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White Cross Offshore Windfarm Environmental Statement

Chapter 5: Project Description

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Glossary of Acronyms

Acronym	Definition
AC	Alternating Current
AfL	Agreement for Lease
AIS	Automatic Identification System
AOD	Above Ordnance Datum
CBS	Cement Bound Sand
CfD	Contracts for Difference
EIA	Environmental Impact Assessment
ES	Environmental Statement
FEED	Front-end engineering and design
FFL	Finished Floor Level
GIS	Gas Insulated Switchgear
ha	Hectare
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HGV	Heavy Goods Vehicle
HVAC	Heating, Ventilation and Air Conditioning
IDB	Internal Drainage Board
km	Kilometre
Km^2	Square kilometre
m	Metre
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MW	Megawatts
NGED	National Grid Electricity Distribution
OFTO	Offshore Transmission Owner
OLEMP	Outline Landscape & Ecology Mitigation Plan
OSP	Offshore Substation Platform
PDE	Project Design Envelope
SAC	Special Area of Conservation
SSSI	Site of Special Scientific Interest
TCE	The Crown Estate
TCPA	Town and Country Planning Act
TJB	Transition Joint Bay
UXO	Unexploded Ordnance
WCOWL	White Cross Offshore Windfarm Ltd
WTG	Wind Turbine Generator

Glossary of Terminology

Defined Term	Description
Agreement for Lease	An Agreement for Lease (AfL) is a non-binding agreement between a landlord and prospective tenant to grant and/or to accept a lease in the future. The AfL only gives the option to investigate a site for potential development. There is no obligation on the developer to execute a lease if they do not wish to.
Applicant	White Cross Offshore Wind Farm Limited
Department for Energy Security and Net Zero	Government department that is responsible for business, industrial strategy, science and innovation and energy and climate change policy and consent under Section 36 of the Electricity Act.
Dynamic cables	The floating substructures will require cables to run through the water column from their platform base at the water surface to the touchdown point on the seabed.
Environmental Impact Assessment	Assessment of the potential impact of the proposed Project on the physical, biological and human environment during construction, operation and decommissioning.
Export Cable Corridor	The area in which the export cables will be laid, either from the Offshore Substation or the inter-array cable junction box (if no offshore substation), to the NG Onshore Substation comprising both the Offshore Export Cable Corridor and Onshore Export Cable Corridor.
Floating substructure	The floating substructure acts as a stable and buoyant foundation for the WTG. The WTG is connected to the substructure via the transition piece and the substructure is kept in position by the mooring system.
Front end engineering and design	Front-end engineering and design (FEED) studies address areas of windfarm system design and develop the concept of the windfarm in advance of procurement, contracting and construction.
Generation Assets	The infrastructure of the Project related to the generation of electricity within the windfarm site, including wind turbine generators, substructures, mooring lines, seabed anchors and inter-array cables
High Voltage Alternating Current	High voltage alternating current is the bulk transmission of electricity by alternating current (AC), whereby the flow of electric charge periodically reverses direction.
High Voltage Direct Current	High voltage direct current is the bulk transmission of electricity by direct current, whereby the flow of electric charge is in one direction.
Inter-array cables	Cables which link the wind turbines to each other and the Offshore Substation Platform, or at the inter-array cables junction box (if no offshore substation). Array cables will connect the wind turbines to one and other and to the Offshore Substation (if utilised). The initial section for the inter-array cables will be freely suspended in the water column below the substructure (dynamic sections) while the on seabed sections of the cables will be buried where possible.
Jointing bay	Underground structures constructed at regular intervals along the Onshore Export Cable Corridor to join sections of cable and facilitate installation of the cables into the buried ducts

Defined Term	Description
Landfall	Where the Offshore Export Cables come ashore
Link boxes	Underground chambers or above ground cabinets next to the cable trench housing electrical earthing links
Mean high water springs	The average tidal height throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest.
Mean low water springs	The average tidal height throughout a year of two successive low waters during those periods of 24 hours when the range of the tide is at its greatest.
Mooring system	The equipment (mooring lines and seabed anchors) that keeps the floating substructure in position during operation through a fixed connection to the seabed.
Mitigation	Mitigation measures have been proposed where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts, and discussed with the relevant authorities and stakeholders in order to avoid, prevent or reduce impacts to acceptable levels. For the purposes of the EIA, two types of mitigation are defined: • Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIA • Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or eliminate any predicted significant effects. Additional mitigation is therefore subsequently adopted by WCOWL as the EIA process progresses.
National Grid Onshore Substation	Part of an electrical transmission and distribution system. Substations transform voltage from high to low, or the reverse by means of the electrical transformers.
National Grid Connection Point	The point at which the White Cross Offshore Windfarm connects into the distribution network at East Yelland substation and the distributed electricity network. From East Yelland substation electricity is transmitted to Alverdiscott where it enters the national transmission network.
Offshore Development Area	The Windfarm Site (including wind turbine generators, substructures, mooring lines, seabed anchors, inter-array cables and Offshore Substation Platform (as applicable)) and Offshore Export Cable Corridor to MHWS at the Landfall. This encompasses the part of the project that is the focus of this application and Environmental Statement and the parts of the project consented under Section 36 of the Electricity Act and the Marine and Coastal Access Act 2009.
Offshore Export Cables	The cables which bring electricity from the Offshore Substation Platform or the inter-array cables junction box to the Landfall.
Offshore Export Cable Corridor	The proposed offshore area in which the export cables will be laid, from Offshore Substation Platform or the inter-array cable junction box to the Landfall.

Defined Term	Description
Offshore Infrastructure	All of the offshore infrastructure including wind turbine generators, substructures, mooring lines, seabed anchors, Offshore Substation Platform and all cable types (export and inter-array). This encompasses the infrastructure that is the focus of this application and Environmental Statement and the parts of the project consented under Section 36 of the Electricity Act and the Marine and Coastal Access Act 2009.
the Offshore Project	The Offshore Project for the offshore Section 36 and Marine Licence application includes all components offshore of MHWS. This includes the infrastructure within the windfarm site (e.g. wind turbine generators, substructures, mooring lines, seabed anchors, inter-array cables and Offshore Substation Platform (as applicable)) and all infrastructure associated with the Onshore Export Cable Corridor and Landfall (up to MHWS) including the cables and associated cable protection (if required).
Offshore Substation Platform	A fixed structure located within the Windfarm Site, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.
Offshore Transmission Assets	The aspects of the project related to the transmission of electricity from the generation assets including the Offshore Substation Platform (as applicable)) or offshore junction box, Offshore Cable Corridor to MHWS at the Landfall.
Offshore Transmission Owner	An OFTO, appointed in UK by Ofgem (Office of Gas and Electricity Markets), has ownership and responsibility for the transmission assets of an offshore windfarm.
Onshore Development Area	The onshore area above MLWS including the underground onshore export cables connecting to the White Cross Onshore Substation and onward to the NG grid connection point at East Yelland. The onshore development area will form part of a separate Planning application to the Local Planning Authority under the Town and Country Planning Act 1990.
Onshore Export Cables	The cables which bring electricity from MLWS at the Landfall to the White Cross Onshore Substation and onward to the NG grid connection point at East Yelland.
Onshore Export Cable Corridor	The proposed onshore area in which the export cables will be laid, from MLWS at the Landfall to the White Cross Onshore Substation and onward to the NG grid connection point at East Yelland.
Onshore Infrastructure	The combined name for all infrastructure associated with the Project from MLWS at the Landfall to the NG grid connection point at East Yelland. The onshore infrastructure will form part of a separate Planning application to the Local Planning Authority (LPA) under the Town and Country Planning Act 1990.
Onshore Transmission Assets	The aspects of the project related to the transmission of electricity from MLWS at the Landfall to the NG grid connection point at East Yelland including the Onshore Export Cable, the White Cross Onshore Substation and onward connection to the NG grid connection point at East Yelland.
the Onshore Project	The Onshore Project for the onshore TCPA application includes all components onshore of MLWS. This includes the infrastructure associated with the offshore export cable (from MLWS), landfall, onshore export

Defined Term	Description
	cable and associated infrastructure and new onshore substation (if required).
the Project	the Project is a proposed floating offshore windfarm called White Cross located in the Celtic Sea with a capacity of up to 100MW. It encompasses the project as a whole, i.e. all onshore and offshore infrastructure and activities associated with the Project.
Project Design Envelope	A description of the range of possible components that make up the Project design options under consideration. The Project Design Envelope, or 'Rochdale Envelope' is used to define the Project for Environmental Impact Assessment purposes when the exact parameters are not yet known but a bounded range of parameters are known for each key project aspect.
Transition joint bay	Underground structures at the Landfall that house the joints between the Offshore Export Cables and the onshore export cables.
Transition piece	The transition piece includes various functionalities such as access for maintenance, cable connection for the energy of the turbine and the corrosion protection of the entire foundation.
White Cross Offshore Windfarm	100MW capacity offshore windfarm including associated onshore and offshore infrastructure.
White Cross Offshore Wind Farm Limited	White Cross Offshore Wind Ltd (WCOWL) is a joint venture between Cobra Instalaciones Servicios, S.A., and Flotation Energy Ltd
White Cross Onshore Substation	A new substation built specifically for the White Cross project. It is required to ensure electrical power produced by the offshore windfarm is compliant with NG electrical requirements at the grid connection point at East Yelland.
Wind Turbine Generators (WTG)	The wind turbine generators convert wind energy into electrical power. Key components include the rotor blades, nacelle (housing for electrical generator and other electrical and control equipment) and tower. The final selection of project wind turbine model will be made post-consent application.
Windfarm Site	The area within which the wind turbines, Offshore Substation Platform and inter-array cables will be present.
Works completion date	Date at which construction works are deemed to be complete and the windfarm is handed to the operations team. In reality, this may take place over a period of time.

5. Project Description

5.1 Introduction

1. This chapter of the Environmental Statement (ES) presents the description of the White Cross Offshore Windfarm Project (landward of Mean Low Water Spring (MLWS)) which is hereafter referred to as 'the Onshore Project'.

2. The Onshore Project is being developed by White Cross Offshore Windfarm Ltd (WCOWL) a joint venture between Cobra Instalaciones Servicios, S.A., and Flotation Energy Ltd.

3. This chapter provides a full description of components and installation required for construction, operation, maintenance, and decommissioning of the Onshore Project. These components have been compiled into a single over-arching Project Parameters Table in **Appendix 5.F**. The details provided inform and underpin the assessments that have been undertaken, although **Chapters 8** to **24** should be referred to for details of the realistic worst-case scenarios that apply to each topic.

4. Planning permission under the Town and Country Planning Act 1990 (TCPA 1990) is required for the following onshore infrastructure assets (landward of Mean Low Water Springs):

- Onshore export cables
- White Cross Onshore Substation
- Onshore Export Cables (66kV or 132kV from Landfall to onshore substation and 132kV from the White Cross Onshore Substation to Grid Point of Connection)
- Temporary main construction compound and temporary construction compounds
- Transition Joint Bay (TJB), jointing bays, link boxes
- Access roads and haul roads
- Grid connection works within the existing East Yelland substation.

5. A separate set of consents/permission is required in order for the Offshore Project (all infrastructure and activities seaward of Mean High Water Spring (MHWS) to proceed and these have been applied for separately and a separate Environmental Impact Assessment (EIA) was undertaken as part of this. Full details are as follows:

   - Consent under the Section 36 of the Electricity Act 1989 and a Marine Licence under the Marine and Coastal Access Act 2009 (MCAA 2009) are required for the following generation assets (within the Windfarm Site):
     - Wind Turbine Generators
     - Semi-submersible floating platforms

  - Subsea catenary mooring lines
  - Anchoring solutions (drag embedment anchors, suction anchor or pin piles)
  - Inter-array cables and associated protection
  - Other associated offshore infrastructure, such as navigational markers.

- A second Marine Licence is required to enable the option for an Offshore Transmission Owner (OFTO) to be appointed under The Electricity (Competitive Tenders for Offshore Transmission Licences) Regulations 2015 for the following transmission assets:
  - Offshore Substation Platform (OSP)
  - Offshore Export Cable (to MHWS at Landfall)
  - Other associated offshore infrastructure, such as navigational markers
  - Taw Estuary Crossing (between MHWS on the northern edge to MHWS on the southern edge).

6. Further detail on the consenting regime and relevant legislation is presented in **Chapter 3: Policy and Legislative Context**.

5.2 Project Design Envelope

7. At this stage in the development of the Onshore Project, the proposed design and precise location of the components of the development are not fixed. A project design envelope (PDE) approach has been utilised in order to set parameters for the EIA. Further details of the use of a PDE or "Rochdale envelope" are provided in **Chapter 6: EIA Methodology**. This is considered a standard approach and is widely accepted by all stakeholders.

8. The PDE sets out a series of design options for the Onshore Project and has a reasoned best and worst case extent for a number of key parameters. The final design would lie between the minimum and the maximum extent of the consent sought, for all aspects of the Onshore Project; this includes spatial and temporal components, and the proposed methodology to be employed.

9. The PDE is used to establish the extent to which the Onshore Project could impact on the environment. The final detailed design of the Onshore Project will fall within this 'envelope', allowing for detailed design work to be undertaken post-consent without rendering the assessment inadequate.

10. Therefore, the information presented in this chapter outlines the options and flexibility required and the range of potential design, location and activity parameters upon which the subsequent impact assessment **Chapters 8 to 24** are based.

