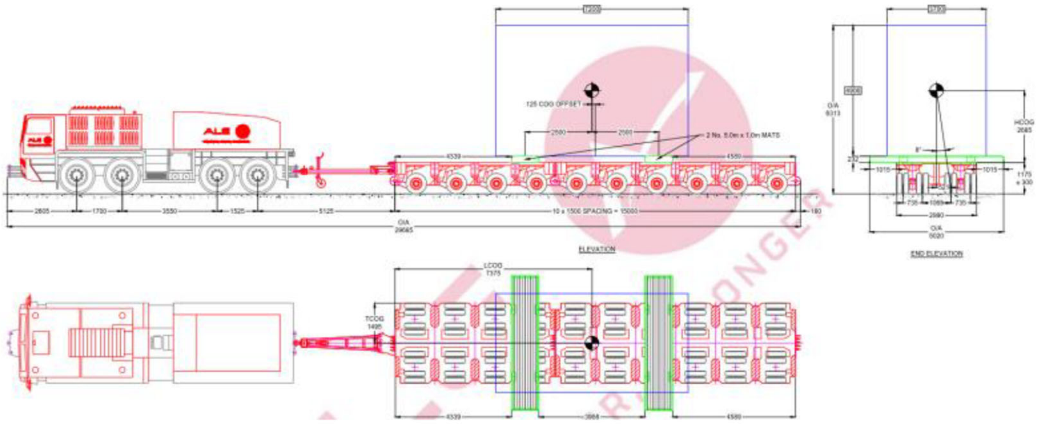


Figure 4.20 10-axle 2-file hydraulic trailer with one or two tractor units | not to scale

Most seagoing vessels are too deep to reach the Great Island power station temporary berth. Therefore, a trans-shipment onto a flat top barge at their port of arrival in Ireland, which is likely to be Belview Port or Rosslare Harbour, will be necessary to enable a roll-off operation at the Great Island power station temporary berth.

Depending upon the specification of the flat top barge, it may be necessary to temporarily remove part of the jetty bridge (this work would not be located in the foreshore). The detail will be discussed and agreed with SSE who have confirmed that similar deliveries have been made with the same quayside apparatus using established and routine methodologies.

The following works will be undertaken ahead of this delivery:

I. the fence at the top of retaining wall (adjacent to the quayside) will need to be removed and reinstated.
II. the existing access road (along the delivery route) will require localised repair and improvement to wearing coarse.

On arrival at the Converter Site, setting the transformers onto the foundation can be either done by jacking and skidding mode or gantry system procedure from hydraulic trailer directly to the place of installation.

Assessments have been carried out to confirm that these activities are feasible.

Provision will be made to ensure continued access to the adjacent site (proposed battery storage facility) during the construction period.

4.8 Site Management

4.8.1 Employment

Greenlink is anticipated to provided employment to 250 people in Ireland during the construction phase.

A breakdown of the number of workers on site for the cable installation during the construction phase is presented in **Table 4.3**.

Table 4.3: Estimate of workforce required for the installation of each of the three sections of the onshore cable

Project stage	Estimated no. of people	Comments
Initial stage	Approximately 10	Typically, project manager, environmental manager, SHEQ manager, project engineers, planner, CAD resources, admin.
Civil construction	30-40	Site supervision increases, the civil contractor joins the project with their project manager, supervisors and installation crew.

Cable installation and jointing	40-50	Cable jointing supervisors and jointers increase the team numbers.
Testing and commissioning	Approximately 25	Some sub-contractors and most cable jointing staff leave site. Cable test managers arrive.
Final commissioning and reinstatement	Approximately 20	Staff dealing with all the final document, snagging issues and reinstatement of hedgerows etc.

Up to 190 will be employed on site on the construction of the converter station and tail station. Circa 10 will be employed on the landfall HDD construction and the Campile River Estuary HDD.

4.8.2 Working Hours

The timing of construction activities, core working hours and the rate of progress of construction works are a balance between efficiency of construction and minimising nuisance and significant effects.

The core construction working hours for the proposed development will be:

- 7am – 7pm: Monday to Friday; and
- 8am – 2pm: Saturday.

The hours above correspond to the current construction programme.

Underground activities (i.e. tunnelling works to lay cables) will occur 24-hours a day, 7-days a week for the duration of the activity. The permissible noise levels are detailed in **Chapter 8** *Noise and Vibration* where 'daytime' noise limits are defined as 7am to 7pm, and lower permissible noise levels are stipulated outside these hours.

Rock breaking/fracturing activities will be undertaken during daytime hours. The removal of waste material off site by road and regular deliveries to site would be generally confined to daytime hours but outside of peak traffic hours (i.e. 10am to 4pm). If blasting is required to excavate rock at the converter station site, the noise levels associated with this activity will not exceed those predicted for rock-breaking, and specific mitigation measures will be implemented to ensure that adverse effects on the Gas Networks Ireland transmission pipeline are avoided.

It may be necessary in exceptional circumstances to undertake certain activities outside of the core construction working hours. Any construction outside of the core construction working hours will be agreed in advance with Wexford County Council and scheduling of such works will have regard to nearby sensitive receptors.

4.8.3 Site Access

Dedicated construction access to the site will be required at each of the construction compounds. All accesses will be temporary and used solely during the construction period.

All site access routes will be connected to the existing local road network. Minor road works may occur such as removal of existing kerbs, paving and a small amount of excavation prior to replacement of paving and realigned kerbs.

4.8.4 Utilities and Services

Surface and sub-surface infrastructure services and utilities which may be temporarily affected during the construction works are as follows:

- Water;
- Foul and surface water drainage;
- Gas;
- Electricity;
- Telecommunications; and
- Utilities owned by stakeholders.

Surface and sub-surface infrastructure services and utilities which may be affected are addressed in **Chapter 16** *Material Assets*.

4.8.5 Hoarding

A site boundary in the form of hoarding or fencing will be established around each of the working areas before any significant construction activity commences, as described above.

The hoarding/fencing will be 2.4m high to provide a secure boundary to what can be a hazardous environment for those that have not received the proper training and are unfamiliar with construction operations.

Site hoarding will also perform an important function in relation to minimising nuisance and effects including:

- Noise emissions (by providing a buffer);
- Visual impact (by screening the working areas, plant and equipment); and
- Dust minimisation (by providing a buffer).

The erection of hoarding will be of a similar nature as to what is carried out on most construction sites. Mounting posts will be erected by using a mini-digger and the posts will be set in concrete. The size and nature of the posts and hoarding will depend on the requirements for any acoustic mitigation as well as preferences that the contractor may have.

Where practicable, hoarding and fencing will be retained and re-configured and re-used between working areas as the construction activities progress.

4.8.6 Services and Site Lighting

Site services will be installed in parallel with the rearrangement and diversion of existing utilities, where relevant. The working areas will be powered by mains supplies or diesel generators where an electrical supply is not available.

Site lighting will typically be provided by tower mounted 1000W metal halide floodlights that will be cowled and angled downwards to minimise spillage to surrounding properties.

4.8.7 Deliveries to Site

Deliveries of materials will be planned and programmed to ensure that the materials are delivered only as they are required at the working areas. Works requiring multiple vehicle deliveries, such as concrete pours, will be planned so as to ensure there will no queuing on the public roadways around the working areas. Deliveries will be limited to outside of peak hours.

4.8.8 Cranage

The construction works will require the use of standard mobile cranes on site. The cranes will be required for the moving of building materials on site such as concrete pipes, formwork for concrete, reinforcement, precast concrete, steelwork, façade, plant and general building materials. Again, the use of mobile cranes may be adopted to assist in the installation of the converter station, the converter station building façade and mechanical plant. Heavy machinery transport on the road network to and from working areas will be restricted to outside of peak hours.

Assessments have been carried out to confirm that these activities are feasible.

4.8.9 Community Liaison During Construction

Greenlink Interconnector Limited recognises the importance of effective community liaison in order to reduce nuisance to residents during the works, to ensure public safety and welfare, and to help ensure the smooth running of construction activities. Important issues in ensuring good relations are:

- Providing information for the public during the construction phase, (particularly nearby sensitive receptors);
- Providing the correct points of contact and being responsive; and
- Ensuring good housekeeping in all aspects of the operations.