11. The need for flexibility in the consent is a key aspect of any large development but is particularly significant for offshore wind projects where technology continues to evolve quickly. The PDE must therefore provide sufficient flexibility to enable the Applicant and its contractors to use the most up to date, efficient and cost-effective technology and techniques in the construction, operation, maintenance and decommissioning of the Onshore Project, without compromising the surrounding environment further than the worst-case scenarios assessed in this ES.

12. Where appropriate, each impact assessment chapter (**Chapters 8 to 24**) contains a section detailing the realistic worst-case scenario for specific receptors and impacts. These realistic worst-case scenario sections are derived from the information provided in this chapter.

13. Design work is ongoing with the intention that the more detailed design work will be completed post-consent. In addition, post-consent/pre-construction site investigation will further inform the detailed design. Key aspects for which flexibility is required include:

- Landfall construction method will be either via trenchless techniques or open-cut trenching, including potential use of cofferdams, allowing for unknown ground conditions
- Onshore Export Cable Corridor allows for micro-siting of the cable route and, for example, crossings of existing utilities and other assets
- Onshore substation maximum parameters allows for flexibility subject to detailed design
- In certain areas, i.e. where trenchless techniques are to be used to install the onshore export cables, or where the Onshore Export Cables connect to the Offshore Export Cables (TJB), or to accommodate temporary construction compounds, a wider site boundary is provided
- Construction timing and methodologies are to be fully developed once project design is finalised and installation contractors are appointed
- Operation and maintenance activities will be adjusted to the final as-built project requirements
- Decommissioning timing and methodologies to be fully developed once project design is finalised.

5.3 Overview of the Project

14. An illustration of the main components of the Onshore Project is provided in **Plate 5.1** alongside the main components of the Offshore Project. The Offshore Export

Cable will make Landfall at Saunton Sands on the North Devon coast. The Onshore Project location is shown in **Figure 5.1**.

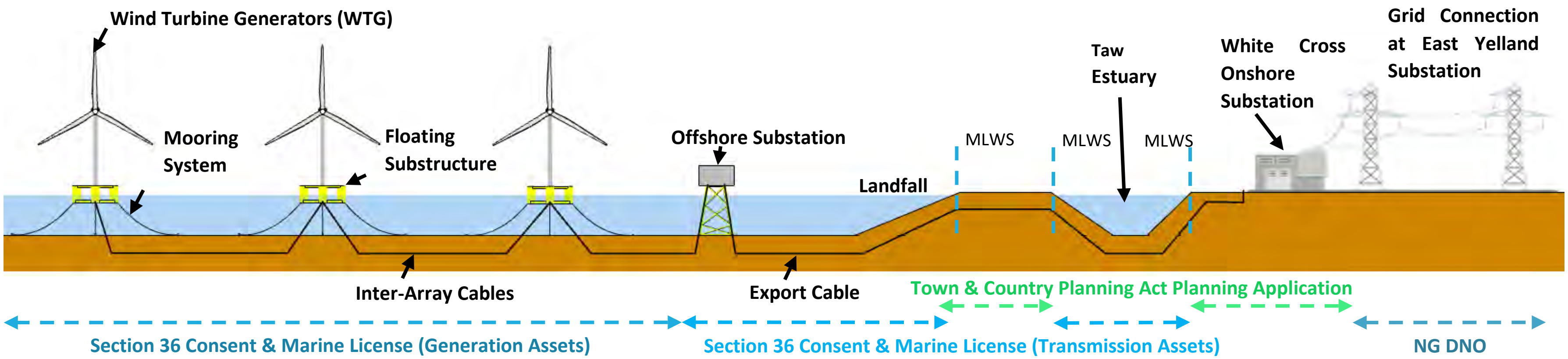
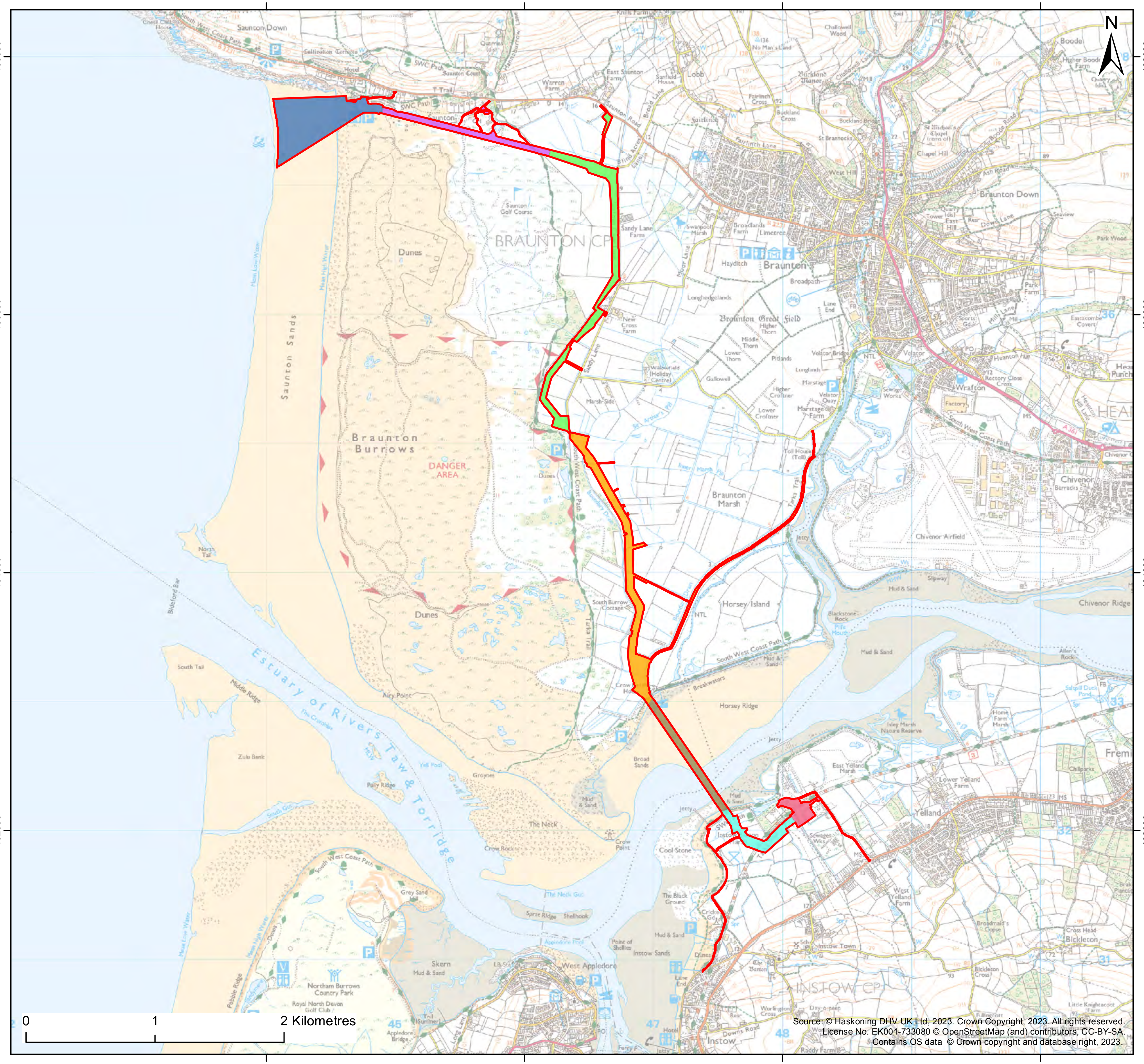
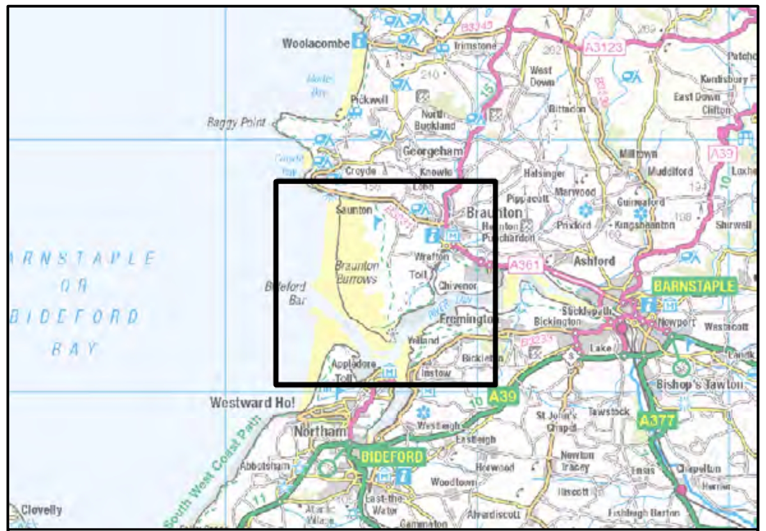


Plate 5.1 Project Infrastructure





Legend:

Onshore Development Area

Onshore Export Cable Corridor Sections

- Section 1
- Section 2
- Section 3
- Section 4
- Section 5
- Section 6
- Section 7

Client:	Project:
Offshore Wind Ltd.	White Cross Offshore Windfarm

Title: Project Location

Figure: 5.1	Drawing No: PC2978-RHD-ZZ-XX-DR-Z-0725				
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Co-ordinate system: British National Grid

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5.3.1 Overview of the Offshore Project components

15. The Windfarm Site is located approximately 52km north-west of the Cornwall and Devon coastline in a water depth of 69m – 78m LAT and covers an area of approximately 50km². The Offshore Project will have a generating capacity of up to 100MW, and there will be a minimum of 5 and maximum of 8 Wind Turbine Generators (WTG) depending on the size and capacity of the individual WTG. The decision about the technology of WTG to use, including the individual size and capacity, will be made post consent as part of the detailed design process.

16. It is assumed that the WTG will be connected, via an inter-array cable, to an OSP. The requirement for and location of the OSP will also be determined post consent as part of the detailed design process. The electricity from the Windfarm Site will be transmitted by either via one or two subsea export cable(s) to shore depending on whether an OSP is required. The Offshore Export Cable will make Landfall at Saunton Sands on the North Devon coast where it will be connected to the Onshore Export Cable via a TJB located in Saunton Sands Car Park.

17. Further details of these offshore components are described and assessed within the separate Offshore Project application.

5.3.2 Overview of the Onshore Project components

18. Above MHWS at Landfall, the Offshore Export Cable will be connected to the Onshore Export Cable via a TJB located in Saunton Sands Car Park. The Onshore Export Cable travels approximately 8km at its maximum inland to a high voltage alternating current onshore substation. This will include a crossing below the Taw Estuary via trenchless technology, which is assessed as part of this Onshore ES. A new White Cross Onshore Substation will be constructed to accommodate the connection of the Offshore Project to the existing East Yelland substation and Grid Point of Connection.

19. The key onshore components of the Onshore Project are as follows:

- Onshore Export Cables (2 x 66kV or 1 x 132kV from Landfall to the White Cross Onshore Substation and 132kV from the White Cross Onshore Substation to existing East Yelland substation and the Grid Point of Connection)
- TJB, joint bays and link boxes installed along the Onshore Export Cable
- Trenchless crossing at certain locations such as sensitive habitats and large watercourse crossings
- Open cut trenching where possible

- Temporary main construction compound and up to four temporary construction compounds
- Temporary access roads and haul roads
- A new White Cross Onshore Substation
- Connection to the National Grid Onshore Substation and Grid Connection Point
- Permanent access to the White Cross Onshore Substation during its operation.

5.3.3 Overview of the Onshore Development Area

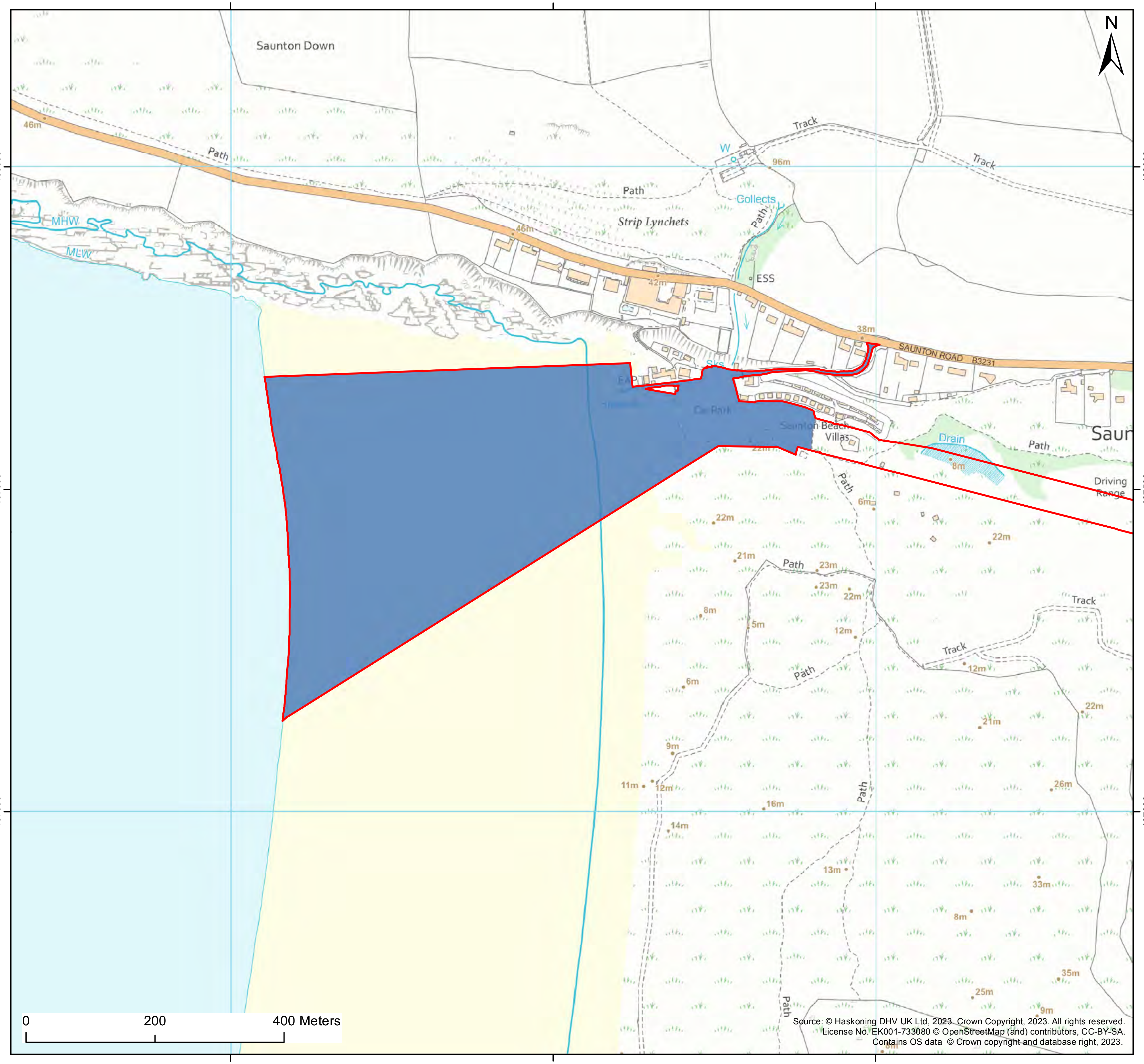
5.3.3.1 Onshore Development Area

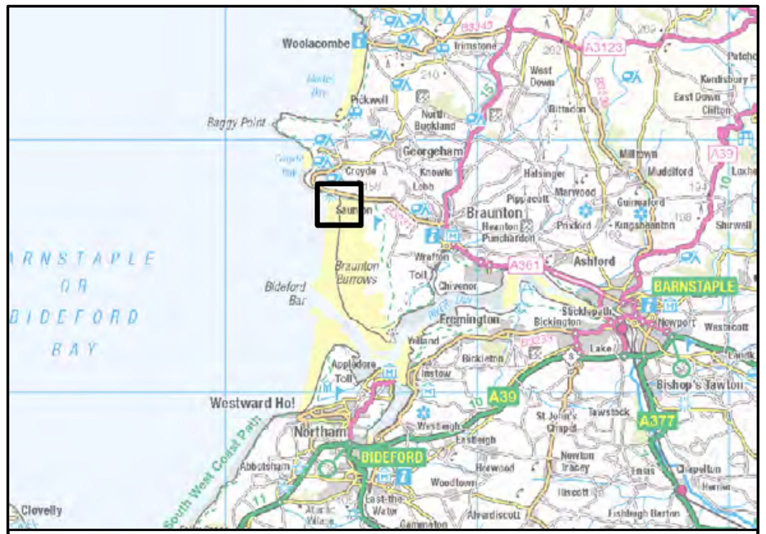
20. The jurisdiction of onshore planning extends down to MLWS[1]. Therefore, the Onshore Development Area is defined as the point from MLWS at Landfall to the Grid Point of Connection at the existing East Yelland substation. The Onshore Development Area is shown in **Figure 5.1**.

21. To aid environmental assessment and design development the Onshore Export Cable Corridor has been divided into seven sections as illustrated in **Figures 5.2** to **5.8** and an overview provided within the following sections. Further details of the construction, operation and maintenance, and decommissioning activities are provided within **Sections 5.4** to **5.10**.

22. Indicative designs and layouts for the Onshore Export Cable Corridor and Onshore Substation are provided in **Appendix 5.D** and **Appendix 5.E**.

[1] Certain works will span across the offshore and onshore consent boundaries, through the intertidal area, such as HDD and/or open cut trenching.





Legend:

Onshore Development Area

Onshore Export Cable Corridor Section

Section 1

Client: Offshore Wind Ltd.	Project: White Cross Offshore Windfarm

Title: Onshore Project Section 1

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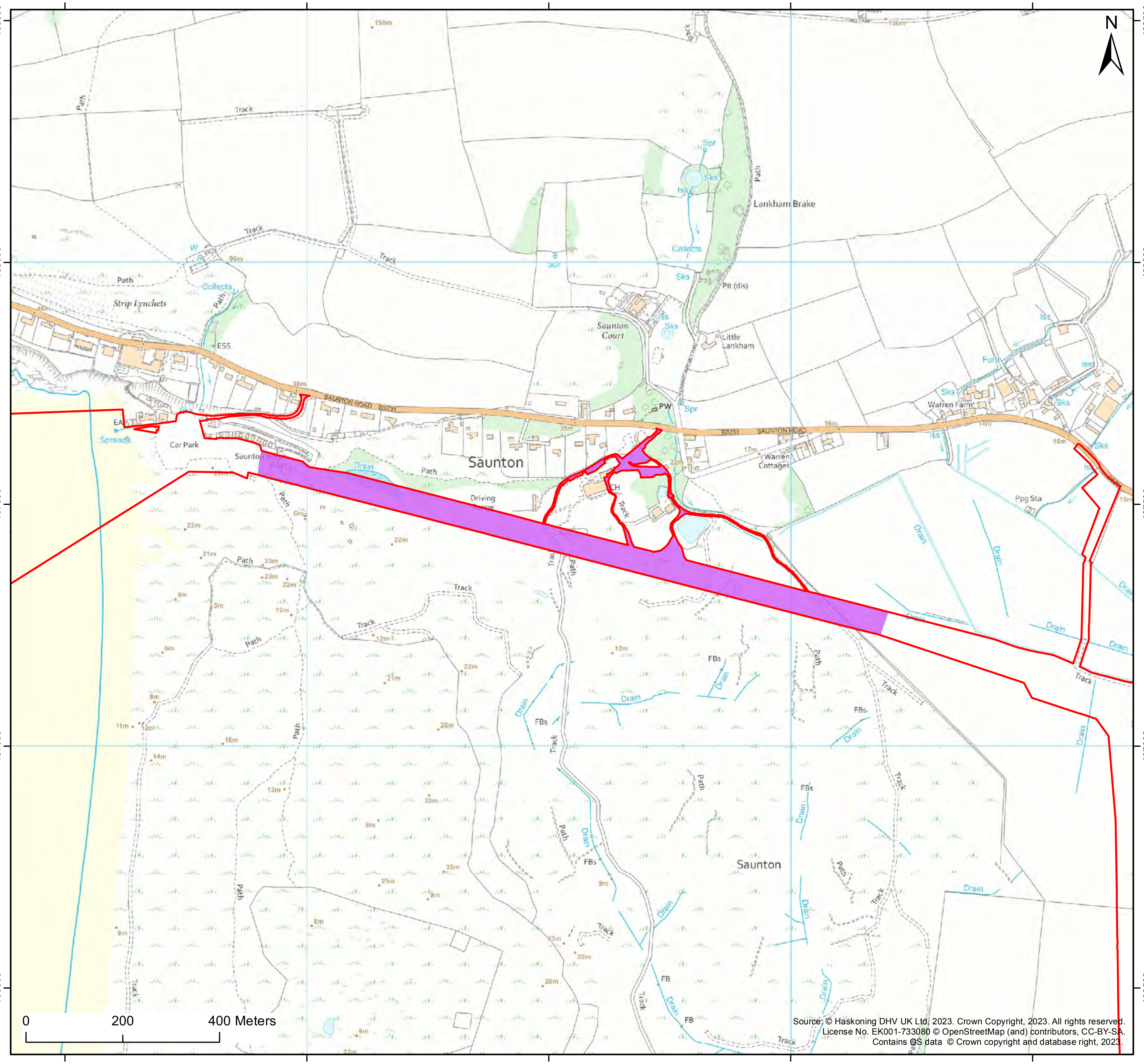

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Legend:

Onshore Development Area

Onshore Export Cable Corridor Section

Section 2

Client:	Project:
Offshore Wind Ltd.	White Cross Offshore Windfarm

Title: Onshore Project Section 2

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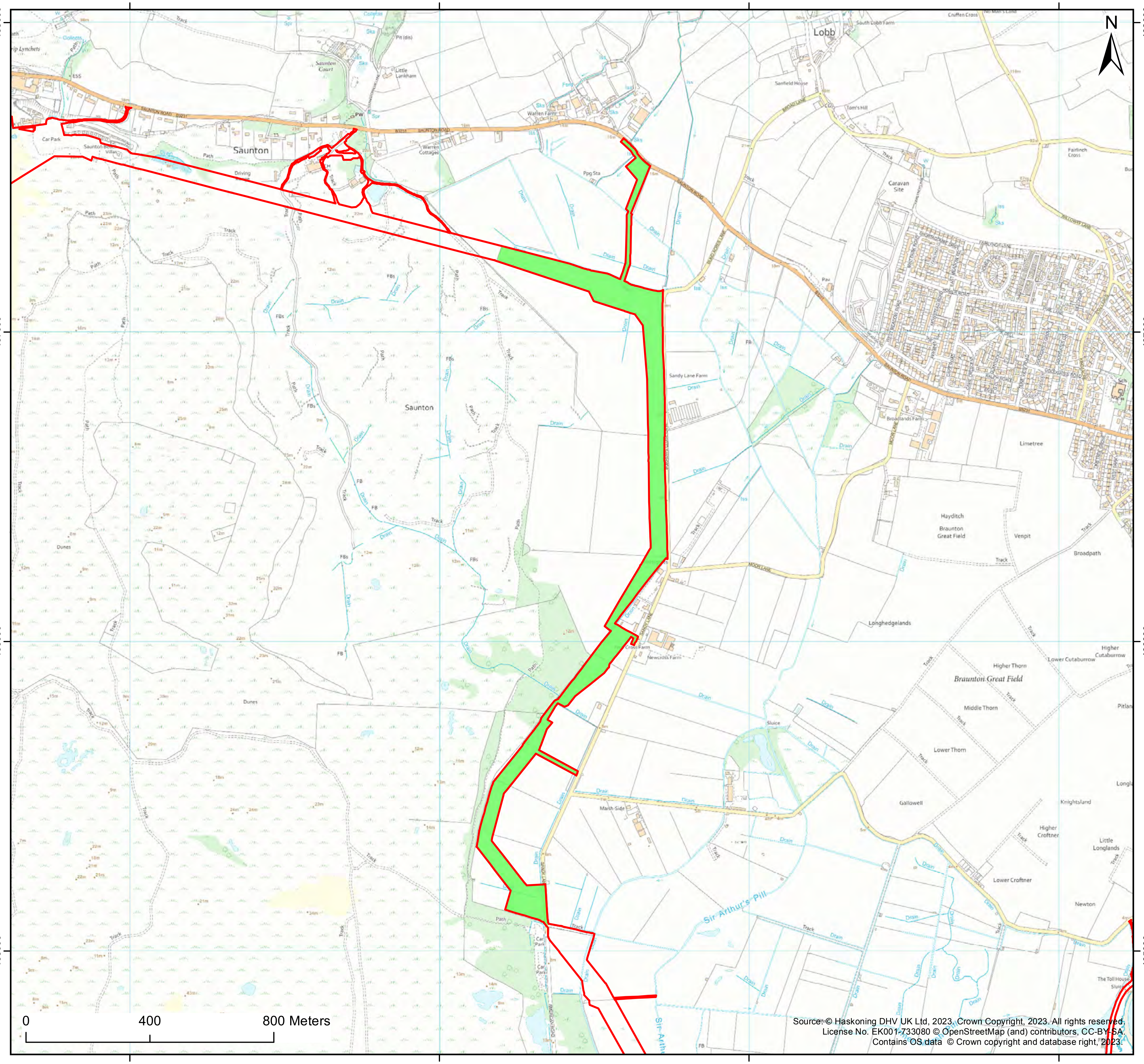

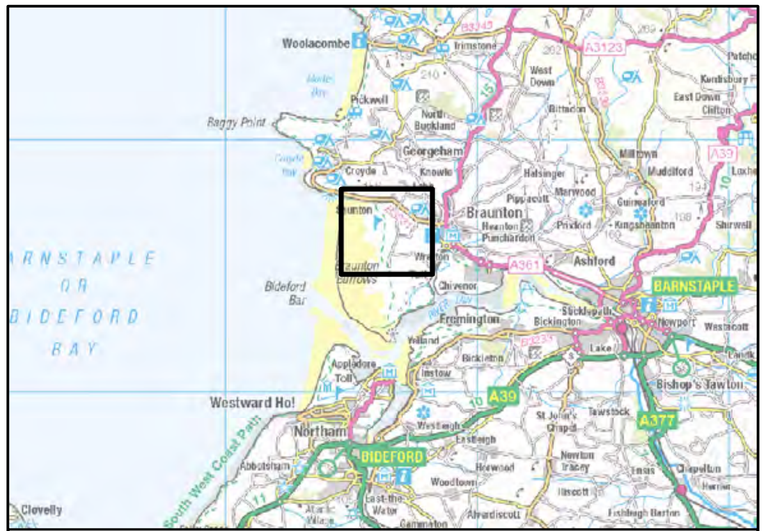

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Onshore Development Area

Onshore Export Cable Corridor Section

Section 3

Client: Offshore Wind Ltd.