A 'good neighbour' policy will be implemented, as far as possible. Key aspects of this policy include:

- Early implementation of the policy i.e. from the commencement of construction;
- Reduction of nuisance factors;
- Maintaining access to neighbouring premises;
- Clear and concise information; and

- Undertaking timely liaison with stakeholders.

With regard to liaison, the Contractor will be required to prepare a Community Liaison Plan, which will include details of how the local community, road users and affected residents will be notified in advance of the scheduling of major works, any temporary traffic diversions and the progress of the construction works.

This plan will typically include details of the following:

- Contractor's community relations policy;
- Personnel nominated to manage public relations;
- A methodology for processing observations, queries and complaints from the general public, relevant authorities, the media and emergency services; and
- The strategy for project-wide liaison with all relevant parties.

A liaison manager will be responsible for managing such tasks as the following:

- Briefing neighbours on progress and issues as necessary;
- Liaison with Wexford County Council and emergency services as appropriate;
- Liaison with local Gardaí, particularly in relation to traffic movements and permits where necessary; and
- Contact details for the liaison manager will be posted on all construction site notice boards and on any other information or correspondence, which may be distributed from time to time.

4.9 Materials Management

4.9.1 Excavated Materials

Excavated material as part of the construction works will generally consist of:

- Rock, mainly from the converter station platform;
- Topsoil and subsoil; and
- Made ground.

The ground level of the converter station platform has been chosen to balance the volume of excavated material with the volume of fill, as far as is feasible.

The total volume of excavation will be 70,900m^3. This will be made up of topsoil, subsoil, weathered rock and intact rock. The rock will be crushed to make it suitable for reuse. However, some of the material, which will be excavated, may be unsuitable for use within 500mm to 1 metre of a structure. Therefore, it is possible that up to an additional 20,500 cubic metres of crushed stone structural fill will be imported to ensure suitable foundations for structures on the site. Circa 23,150m^3 of excavated material will be used to create the platform on which the converter station and tail station will be constructed. Up to 47,750m^3 of excavated material will be reused in the landscaping screening berms, which will be located to the south and the east of the converter station platform. Thus, there will be no export of spoil from the converter and tail station site, while the import of fill will be minimised.

The estimated earthworks balance is presented in **Table 4.4** below.

Table 4.4: Earthworks Balance Table (estimated values)

	Quantity	Totals
Total excavation required to create platform	60,650m^3	
This excavated material will consist of topsoil, rock and subsoil		
1. Topsoil	9,050m^3	
2. Intact and weathered rock	23,000m^3	
3. Subsoil	28,600m^3	
Additional excavation for 1m of structural fill under building footprint	10,250m^3	
Total excavation		**70,900m^3**
Maximum structural fill to be imported (1m over building footprint)	(up to) 20,500m^3	
Fill required to create platform	33,400m^3	
1m of structural fill under building footprint	10,250m^3	
Excavated material to be used to create platform	23,150m^3	**23,150m^3**
Excavated material to be used in landscaping		**47,750m^3**
South of converter station	40,000m^3	
East of converter station	7,750m^3	

Transport of material to and from the site will be managed in accordance with the construction traffic management measures outlined **Chapter 6** *Traffic and Transportation* and included in the Construction Environmental Management

Plan (CEMP) to ensure that there will be no queuing of trucks on public roadways around the working areas.

A significant proportion of the surplus excavation material from the landfall site and cable route will consist of uncontaminated soil, stone and naturally occurring material which may be reused in its natural state within the site. This reuse is certain and as such the material is not deemed to be a waste in accordance with Article 2 of the Waste Framework Directive (2008/98/EC) (EC, 2008) and Section 3 (c) of the Waste Management Act 1996 (as amended).

Surplus uncontaminated material from a greenfield site (or equivalent) may be moved off-site as material or a by-product according to criteria as set out in the Directive, and in accordance with EPA guidance. **Chapter 14** *Resource and Waste Management* provides further information.