Project: White Cross Offshore Windfarm

Title: Onshore Project Section 3

Figure: 5.4

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Co-ordinate system: British National Grid

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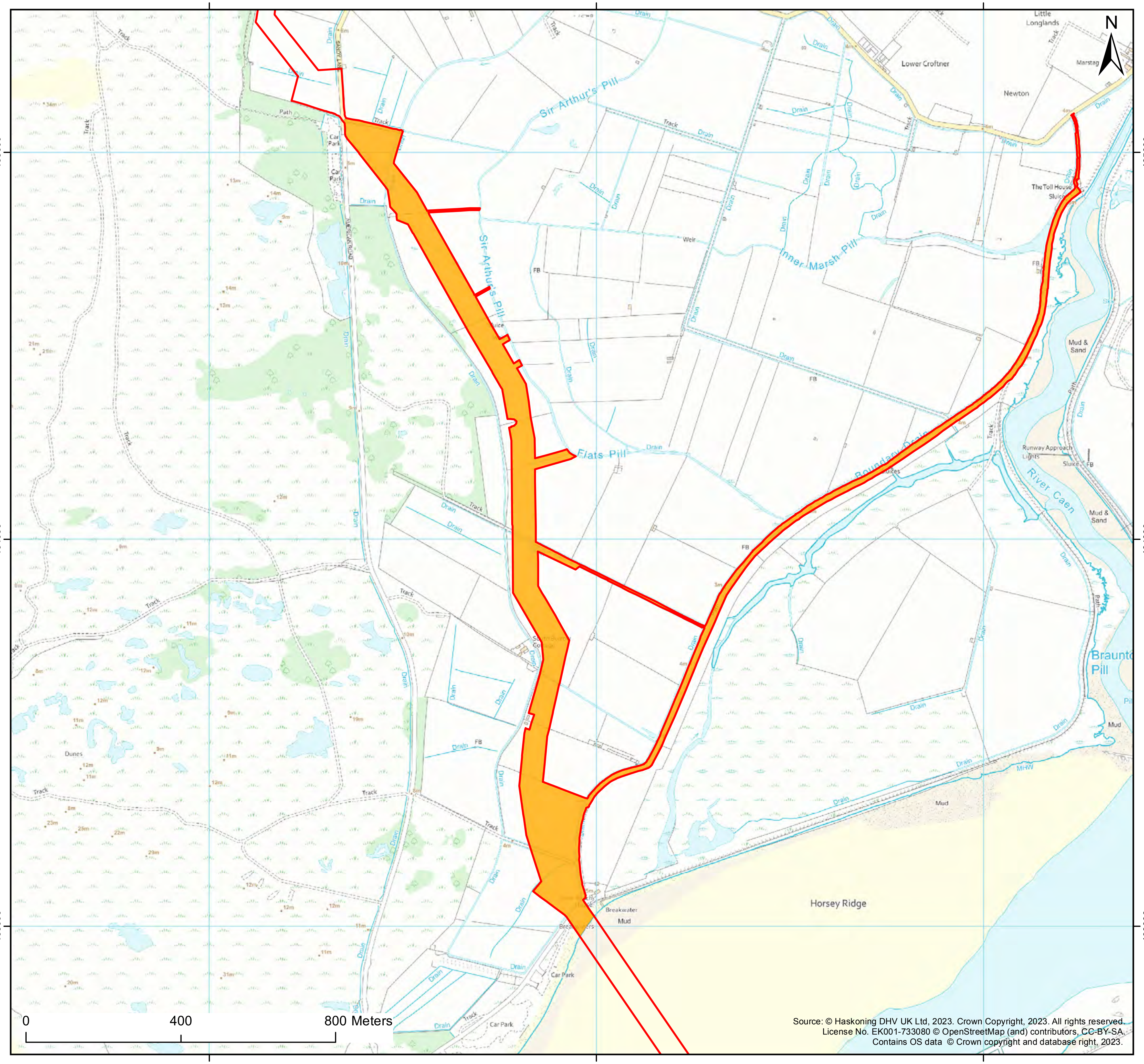

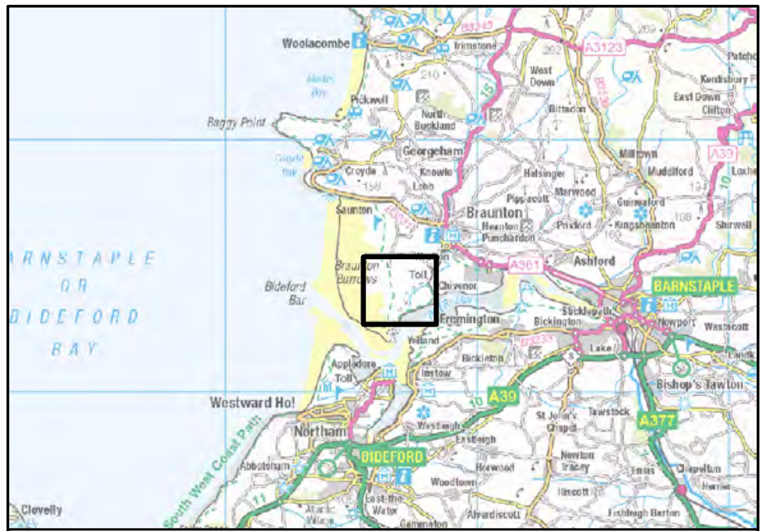

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Onshore Development Area

Onshore Export Cable Corridor Section

Section 4

Client: Offshore Wind Ltd.	Project: White Cross Offshore Windfarm

Title: Onshore Project Section 4

Figure: 5.5

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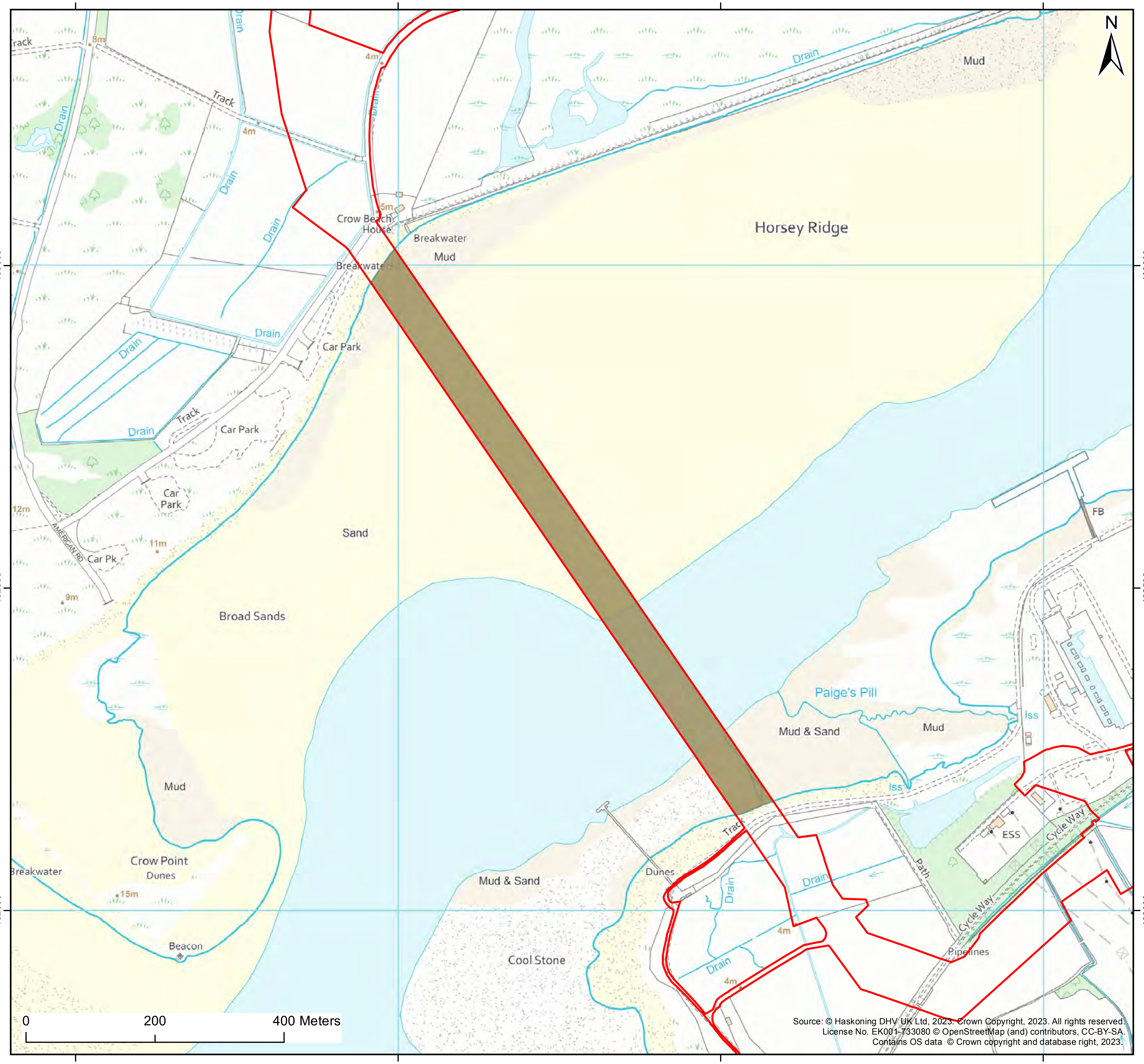

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Onshore Development Area

Onshore Export Cable Corridor Section

Section 5

Client:	Project:
Offshore Wind Ltd.	White Cross Offshore Windfarm

Title: Onshore Project Section 5

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Co-ordinate system: British National Grid

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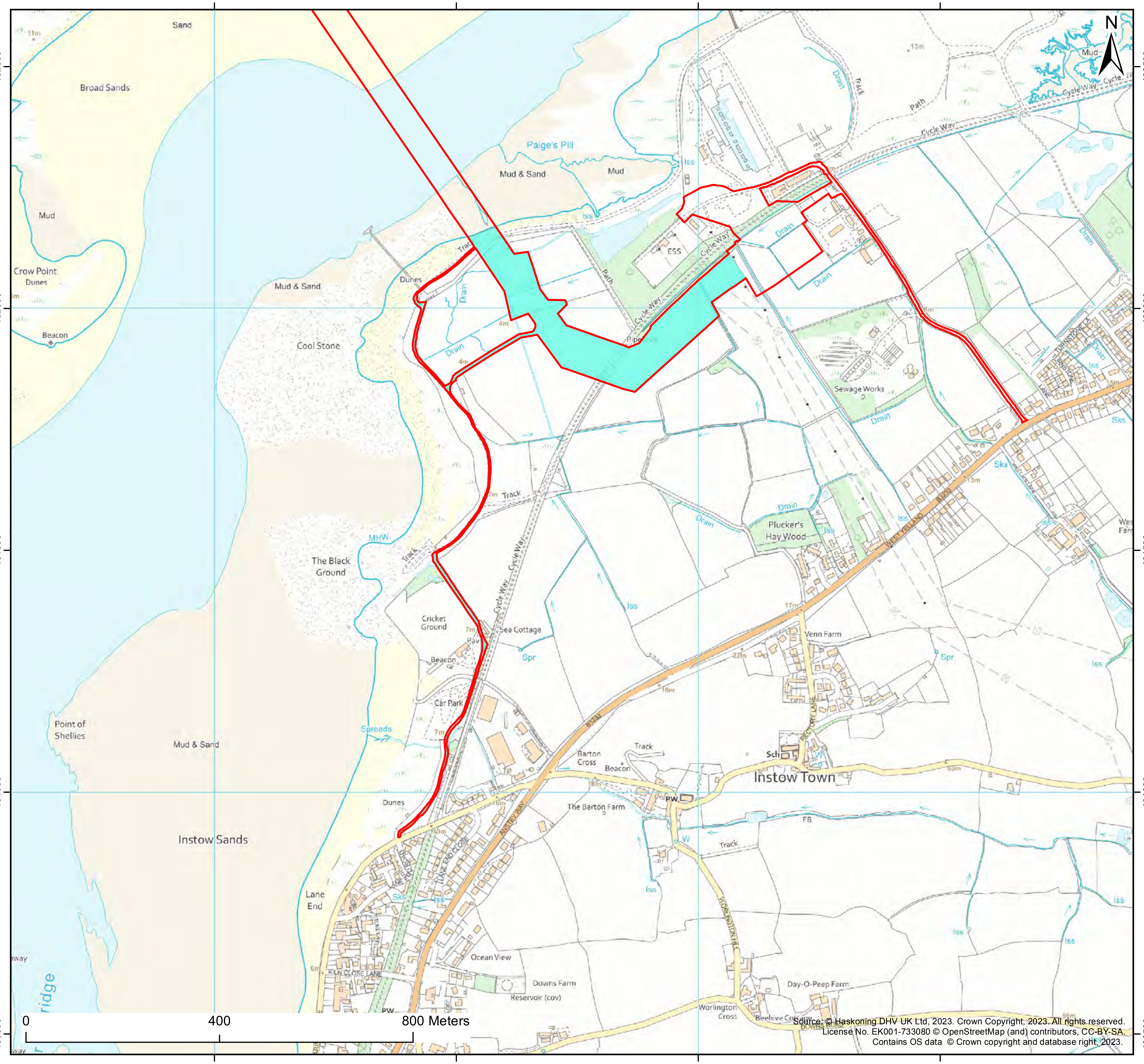

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Onshore Development Area

Onshore Export Cable Corridor Section

Section 6

Client:	Project:
Offshore Wind Ltd.	White Cross Offshore Windfarm

Title:

Onshore Project Section 6

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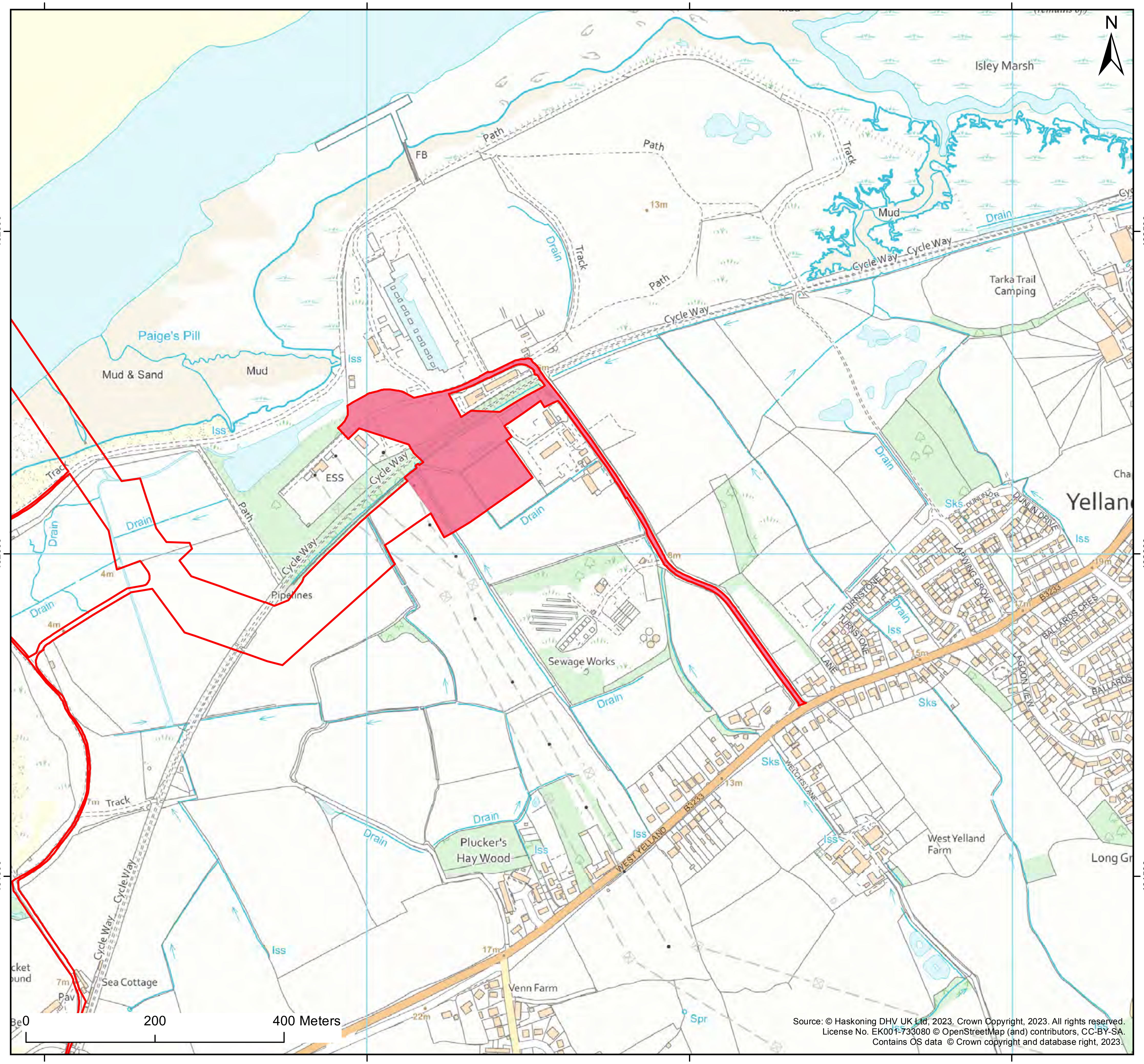

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Onshore Development Area

Onshore Export Cable Corridor Section

Section 7

Client:	Project:
Offshore Wind Ltd.	White Cross Offshore Windfarm

Title:

Onshore Project Section 7

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Co-ordinate system: British National Grid

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5.3.3.2 Section 1 Landfall Area (from MLWS)

23. Section 1 runs eastwards inland from MLWS to the eastern end of the Saunton Sands Car Park. The construction methodology at Landfall (to MLWS) along the beach and into the car park will be undertaken using either open trench or a trenchless technique within the spatial extent defined by the Onshore Development Area are shown in **Figure 5.2**.

24. The car park is the proposed location of the temporary Landfall compound, trenchless installation rig, and the TJB. From there, it turns southeast to cross Saunton Golf Course using a trenchless technique.

5.3.3.3 Section 2 Saunton Golf Club (Trenchless Technology)

25. Section 2 runs southeast crossing Saunton Golf Club (see **Figure 5.3**). Access routes required for geotechnical investigation and for maintenance activities is provided from the existing access to Saunton Golf Club from Saunton Road. Careful environmental and technical consideration have been taken to determine the access routes of least impact to the operations of the Saunton Golf Club.

26. The Onshore Export Cable in this section will be installed using trenchless techniques within the spatial extent defined by the Onshore Development Area.

5.3.3.4 Section 3 North Fields (north of Sandy Lane Car Park)

27. Section 3 runs southeast and then south from the eastern edge of Saunton Golf Club through arable fields and crossing 11 field boundaries and drainage ditches before extending to the field to the north of Sandy Lane Car Park (see **Figure 5.4).**

28. The construction methodology within this section is still to be determined but will be undertaken using either open cut or trenchless techniques within the spatial extent defined by the Onshore Development Area. Micro-siting during detailed design will seek to ensure the route of least impact is chosen.

29. To the north of Section 3 is a new temporary access route that will be utilised to provide access to Onshore Development Area during the cable installation. For more details on the access strategy see **Section 5.3.3.9** Onshore Access Strategy below.

5.3.3.5 Section 4 South Fields (south of Sandy Lane Car Park)

30. Section 4 passes south extending from the east of Sandy Lane Car Park to the Taw Estuary Crossing (**Figure 5.5**). The Onshore Export Cable Corridor will cross from Section 3 to the pastural fields to the east of Sandy Land Car Park using trenchless technology to avoid disturbance to vegetation on the boundaries of Braunton

Burrows Special Area of Conservation (SAC) and Greenaways and Freshmarsh, Braunton Site of Special Scientific Interest (SSSI).

31. The construction methodology within this section is still to be determined but will be undertaken using either open cut or trenchless techniques within the spatial extent defined by the Onshore Development Area. Micro-siting during detailed design will seek to ensure that a route which minimise environmental impact is chosen.

5.3.3.6 Section 5 The Taw Estuary Crossing using Trenchless Technology

32. Section 5 contains the Taw Estuary Crossing and extends from the northern edge to the southern edge of the River Taw (see **Figure 5.6**). The methodology to install the Onshore Export Cable underneath the River is via a trenchless technique which is expected to be Horizontal Directional Drill (HDD) or Direct Pipe. A temporary construction compound will be required at both ends of this crossing to facilitate the trenchless solution. A construction method statement for the Taw Estuary Crossing is provided in **Appendix 5.A**. This crossing is also assessed in the Environmental statement (ES) submitted to support the application for the Offshore Project as the Taw Estuary is tidal so therefore there are areas which are below MLWS.

5.3.3.7 Section 6 Connection to the White Cross Onshore Substation

33. Section 6 runs southeast from the southern edge of the Taw Estuary Crossing towards the White Cross Onshore Substation (see **Figure 5.7**). The Onshore Export Cable installation methodology in this section is expected to be a combination of opencut and trenchless technique but is yet to be determined.

34. The crossing of the Tarka Trail and below the existing Overhead Lines from the East Yelland substation will be via a trenchless technique.

5.3.3.8 Section 7 White Cross Onshore Substation to Grid Connection Point

35. The White Cross Onshore Substation will be located to the west of the Estuary Business Park partly on the site of a former oil storage depot. Cables will exit the onshore substation running east/north for 350m towards the grid connection point at East Yelland substation. This section will be installed by a combination of open cut and trenchless techniques, including a crossing of the Tarka Trail via a trenchless technique (**Figure 5.8**).

5.3.3.9 Onshore Access Strategy

36. The access strategy for the Onshore Project has been designed to avoid Heavy Goods Vehicles (HGVs) acceding the narrow local roads, and where possible to keep

traffic associated with the construction phase of the Onshore Project within the onshore export cable construction corridor.

37. Further details of the onshore access strategy, including the proposed mitigation measures can be found in **Chapter 19: Traffic & Transport**. The proposed access routes are shown on **Appendix 19.A** *Figure 1*.

5.3.3.9.1 Early works access

38. In advance of the main construction activity, access will be required to undertake survey activities and other early works along the onshore cable corridor to facilitate the finalising of mitigation and construction methodologies. Some early works accesses would be required to facilitate initial works to create the construction accesses.

39. Early works accesses would be very short term in nature, requiring limited personnel and materials. Given their very short term and low impact nature, it is proposed that early works activities would be undertaken using vehicles capable of utilising existing access points such as field gates and the existing highways network.

5.3.3.9.2 Construction access

40. The proposed access strategy for construction access contains up to three points of access for HGVs from the public highway, and a haul road crossing, allowing traffic to cross the highway only.

41. The access locations would allow construction traffic to access and egress from the from the public highway. Where accesses are located opposite each other, they would also allow construction traffic to cross from one side of the public highway to the other i.e., to traverse along the temporary haul road and minimise trips on the local highway network.

42. Access to the Landfall site from the public highway is via the existing Saunton Sands car park junction with the B3231 Saunton Road. The junction operates as a priority 'T' junction, with the car park access giving way to Saunton Road. Saunton Road is subject to a 30 mph speed restriction in the vicinity of the access. A bus stop layby is provided opposite the junction.

43. The proposed priority access from the B3231 Saunton Road into the consolidated construction site is located west of Broad Lane / Blind Acres staggered crossroads. This junction has been designed with visibility splays of 2.4 m by 120/90m (see **Appendix 19.A, Annex 5: Outline access designs**), based on the outcome of speed surveys that identified an 85th percentile speed of 38.7 mph. The junction has

been designed to accommodate the largest anticipated construction vehicles, i.e., a 16.5 m maximum legal length articulated HGV.

44. Two priority junctions are proposed east and west of Sandy Lane to create a haul road crossing. The junctions have been designed to minimise impact on surrounding vegetation whilst allowing a 16.5 m maximum legal length articulated HGV to manoeuvre from east to west and vice versa. No traffic management would be proposed for Sandy Lane. Given the narrow, rural nature of Sandy Lane, 2.4 m by 40 m visibility splays are proposed (see **Appendix 19.A, Annex 5: Outline access designs**).

45. The construction access for the White Cross Onshore Substation would connect onto an existing private access road running south to the public highway at the B3233 West Yelland. It is not proposed to alter the existing priority junction between the B3233 West Yelland and the private access road, which already accommodates HGVs.

46. A haul road crossing of the Tarka Trail long distance footpath and cycleway is proposed. The crossing would utilise existing field gates on either side of the Tarka Trail and would be subject to traffic management by banksmen to ensure the safety of pedestrians and cyclists.

47. This strategy has been developed to minimise the impact of HGVs upon the local highway network, focussing HGVs on exiting classified roads wherever practical.

48. It is proposed that all construction accesses and crossings except the substation access would be temporary and following completion of construction works would be removed and reinstated.

5.3.3.9.3 Operational access

49. Upon completion of the construction works there will be a requirement for periodic visits to the onshore substation to undertake routine checks and carry out maintenance. The onshore substation is not however expected to be permanently manned.

50. These movements would typically be made by light vehicles, cars, vans, etc. However, occasional access may be required by HGVs to deliver larger components. The projects' transformers are designed not to require replacement during the lifetime of the project and as such, operational access for abnormal loads is not anticipated to be required.

5.3.4 Overview of programme

51. It is anticipated that the realistic worst-case for construction of the Onshore Project will take 28 months (18 months for cable installation and 16 months for the White Cross Onshore Substation Construction). The operational phase of the Onshore Project will last for 50 years, the decommissioning phase is anticipated to last up to 18 months.