Any surplus excavated material from the construction of the trench will be taken offsite to a suitably licenced facility immediately by waiting trucks.

In the very unlikely event that asbestos is uncovered, the Asbestos Containing Material will be double-bagged, stored, collected and removed from site by a competent contractor and disposed of in accordance with the relevant procedures and legislation. As requested by Wexford County Council the appointed contractor will have a sufficient stock of pipe on site in order to minimise the repair time by the local authority.

A Construction Waste Management Strategy has been established and is included as part of the CEMP (**Appendix 4.1**).

4.9.2 Construction Materials Requirements

The proposed development will have a requirement for imported materials, primarily concrete, crushed stone, road paving materials and steel, for the construction of the converter station and crushed stone and PVC ducting for the construction of the cables.

Concrete, sand, crushed stone and steel will be imported to site during the construction works, when required. Breakdowns of the volumes of these materials required are presented below:

4.9.2.1 Cable Route

Concrete in Cable Routes

There will be a weak mix concrete (i.e. CBS, a 14:1 sand/cement mix) required for most of the cable route. A standard concrete pad will be required at the base of the joint-bay. Estimated volumes of concrete required for the cable route are provided below.

HVDC Circuit:

- Estimated volume of weak mix concrete (i.e. 14:1 sand/cement mix) per metre of trench = 0.2 m^3.
- Estimated volume of weak mix concrete per route = 4,590 m^3.
- Estimated volume of standard concrete per joint-bay = 7m^3

- Assuming 22 joint-bays, estimate volume of standard concrete = 22 x 7 = 154 m^3.

HVAC Circuit:

- Estimated volume of weak mix concrete (i.e. 14:1 sand/cement mix) per metre of trench = 0.5 m^3.
- Estimated volume of weak mix concrete per route = 210 m^3.

The above values should be regarded as a rough estimate.

Sand

Weak mix concrete is comprised primarily of sand. The estimated volume of sand required for the cable route is approximately 4450m^3.

Cable Materials

Total HVDC cable length will be circa 46000m (based on two cables required within the 22.95kilometre route).

Total HVAC cable length will be circa 1400m (based on three cables required within the 0.45kilometre route).

Total fibre optic cable length will be 23000m.

4.9.2.2 Construction compounds and Converter Station and Tail Station

Crushed Stone - Imported Structural Fill

Approximately 20,500m^3 of crushed stone structural fill will be imported for the converter station and tail station site.

Crushed Stone and Stone Chippings

The temporary HDD compounds, temporary cable contractor compounds, temporary converter station compound, haul roads, and converter station and tail station stone chipping site cover will require approximately 13,100 m^3 of crushed stone.

Concrete in Converter station and Tail Station

The converter station and tail station foundations and the other concrete structures on the site will require circa 4370m^3 of concrete.

Steel Reinforcement

The reinforced concrete elements in the converter station and tail station will require approximately 870tonnes of reinforcing steel.

Steel

The structures on the converter station and tail station site will required circa 460tonnes of structural steel.

Steel Cladding

The buildings on the converter station and tail station site will require approximately 7200m2 of roof and wall cladding.

Road Surfacing – Asphalt and Crushed Stone Sub-base

The permanent site access road and internal roads will require circa 935m^3 of asphalt and 2600m3 of crushed stone sub-base.

4.9.3 Materials Storage

The storage of materials in working area construction compounds will be limited to materials required in the short term. The main construction compounds, located at the proposed converter station site, Lewistown and the landfall site, will be used as the primary location for storage of materials, plant and equipment, site offices, welfare facilities and car parking.

No stockpiling will be permitted in any other areas, apart from in the immediate vicinity of the cable route, where excavated material will be stored temporarily, while the trench is open. Surplus excavation material will be removed off site by an authorised waste Contractor to an appropriately licensed/permitted waste facility. A surface water management strategy, as detailed in the CEMP, which is provided in **Appendix 4.1**, will be implemented at all working areas. These measures will prevent any silt-laden run-off, including that from stockpiles, entering nearby watercourses.