52. A high-level development and installation programme is provided in **Plate 5.2**.

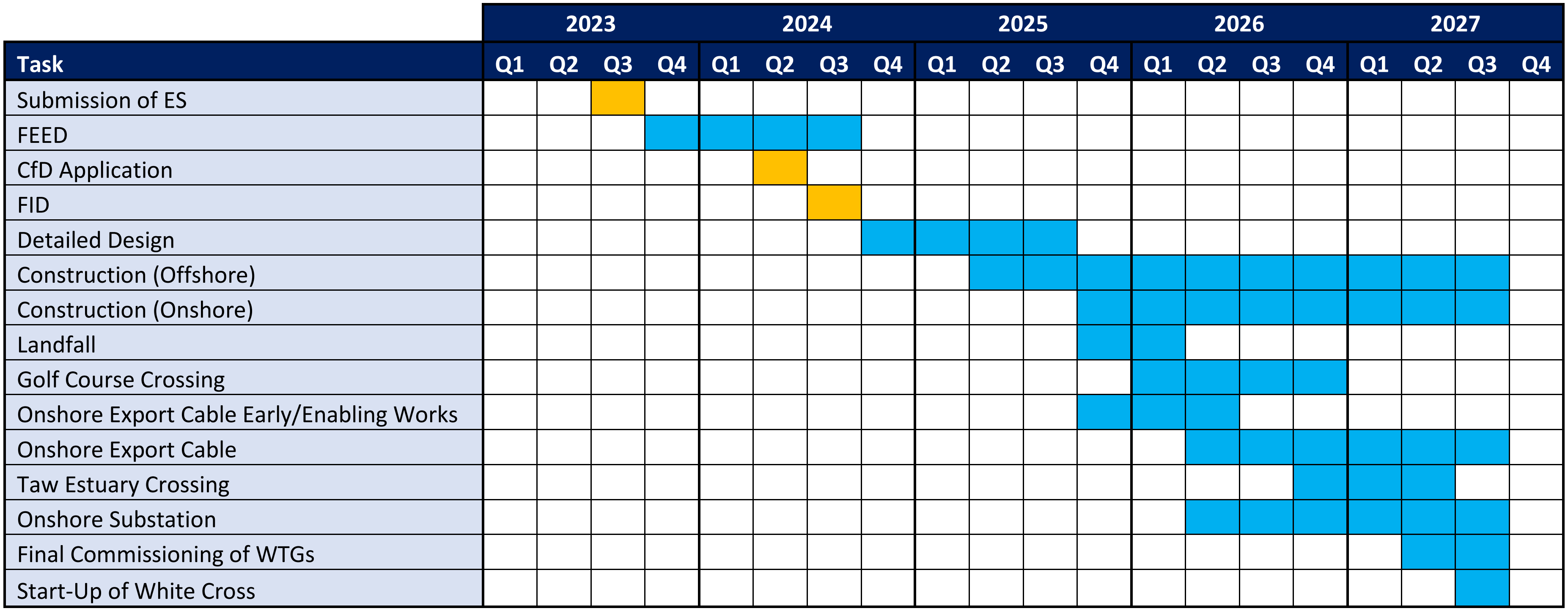

Plate 5.2: Indicative development and installation programme for the Onshore Project

5.4 Landfall (Section 1)

5.4.1 Background

53. Electricity from the Windfarm Site will be transmitted via subsea Offshore Export Cable.

54. The Landfall is the point at which the Offshore Export Cables come ashore and are joined with the Onshore Export Cables within a TJB. It is proposed for the Project that the Offshore Export Cables will make Landfall at Saunton Sands Car Park.

55. The choice of Saunton Sands as the location for the Landfall was the result of a site selection process, considering environmental and technical constraints. The site selection process is described in **Chapter 4: Site Selection and Assessment of Alternatives**.

5.4.2 Landfall Infrastructure

56. The Offshore Export Cable will be formed of either one or two circuits depending on whether an OSP is required. Each offshore export circuit would have three conductors (one for each phase) and a fibre-optic bundled/ wrapped into one cable (see **Plate 5.3**).

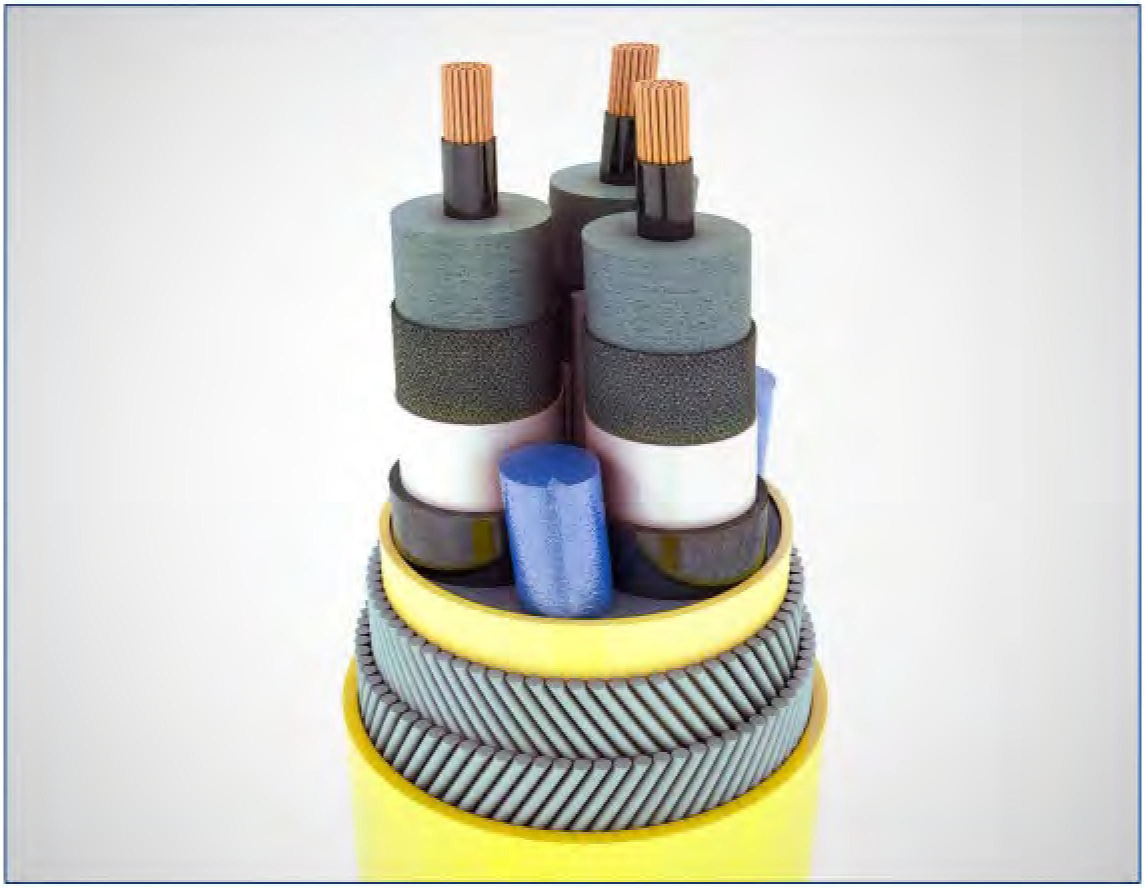

Plate 5.3: Typical 66kV dynamic cable design

57. If there is an OSP the Offshore Export Cable will be formed of a single 132kV Alternating Current (AC) circuit, or with no OSP the likely design will be two 66kV AC circuits. The decision over the OSP and therefore which Offshore Export Cable will not be made until the detailed design of the Offshore Project is completed which is likely to be the end of Q3 2025. Therefore, two options have been considered for the Offshore Export Cable and the worst case assessed for each impact/receptor within this ES.

58. The TJB will be located within the car park at Saunton Sands, therefore above MHWS. The final location of the TJB within the car park will be selected following the detailed design and will depend on the selected method for the installation of the Offshore Export Cables at landfall (see **Section 5.4.3.2**).

59. For both options, single 132kV or two 66kV, there will only be a single TJB. Although the TJB for the two 66kV option will need to be larger to accommodate the two Offshore Export Cables. Again, the worst-case scenario for each receptor is assessed throughout each technical chapter within the ES.

60. The Offshore Export Cables will be installed using either open-trenching, a trenchless technique, or a combination of the two. A Ground Investigation campaign will be undertaken in Q3 2023 at the Landfall providing a high degree of confidence in the feasibility of trenchless techniques at this location.

5.4.3 Construction

5.4.3.1 Site setup and establishment

61. A temporary onshore construction compound will be required to accommodate the drilling rig, materials and welfare facilities and would be up to 100m long by 50m wide (Stage 1 on **Appendix 5.D** *Figure 19*). The temporary onshore compound will be set within the car park at Saunton Sands, the final location will depend on which technique is used for the installation Offshore Export Cable and the location of the TJB.

62. When the works associated with the Landfall (to MLWS) are completed the area will be reinstated and the areas with the carpark returned to the operator in order to minimise the disruption. Only the area needed for the Saunton Golf Club Trenchless Crossing will be retained (Stage 2 on **Appendix 5.D** *Figure 19*).

63. Access to the onshore compound and landfall working area will be from Saunton Road (B3231) using the existing car park access road. It is not anticipated that any major works will be needed to improve this access for the Onshore Project.

64. The initial site setup and establishment will be undertaken outside of the peak summer holiday season, defined as July – August in order to mitigate any impacts on either the local highways or the users of the car park.

65. Movement to site for plant and materials will be optimised in order to minimise traffic movements from the Onshore Project wherever possible.

66. The working hours for the Landfall (to MLWS) are the standard working hours for the Onshore Project, Monday to Friday 07.00-19.00, Saturday 07.00-13.00; however some 24 hour working we be required for the drilling associated with the trenchless cable installation methods (Options 2 and 3). A maximum of 14 days of 24 hour working for each drill has been assessed.

5.4.3.2 Cable installation

67. Cable installation methodology at the Landfall (to MLWS) will be selected based on a comparative assessment of environmental, commercial, and technical factors. Three different options have been identified which include a mix of open cut trenching and trenchless techniques, each option is presented below and has been

assessed within this ES. A final decision on this methodology will be made post-consent.

68. Open cut is a well-known installation methodology for underground cabling in relatively unconstrained areas. It can also be used to install a cable in a Landfall and would require an open trench to be dug out before a cable is installed and the trench refilled.

69. If a trenchless technique is chosen as the appropriate installation methodology at Landfall, the trenchless technique is drilled from above MHWS at the onshore construction compound and will exit either on the seabed in an exit pit at a suitable water depth or on the beach at Saunton Sands. The length of the trenchless technique will depend upon factors such as water depth, seabed topography, shallow geology/soil conditions and environmental constraints.

70. Further details of methods used for cable instillation at landfall are presented within the **Appendix 5.A: Braunton Burrows and Taw Estuary Crossing Method Statement**, and summarised below.

71. The separate Offshore Project application provide a description and assessment of the works below MLWS including the trenchless technique exit point. The ES submitted for the Offshore Project also included an assessment of the works in the intertidal zone (between MLWS and MHWS) based on the design parameters at submission.

72. Since the submission of the ES for the Offshore Project further progress to the design for the Landfall options has been undertaken, providing additional information allowing a more accurate assessment to be undertaken. This includes further details for the open cut option, including the use of a cable plough for installing the cable in the intertidal zone, and the addition of a second shorter option for the trenchless technique.

5.4.3.2.1 Option 1 – Piperam duct (trenchless) and open cut in intertidal zone

73. This option consists of a combination of a trenchless technique to cross the dunes at the edge of the Saunton Sands carpark, with open cut used across the beach and into the intertidal zone.

74. The compound for the trenchless section will be located at the western edge of the carpark. This will include a drive pit excavated below ground within which a Grundoram pneumatic pipe rammer will be installed (see **Plate 5.4**). A maximum of two steel casings will be installed for a distance of approximately 60m to an exit

pit located on Saunton Sands beach. Each casing will have a maximum diameter of 600mm sufficient for the installation of the Offshore Export Cable.

Plate 5.4 Typical pipe ram pneumatic hammer

75. A drive pit will need to be excavated within the onshore compound for the pipe ram, this will measure a maximum of 18m long by 10m wide with a depth of up to 2m. Depending on the ground conditions it may be necessary to install a concrete base in the floor of the excavations to provide a solid working base for the pipe rammer.

76. Once the duct(s) are fully installed, an excavator will carefully excavate the face of the ducts at the reception location, on the beach west of the dunes, in preparation for cable installation from offshore. No excavation will be undertaken within the dunes, and the reception location will be located a minimum of 10m from base of the dunes. This will ensure that there is no direct impact to the dunes from this option.

77. The spoil from the pipe rammer will be removed using compressed air and/or water jetting once the pipe ram has arrived at the exit pit. All spoil will be removed from site in accordance with the project Construction Environment Management Plan.

78. From the exit pit the installation method across the beach and intertidal zone will be by way of cable plough, from a cable lay barge for a distance of approximately 2.3km, of which 700m is above MLWS. A non-displacement type cable plough will be employed, this causes relatively little disturbance with the majority of the sediment falling back into the trench as the cable is laid. This type of cable plough is particularly suited to installing long continuous lengths of cable in a variety of ground conditions, including fine sand like that encountered at Saunton Sands.

79. The cable plough will be winched from the winch tractor, located on the foreshore, aligned with the duct(s) (below the dunes). The area of disturbance for the trench

will typically be 0.5m wide (based on a maximum cable diameter of 250mm for the offshore export cables) with a burial depth of 2m.

80. Once the cables arrive at the terminal point close to the pre-installed ducts below the dunes, the onshore winch spread will pull the cable through the ducts towards the TJB location which will be located at the western end of the carpark.