The following construction management measures will be implemented at all construction compounds.

- Any containers of potential polluting materials such as fuels and oils will be stored in a bunded area protected from flood damage and inundation;
- All bunded storage areas will be a minimum distance of 10m away from any watercourse;
- All bulk fuel storage will be integrally bunded or kept within a bunded area;
- A designated bunded refuelling area on an impermeable surface will be provided at all construction compounds, again at a minimum distance of 10m away from any watercourse.

4.10 Safety Management

4.10.1 Health and Safety

The Contractor will be required to ensure all Health & Safety, Fire Safety and security requirements are provided for in co-ordination with Wexford County Council and Greenlink Interconnector Limited. The contractor will prepare a Construction Traffic Management Plan. This is to protect the public in the vicinity of the working areas during the construction phase of the works and will include all suitable temporary signage, barriers and hoarding as necessary. **Chapter 6** provides more information on the issues to be addressed in the Plan.

All construction staff and operatives will be inducted into the security, health and safety and logistic requirements on site prior to commencing work.

All Contractors will be required to progress their works with reasonable skill, care and diligence and to proactively manage the works in a manner most likely to ensure the safety, health and welfare of those carrying out construction works, all other persons in the vicinity of the working areas and interacting stakeholders.

Contractors will also have to ensure that, as a minimum, all aspects of their works and project facilities comply with legislation, good industry practice and all necessary consents.

The requirements of the Safety, Health and Welfare at Work Act 2005 (Government of Ireland, 2005), the Safety, Health and Welfare at Work (Construction) Regulations, 2013 (Government of Ireland, 2013), as amended, (the "Regulations") and other relevant Irish and EU safety legislation will be complied with at all times.

As required by the Regulations, a Health and Safety Plan will be formulated which will address health and safety issues from the design stages through to completion of the construction and maintenance phases. This plan will be reviewed and updated as required, as the development progresses.

In accordance with the Regulations, a 'Project Supervisor Design Process' has been appointed and a 'Project Supervisor Construction Stage' will be appointed as appropriate.

The Project Supervisor Construction Stage will assemble the Safety File as the project progresses.

4.10.2 Emergency Response Provisions

Appropriate site personnel will be trained as first aiders and fire marshals. In addition, appropriate staff will be trained in environmental issues and spill response procedures. Tanks and drums of potentially polluting materials will be stored in secure containers or compounds which will be locked when not in use. Secure valves will be provided on oil and fuel storage facilities. Equipment and vehicles will be locked, have keys removed and be stored in secure compounds.

The Contractor will be required to maintain an emergency response plan which will cover all foreseeable risks i.e. fire, flood, collapse etc.

In preparing this plan the Contractor will be required to liaise with the emergency response services.

4.11 Environmental Management

Every effort will be made to ensure that any significant environmental effects will be avoided, prevented or reduced during the construction phase of the proposed development.

The CEMP, provided in **Appendix 4.1** comprises all the construction mitigation measures and any additional measures which are required by the conditions attached to the planning decision. Implementation of the CEMP will ensure disruption and nuisance are kept to a minimum.

The CEMP has regard to the guidance contained in the handbook published by Construction Industry Research and Information Association (CIRIA) in the UK; Environmental Good Practice on Site Guide, 4th Edition (CIRIA, 2015). The CEMP is in accordance with industry best practice and will be effective for the duration of the construction works. The CEMP will be a live document during the construction phase and will be updated/added to as construction progresses. It includes the following attachments:

- Frac-out Contingency Plan;
- Pollution Prevention and Emergency Response Plan;
- Procedure for Dealing with Silty Water; and
- Environmental Preparedness Plan.

Specific environmental control measures for construction run off, dewatering, over pumping and accidental spills to minimise the risk of the pollution of waters or the contamination of groundwater are outlined below for both the converter station site and the onshore cable route.

4.11.1 Converter Station Site

Steps will be taken to reduce the probability of an incident occurring and to also reduce the magnitude of any incident from a combination of good site environmental management procedures, including additional precautions when operating machinery close to watercourses, soil management, staff training, contingency equipment and emergency plans.