81. The combined timescale for the described works could be as little as 14 days. This installation process at less risk of waiting on weather than a trenchless marine spread, as the cable lay barge will be of a sufficient size to operate in moderately inclement weather. The cable plough is operated from onshore, with the plough itself subsea, installing the cable below the seabed.

5.4.3.2.2 Option 2 – HDD duct with intertidal exit

82. This option will utilise HDD to install a maximum of two ducts from the carpark to the intertidal zone at a depth of 0m A.O.D. The ducts will be 560mm high density polyethylene (HDPE) SDR 11 pipe, with a length for the drill of approximately 860m to MLWS.

83. The onshore compound will be located in the centre of the carpark. The drill rig for the HDD will be located within the onshore compound and drill from the entry pit out towards the intertidal zone and the exit pit.

84. The HDD exit point is in the intertidal zone, which will allow for construction activities to continue from the beach with reduced marine support. As the HDD approaches the exit point, a reception pit will be excavated to clear the exit zone of beach/marine sediments in order to prevent sedimentary material entering the bore and damaging the duct as it is pulled into the bore.

85. It is proposed to install the ducts from offshore to onshore to reduce the risks associated with bore collapse, and also removes the need for a second rig to be placed offshore on a jack-up barge.

86. The ducts will be fabricated either offsite at a local port, or at the onshore compound if there is sufficient space. The ducts will then be bought to HDD exit point prior to being installed.

87. Once the cables arrive at the exit point close to the pre-installed ducts, the onshore winch spread will pull the cable through the ducts towards the TJB location which will be located in the centre of the carpark.

5.4.3.2.3 Option 3 – HDD duct with offshore exit

88. This option will utilise HDD to install a maximum of two ducts from the carpark to exit offshore at a depth of -5m A.O.D. The ducts will be 560mm HDPE SDR 11 pipe, with a length for the drill of approximately 1850m, of which approximately 850m is above MLWS. A preliminary profile design for this option is included **Appendix 5.D** *Figure 16*.

89. The onshore compound will be located in the centre of the carpark. The drill rig for the HDD will be located within the onshore compound and drill from the entry pit out towards offshore and the exit pit.

90. With up to 7m of marine sediments/sand overlying the HDD exit point, it will be necessary to excavate (vacuum dredge) at the HDD exit point, in order to prevent debris ingress into the bore when the HDD exits the competent geology (mudstone/siltstone).

91. It is proposed to install the ducts from offshore to onshore to reduce the risks associated with bore collapse, and also removes the need for a second rig to be placed offshore on a jack-up barge.

92. The ducts will be fabricated either offsite at a local port, or at the onshore compound if there is sufficient space. The ducts will then be bought to HDD exit point prior to being installed.

93. Once the cables arrive at the exit point close to the pre-installed ducts, the onshore winch spread will pull the cable through the ducts towards the TJB location which will be located in the centre of the carpark.

5.4.3.3 Transition Joint Bay

94. The Offshore and Onshore Export Cables will be joined together in one TJB located onshore within the Landfall compound. This would have a maximum excavated area of 20m x 8m, with a reinforced concrete floor to allow winching during cable pulling and a stable surface to allow jointing.

95. Following cable pulling and joining activities, the joints would be buried to a depth of up to 2m using stabilised backfill, pre-excavated material or a concrete box. The remainder of the TJB will be backfilled with the pre-excavated material and returned to the pre-construction condition, so far as is reasonably possible.

96. The top of the TJB would sit flush with the level of the carpark, with a hatch to provide access, if required, during the operations and maintenance phase of the Onshore Project. The area above the TJB will be available to be used for parking.

5.4.3.4 Connection between Landfall and Golf Course Crossing

97. Whichever construction option is selected for the Landfall a section of cable installed in an open cut trench will be required to connect the TJB to the exit point for the trenchless crossing of the Saunton Golf Club (Section 2).

98. This will be located entirely within the carpark and will have a maximum length of 100m, the construction methodology will be that same as outlined in **Section 5.6.3.1** below. Following the completion of the works the carpark will be reinstated.

5.4.4 Landfall parameters

99. **Table 5.1** shows the main construction parameters for the Landfall up to MLWS. The Landfall below MLWS has been considered within the separate Offshore Project ES. **Figure 5.2** shows the location of the Landfall.

Table 5.1 Landfall construction parameters

Landfall	Minimum	Maximum
Landfall installation method	Combination of trenchless techniques and open cut trench	
Number of Transition Joint Bays	N/A	1
Number of drills	1	2
Number of days for 24 hour working	0	14
Transition Joint Bay dimensions (length x width) (m)	20 x 5	20 x 8
Transition Joint Bay dimensions depth (m)	N/A	2
Onshore construction compound area (above MHWS at Landfall)(length x width) (m)	50 x 50 (main compound plus 18 x 10 (drive pit compound for Option 1)	100 x 50
Trench dimensions for open trench down the beach to MLWS (cable plough)	N/A	0.5m wide x 2m deep
Trenchless technique horizontal length (m)	60	1,860
Open cut trench down the beach to MLWS length (m)	N/A	700

Landfall	Minimum	Maximum
Open cut within carpark length (m)	N/A	100
Open cut within carpark no. trenches	1	2
Trench dimensions for open cut trench through the carpark (each trench)	0.89m wide x 1.6m deep	4m wide x 1.9m deep

5.5 Saunton Golf Club Trenchless Crossing (Section 2)

5.5.1.1 Background

100. The installation of the Onshore Export Cable through the Saunton Golf Club and Braunton Burrows SAC will be undertaken using a trenchless technique.

101. The use of a trenchless technique will avoid any direct impacts on the Braunton Burrows SAC and mitigate any disruption to the Saunton Golf Club.

102. The choice of a trenchless crossing of the Saunton Golf Club was the result of a site selection process, considering environmental and technical constraints. The site selection process is described in **Chapter 4: Site Selection and Assessment of Alternatives**.

5.5.1.2 Golf Club Trenchless Crossing Infrastructure

103. As at Landfall, the choice of whether there will be one or two Onshore Export Cables will be dependent on the detailed design of the Offshore Project and the decision about the need for an OSP.

104. There will be a temporary construction compound at each end of the trenchless crossing, with access to the trenchless entry via Saunton Sands Car Park and access to the trenchless exit via the main construction access from the B3231. The drill rig will be located within the carpark at Saunton Sands beach, with the direction of drilling being from west to east.

105. One joint bay and link box per Onshore Export Cable will be installed at each end of the trenchless section to link the Onshore Export Cable sections together.

106. The length of the trenchless crossing within this section is approximately 1300 m and given the restricted working area within the trenchless entry compound at Saunton Sands Car Park, it will be necessary to pull the HDPE duct from the east side of the golf course to the west, with the full length of the HDPE duct being fabricated along the right of way to the east side of the golf course.

5.5.1.3 Construction

5.5.1.3.1 Site setup and establishment

107. A temporary compound will be required at each end of the trenchless crossing, at the drilling end to accommodate the drilling rig, materials and welfare facilities and would be up to 50m long by 50m wide. The temporary compound for the entry pit will be set within the car park at Saunton Sands (Stage 2 on **Appendix 5.D** *Figure 19),* the final location will depend on which technique is used for the installation Offshore Export Cable and the location of the TJB (see **Section 5.4.3.2**).

108. When the works associated with the Landfall and Golf Course trenchless crossing are completed, the area will be reinstated and the areas with the carpark returned to the operator in order to minimise the disruption.

109. Access to the onshore compound and Landfall working area will be from Saunton Road (B3231) using the existing car park access road. It is not anticipated that any major works will be needed to improve this access for the Onshore Project.

110. The initial site setup and establishment will be undertaken outside of the peak summer holiday season, defined as July – August in order to mitigate any impacts on either the local highways or the users of the car park.

111. Movement to site for plant and materials will be optimised in order to minimise traffic movements from the Onshore Project wherever possible.

112. The working hours for the Golf Course trenchless crossing are the standard working hours for the Onshore Project, Monday to Friday 07.00-19.00, Saturday 07.00-13.00; however, some 24 hour working we be required. A maximum of 14 days of 24 hour working for each drill has been assessed.

5.5.1.3.2 Cable installation

113. Cable installation methodology at the Golf Course crossing will be trenchless technique, namely either HDD or direct pipe and will be selected based on a comparative assessment of environmental, commercial, and technical factors.

114. The Golf Course trenchless crossing operations will commence following the completion of the Landfall works.

115. The trenchless technique is drilled from a temporary construction compound located in Saunton Sands Car Park and will exit at a second temporary construction compound to the east of Saunton Golf Club, outside of the Braunton Burrows SAC. The length of the trenchless technique will be approximately 1300 m from the entry point to the exit point. The stringing out of the HDPE ducting, if HDD is the selected technique, to be used for trenchless crossing will undertaken in the fields on the east side of the Golf Course.

116. Further details of method used for cable instillation at the Golf Course crossing are presented within the **Appendix 5.A: Braunton Burrows and Taw Estuary Crossing Method Statement**. A preliminary profile design for this Golf Course crossing is included **Appendix 5.D** *Figure 17*.

5.5.1.3.3 Joint Bay (JB) and Link Boxes (LB)

117. There will be a maximum of two joint bays and link boxes installed at each end of the trenchless crossing, one for each cable circuit. Each joint bay would comprise an excavated area of 12m x 4m with a reinforced concrete floor to allow winching during cable pulling and a stable surface to allow jointing.

118. Following cable pulling and joining activities, the joints would be buried to a depth of up to 1.5m using stabilised backfill, pre-excavated material or a concrete box. The remainder of the joint bay will be backfilled with the pre-excavated material and returned to the pre-construction condition, so far as is reasonably possible.

119. The top of the joint bay would sit flush with the existing ground level, the link boxes will include an access hatch at ground level to provide access during the operations and maintenance phase of the Onshore Project.

5.5.1.4 Saunton Golf Club crossing parameters

120. **Table 5.2** shows the main construction parameters for the crossing of the Saunton Golf Club. **Figure 5.3** shows the location of Saunton Golf Club crossing.

Table 5.2 Saunton Golf Club crossing construction parameters

Landfall	Minimum	Maximum
Saunton Golf Club crossing installation method	Trenchless technique such as HDD or Direct Pipe	
Number of Joint Bays	2	4
Number of drills	1	2
Number of days for 24 hour working	n/a	14
Joint Bay dimensions (length x width) (m)	n/a	12 x 4
Joint Bay dimensions depth (m)	n/a	1.5
Crossing construction compound area (length x width) (m)	n/a	50 x 50
No. crossing construction compounds	n/a	2
Trenchless technique horizontal length (m)	n/a	1,300

5.6 Onshore Cable Corridor (Sections 3, 4 & 6)

5.6.1 Background

121. The location of the Onshore Export Cable Corridor is presented in **Appendix 5.D** *Figures 6 to 10* and is mostly between 50m to 60m wide, increasing in some places to allow for micrositing and construction equipment storage, and reduced in other areas to mitigate potential effects. The actual working width during cable construction will be 30m across most of the route, reduced to 12m at pinch points and crossings, which will be located entirely within the Onshore Export Cable Corridor.

122. From the Landfall at Saunton Sands (Section 1), the Onshore Export Cable Corridor travels east initially, crossing Saunton Golf Club south of Saunton village (Section 2), before turning and running south crossing agricultural and pastural farmland. It then crosses the Taw estuary (sections 3, 4, and 5). After crossing the Taw estuary, the cable corridor runs to the onshore substation (section 6) before connecting to East Yelland Substation (section 7).

123. Throughout sections 3, 4 & 6 of the cable corridor the cable installation method will be mainly open-cut trenching with small sections of trenchless techniques for main watercourse, road, and sensitive habitat crossings.

124. The choice of crossing methodology throughout this section was the result of a site selection process, considering environmental and technical constraints. The site selection process is described in **Chapter 4: Site Selection and Assessment of Alternatives**.

5.6.2 Onshore Export Cable Infrastructure

125. **Table 5.3** shows the main parameters for the Onshore Export Cable corridor and its construction. The standard temporary working width of the Onshore Export Cable Corridor will typically be 30m and comprises the trench or trenches, storage of excavated material (split into segregated subsoil and topsoil) and a haul road. At specific locations along the Onshore Export Cable Corridor, the working width may require widening to accommodate access at crossings or specific specialist equipment associated with trenchless techniques or micro-tunnelling or indeed decreasing at pinch points to around 12m. The typical cross section through the construction strip, based on two cable circuits, is shown in **Appendix 5.D** *Figure 21*.

Table 5.3 Onshore cable parameters

Onshore cable corridor	Minimum	Maximum
Electrical connection	High Voltage Alternating Current	
Number of cable circuits / trenches	1	2
Cable construction width (onshore corridor) (m)	12	60
Cable construction width at trenchless crossings (m)	7	15
Cable route length (km)	N/A	5.5
Cable trench width (m)	0.89	4
Cable trench depth (m)	1.6	1.9
Depth to top of buried infrastructure (ducts) (m)	1.2	1.5
Running track width (m)	N/A	4
Typical jointing bay frequency (m)	600	1,000
No. of jointing bay	15	30
Jointing bay dimensions (length x width x height) (m)	N/A	12 x 4 x 1.5
Depth to top of jointing bay (m)	1.2	1.5
Link box frequency	600	1,000
No. of link box	15	30
Link box (height) (m)	1	2
Link box (length x width) (m)	2 x 2	3 x 3
Haul road width (m)	5	8
Haul road length (km)	N/A	6.5
Main construction compound area (m2)	N/A	3,500
Mobilisation areas (m2)	N/A	30,000

126. The onshore underground cable system will be installed in one or two trenches consisting of one 132kv or two 66kv cables and one fibre optical cable per trench. The trench holding the circuit may be up to 4m wide, but typically would be less than 1m wide at the base. If two 66kV circuits are chosen for the export cable then there will be a separation distance of 5m (centre to centre) between the two circuits (see **Plate 5.5** below). A running track up to 4m wide would provide a safe working area construction plant and vehicle alongside the cable trench. The topsoil and subsoil will be bunded and stored separately.