Key measures identified to reduce erosion and sedimentation include:

- Secure oil and chemical storage in over-ground bunded areas, limited to the minimum volume required to serve immediate needs with specified delivery and refuelling areas;
- Emergency spill kits retained onsite at sensitive locations;
- Cessation of work and development of measures to contain and/or remove pollutant should an incident be identified;
- Silt traps will be employed and maintained in appropriate locations;
- Temporary interception bunds and drainage ditches will be constructed up slope of excavations to minimise surface runoff ingress and in advance of excavation activities; and
- Excavation and earthworks will be suspended during and immediately following periods of heavy rainfall to minimise sediment generation and soil damage.

4.11.2 Onshore Cable

The cables will be installed in ducts, so the only section of trench that will be open is that which is being excavated and in which ducts are being installed. Typically, 50m of trench will be fully open at any time, with up to 200m of trench backfilled to the level of the asphalt courses, that will then be reinstated at the end of each week.

Any groundwater or rainwater that collects in a trench will be pumped to locations agreed with the landowners and local authorities. Typically, this will be onto adjacent land, not directly into waterways, and through a filter medium, to avoid the build-up of silt, as some granular material will, inevitably, be pumped out with the water. The pump flowrates will match that of the water into the trench, as it must be kept generally free of water. A single pump with a 75mm hose will usually be adequate to deal with rainwater running into a trench. A similar arrangement will apply at joint bays, where a sump will be cast into the concrete base for a pump. For the HDDs, any groundwater or rainwater that collects in a HDD drilling pit will be pumped away as described above. Any bentonite (or similar HDD drilling head lubrication material) will be handled and removed by the drilling contractor. The volume of bentonite (or similar material) will be subject to ground conditions encountered and length of HDD. Typically for a land-based HDD maxi-rig the volume of bentonite would be approximately 5 cubic metres per shift, and for the landfall HDD maxi-rig, the volume of bentonite would be approximately 15 cubic metres per shift.

4.11.2.1 General mitigation / avoidance of bentonite breakout

Design

The first step in minimising drilling fluid breakout is through correct design of the HDD. The depth of cover of the drill will be maximised but must be balanced with the requirements of the cable, particularly dissipation of heat from the cable. Hydrofracture analysis of the design – comparing drilling fluid pressures to the inherent ground strength along each point of the design – will be used to optimise the design and identify any locations with increased risk of breakout.

Construction

Identification of higher risk locations allows the contractor to instigate additional measures such as optimising the drilling fluid properties and instigating additional hole cleaning to increase the margin of safety against drilling fluid losses. The use of downhole pressure monitoring tools during pilot hole drilling gives the driller live readings of the drilling fluid pressure in the borehole near the drilling bit. This allows early warning of downhole pressures that are higher or lower than a safe working window at any point along the drill. The safe working window is determined by the hydrofracture modelling of the design prior to construction using ground strength parameters determined by testing results in ground investigation boreholes and samples.

The drilling fluid properties can be optimised during the drilling by the drilling fluids engineer. The formulation will be changed to suit the requirements at particular locations; in zones with low risk of bentonite breakout the fluid viscosity will be increased to ensure all cuttings are removed from the hole, thereby increasing the cross sectional area available for fluid flow resulting in a reduction in the drilling fluid pressure in the hole.

Campile Estuary

The conceptual HDD design for Campile Estuary has 16m depth of cover beneath the bed of the Estuary. Unfortunately, there is no ground investigation information directly beneath the estuary, however the geophysics just to the south of the estuary indicates that the HDD will have 6m of stiff clay and 10m of rock overlying it when drilling beneath the estuary. As a general rule of thumb, 10m cover in rock alone is sufficient to avoid risk of drilling fluid breakout and the risk at the estuary is assessed as low.

Bentonite drilling fluid is composed of approximately 30kg of bentonite clay, a natural occurring clay, per 1m3 of fresh water. Depending on ground conditions, polymer additives may be added. The polymer additives (e.g. polyacrylamide (PHPA) and polyanionic cellulose (PAC)) are organic, usually starch or sugar based. Polymers can be used as a drilling fluid themselves, instead of bentonite, however they are not as effective as bentonite.

The environmental risk from bentonite is that in freshwater environments they are not readily dispersed and, having a higher specific gravity than water, cover the bottom of the watercourse, smothering benthic flora and breeding sites for fauna. In saltwater environments the bentonite drilling fluid is quickly degraded by to ionic exchange between the salts in the seawater and the bentonite clays in the fluid. The bentonite flocculates and is dispersed by currents and wave action with turbidity (discolouration) the only noticeable effect.

Polymer drilling fluids are biodegradable so for most environments they are acceptable. However, they are not recommended where there is a risk of dispersal in artesian water, particularly if the aquifer is used for potable water. When the starches and sugars decay or are broken down by microbes they can affect the water quality.

For the Campile Estuary, if fluid was lost it would be in the order of 1-5m3 which would have a clay content of 30-150kg. The salt water in the estuary would flocculate the bentonite fluid and the clay content would initially be in suspension before settling. It is important to stress that the bentonite clay is inert. It used because of its swelling properties in water, however when it contacts seawater, ionic exchange removes its capacity and it is equivalent in properties to the silt and clay that forms the bed and banks of the Campile Estuary.

Baginbun

Beach

The conceptual design for Baginbun has its minimum depth of cover at the base of the cliffs where the cover is 18m. As a general rule of thumb, 10m cover in rock alone is sufficient to avoid risk of drilling fluid breakout and the risk of breakout on the beach is assessed as very low. For a breakout to occur it would require an open fracture extending from the drill to surface. The risk of this is extremely low – any fracture will be infilled with sediment and even very soft clay would provide sufficient resistance at 18m depth to prevent breakout.

While the design is sufficient to minimise the risk ALARP (as low as reasonably practicable), annular pressure monitoring and good drilling practices will be used as a precaution.

Exit

It must be understood that there will be unavoidable loss of drilling fluid when the HDD exits at the sea floor; this occurs on all landfall HDD's. Containment of the fluid at the exit point is not a practical option in active coastal environments; silt curtains are ineffective and liable to be damaged or lost by wave and current action and engineered solutions such as exit casing and coffer dams introduce much greater environmental risk.

As discussed above, when the loss of bentonite drilling fluid to marine environment results in the bentonite being quickly broken down and dispersed, localised discolouration of the water around the exit point typically lasts for 20-60 minutes before it is dispersed by currents. A strategy that can be used is to drill the majority of the HDD with bentonite drilling fluid and then switch to a biodegradable polymer fluid (starch and sugar based) for the exit.

The volume of losses at the exit point depends on the methodology and the strength of the ground at exit. For Baginbun the HDD contractor will stop the pilot hole 50m before the exit then forward ream the hole to the final diameter by push reaming from land towards the exit. The pilot hole is then continued to the seafloor and drilling fluid in the bore is lost to the sea. The final 50m must then be reamed to final diameter and drilling fluid used during this time will mostly be lost to the sea. Finally, when the duct is inserted into the hole drilling fluid will be displaced from the hole and lost to the sea.

Very approximate volumes are 20 m3 for pilot hole exit, 100 m3 for reaming exit, and 50 m3 for the duct installation. Note that these are fluid volumes; the clay percentage is typically 3% if bentonite fluid is used, the cuttings percentage (rock chippings, generally coarse sand size) is typically 1-5%.

Note that on dozens of previous landfall projects, even on those in very quiet coastal environments, there has been no observable sediment on the beach due to the losses at the exit point, so the beach at Baginbun will not be affected by the exit losses.

4.12 References

Construction Industry Research and Information Association (CIRIA) 2015 *Environmental Good Practice on Site Guide*. 4th Edition.

Department of Transport, Tourism and Sport (2017) *Guidelines for Managing Openings in Public Roads* (Second Edition, April 2017)

Government of Ireland (2013) *Safety, Health and Welfare at Work (Construction) Regulations 2013.*

Government of Ireland (2005) *Safety, Health and Welfare at Work Act 2005.*