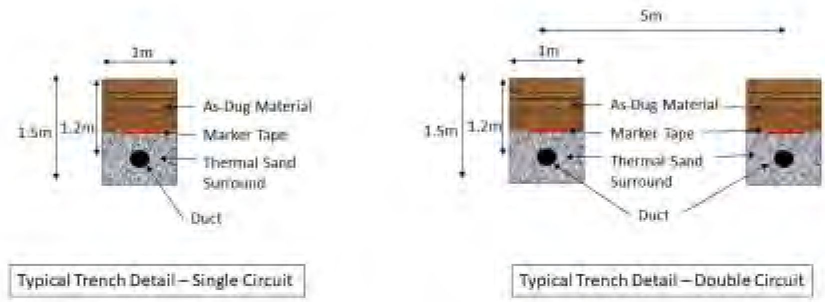

Plate 5.5 Typical trench detail

127. Jointing bays will be used to pull the cable into the ducts and/or to join the cable lengths to each other. Link boxes are used for earthing cables and will be installed inside a protective concrete chamber. The jointing bays are subsurface structures, while the link boxes will require access (for inspections) from the surface during operations and will therefore be located at ground level. At each jointing location there will be one link box for the circuit. The frequency of jointing bays and link boxes will occur every 600 m - 1,000 m, with one jointing bay and link box per cable circuit. Where possible the link boxes will be located within, or at close proximity to the joint bays.

5.6.3 Construction

128. The Onshore Export Cable duct will be installed in sections of up to 1km at a time, with a typical construction presence of up to four weeks along each 1km section.

129. A description of the activities undertaken as part of the construction of the onshore export cable is presented in the following sections.

5.6.3.1 Pre-construction works

130. Following the granting of planning permission but in advance of the main construction there will be a number of activities undertaken along the onshore export cable corridor. Some works will be required as part of the detailed design of the onshore export cable route, and some works will be undertaken as part of the mitigations identified within this environmental statement. These activities include ground investigations, ground penetrating radar, topographical, Unexploded Ordnance (UXO), ecological, and archaeological surveys, soil surveys, utility, and private supplies surveys. With the exception of archaeological investigations, ground investigations and in the event a UXO is identified - where targeted excavations would be conducted, works are generally non-intrusive. These are conducted to highlight specific areas of interest along the proposed White Cross onshore cable corridor and at the onshore substation well in advance of the construction activities.

5.6.3.1.1 Site Investigation / Ground Investigation

131. An initial programme of site and ground investigation works will be undertaken in autumn 2023 to provide information on the ground conditions across the onshore export cable corridor as part of the Preliminary Design. Proposed locations for the boreholes, trial pits, resistivity testing and geophysical survey are shown in **Appendix 5.D** *Figures 11 to 15*.

132. A further programme of works may be required in order to provide information as part of the Detailed Design Phase of the onshore export cable route. These will include a combination of methods and techniques including boreholes, window samples and trial holes.

133. Boreholes will be sited at appropriate locations throughout the route and particularly at major crossing points. They may be performed using a bipod light cable percussive boring rig. Further and deeper survey involving rotary rigs may also be necessary to investigate some areas of the route, particularly where deeper trenchless crossings are being considered.

134. Trial holes will also be excavated, by hand (or using a small tracked excavator), during the Detailed Design Phase to prove the location, depth, size, material and condition of existing services and plant, both in-field and at roadsides. This will ensure that the crossing methods envisaged are appropriate. A Trial Hole (Service) Report will be produced to record the location, depth, size, material and condition of existing services and plant.

135. Trial holes will be excavated every 100-500m during the preparation of the right of way (**Section 5.6.3.2.1** below) to prove ground conditions in each section to ensure that the trenching and crossing methods envisaged are appropriate. A Trial Hole (Geology) Report will be produced which records the location, depth, size, strata, water ingress, and stability.

5.6.3.1.2 Archaeological Investigations

136. Archaeological investigations will be undertaken along the White Cross onshore cable corridor at predetermined locations to ascertain if any archaeological items of interest are present.

137. The initial programme of archaeological excavations was undertaken in June 2023 with a second phase planned for September 2023. These works required the excavation of a number of archaeological trial trenches at predetermined locations along the onshore export cable route.

138. The aim of the archaeological investigations is to examine a representative sample of the remains affected by development in order to generate accurate information on the heritage assets actually present. This stage generally consists of small-scale, selective, and sample based trial work, whilst still being sufficient to quantify, characterise and date the full range of archaeological remains potentially affected by the development works.

139. A range of archaeological techniques may be employed, including archaeological trenches, boreholes, and non-intrusive geophysical investigations. Archaeological investigations in the early stages may also rely upon watching briefs from suitably qualified personnel.

140. Early archaeological field testing may potentially lead to further, more extensive archaeological investigation. This may include full or sample archaeological excavation, further general and targeted investigations.

5.6.3.1.3 Soil Surveys

141. Prior to the commencement of works, the contractor will need to document information on the existing soil/land conditions and agricultural management. To successfully carry out this action, soil condition surveys and intrusive soil survey trial pits may be required to identify and describe the physical and nutrient characteristics of the existing soil profiles. The trial pits would typically be dug by hand along the White Cross onshore cable corridor at approximately 100 m intervals.

142. Further associated preparation activities (non-intrusive) may include: surveys of existing crop regimes, condition of existing access arrangements, position and condition of field boundaries, review of the type of agriculture taking place, establishment of location of private water supplies, quality of grazing land, assessments of yield of crops, and existing weed burden.

5.6.3.2 Site preparation and enabling works

143. Immediately in advance of the main works to construct the Onshore Export Cable a number of site preparation and enabling works will be undertaken. These works include survey and investigation works and will, where possible be computerised to aid the production of the construction and as built drawings.

144. Some of these are required in order to prepare the site before other works can commence.

5.6.3.2.1 Right of Way Preparation

145. Before the site is fully established many of the early and enabling works will take their access to the cable corridor by using existing gateways, tracks, or from the

public highway. Therefore, the first task will be to survey, set out and prepare the right of way in advance of the other enabling works. A number of activities will be completed, with different work crews following in sequence.

146. Generally, the working width design allows for adequate working space, although, around certain crossings and dependent upon the crossing methodology, subject to topography and ground conditions, it may be necessary to re-engineer the fence lines. This will also be the case where the working width design shows boxes at crossings of overhead lines, or where the spread runs parallel to overhead lines, or existing underground services. Working width drawings will detail with dimensions the required site land take. Security patrols will also be present on site.

5.6.3.2.1.1 Route Survey, Setting Out & Record of Condition

147. Prior to erecting the temporary fencing, the perimeter of the right of way will be defined, marked and checked for services using CAT and Genny, by the surveying teams.

148. Information will be digitised and used to generate the construction issue Plan and Profile long sections/strip maps.

149. Photographic records will be carried out during route survey and setting out of the works. Detailed records of the condition of the roads in the vicinity of the route will also be taken. Photographic records will also be taken of any features that are likely to be affected by the Onshore Project.

150. Excavations will also be undertaken along the route in order to locate any buried services that have previously been identified through desk-top studies, and to mark out their locations/erect warning notices. Any excavations within the vicinity of buried services will be undertaken under a permit to dig.

5.6.3.2.1.2 Temporary Fencing

151. Fence posts will be distributed along the marked lines and driven into the ground, generally with an excavator bucket. Fencing for stock accesses will be installed at this time and topsoil strip will be carried out across them. Gates at road crossings, stock and other accesses, together with any required signs, will also be installed. The fencing crew foreman shall ensure that all service protection fencing, and matting is in place when they pass through. The fencing will be suitably earthed with rods beneath overhead electric lines if it is required.

152. Where identified on the working width drawings, specific fencing will be installed, with demarcation fencing in arable areas, stock fencing in cattle areas, post and rain fencing in horse areas, and Heras fencing/hoarding in urban/security risk areas.

5.6.3.2.1.3 Hedgerow and Vegetation Removal

153. Where hedgerows and vegetation occur within the working area, they will be removed ahead of each working section. The width of hedgerow removed will be limited wherever possible to minimise the impact on local ecology. All crossings are listed within a crossing schedule provided as **Appendix 5.G** to this chapter.

154. Prior to the commencement of any works to a hedgerow, an Ecological Clerk of Works will be present on site to ensure that the specified protection and mitigation measures are appropriately implemented, including any measures set out within the Arboricultural Method Statement (see **Appendix 16.R**).

155. At the completion of the project hedgerows will be reinstated in accordance with the Landscape and Ecology Mitigation Plan.

5.6.3.2.2 Topsoil Strip

156. Where topsoil stripping takes place, every care will be taken to prevent topsoil and subsoil mixing and the work will be continuously monitored to ensure this is the case. Topsoil will be stripped to its full depth and records will be kept of the depths stripped in every parcel of land.

157. Track mounted 360-degree slew backhoe excavators will (where appropriate) be used to pull the topsoil away from the left-hand temporary fence far enough to allow a tracked dozer to push and strip towards the right hand fence where it is stacked. Banksmen will be in position to make sure that material does not get pushed outside the easement or damage the temporary fence. To ensure that the heap is weatherproof and not impeding the working spread more than required, it will be built neatly, left tidy and be well-shaped. Where topsoil is removed from the banks of watercourses or ditches it will be stacked separately. Gaps will be left in the topsoil heap to permit the maintenance of public rights of way, water management and beneath all overhead cables. Stripping will not take place above underground services. When working in a flood plain is unavoidable, special measures will be agreed with the Environment Agency, this may include weather monitoring, topsoil wrapping fuel storage constraints and emergency procedures. If required, side slope benching will be carried out to give a level running track and working platform along the side of the trench.

5.6.3.2.3 Haul Road

158. The haul road would provide safe access for construction vehicles along the Onshore Export Cable Corridor, between construction compounds and the work fronts. As set out in the project strategy for access (**Chapter 19: Traffic & Transport**, and **Appendix 19.A: Transport Assessments**) all HGVs will be required to use the

haul road for deliveries with no HGVs from the project accessing the Onshore Export Cable Corridor via the narrow local roads. The haul road would be up to 5m wide (and up to 8m wide at passing bay locations). Speed limits on the haul road are expected to be limited to 20mph.

159. Following an initial topsoil strip, the haul road would be installed in stages as each work front progresses. Typically, it would be excavated to a depth of 400mm with a sub base and MOT Type 1 stone running course on top of a layer of protective matting. Protection to existing underground services will be provided by means bogmat protection above, and quarantine hi-vis netlon fencing to limit crossing of the service to the temporary haul road.

160. In some areas dependant on the ground conditions, for example in areas that are very wet, an alternative method may be employed for the construction of the haul road. This could include laying of bogmats directly on to the ground surface, or through the use of a 'floating road', a technique developed for installing haul roads across peat in Scotland. For both alternative techniques the road is lain directly on the ground surface without the need for any topsoil stripping.

161. When all works are completed the haul road would be removed and the ground reinstated using the stored topsoil.

5.6.3.2.4 Highways Access

162. Three new temporary and one permanent access will be created by the Onshore Project to provide access to and along the Onshore Export Cable Corridor and haul road. The temporary access will be removed and reinstated following the completion of the Onshore Project, and the permanent access will become the permanent access for the new White Cross Onshore Substation. The proposed access routes are shown on **Appendix 19.A** *Figure 1*.

5.6.3.2.4.1 Access 003

163. Access 003 is a proposed new temporary priority access junction from the B3231 Saunton Road. The proposed junction is located west of the Broad Lane / Blind Acres staggered crossroads.

164. To the north of this access the hedgerow will be coppiced to reduce the height to approx. 200mm above ground level for an area 2.4m by 90m to provide visibility of drivers emerging from the access to other road users. The access at the junction will be widened to accommodate the largest anticipated construction vehicles, i.e. a 16.5m maximum legal length articulated HGV.

165. A bellmouth or turning area will be created at the access junction comprising geotextile membrane or similar lain directly on top of the subsoil which will have stone spread over the top of it to a depth of approximately 350mm.

166. This access will be removed and reinstated following the completion of the Onshore Project with the coppiced hedgerow grown back and if required planting to fill in any gaps.

5.6.3.2.4.2 Access 008

167. Access 008 comprises of two priority junctions to the east and west of Sandy Lane to create a haul road crossing.

168. These accesses would allow HGV traffic to access from access 003 to the north and travel via the temporary haul road and cross over Sandy Lane towards the River Taw (thus avoiding the need for HGVs to travel via Sandy Lane). Access for LVs at access 008 would however be permitted from Sandy Lane.

169. The junctions have been designed to minimise impact on surrounding vegetation whilst allowing a 16.5m maximum legal length articulated HGV to manoeuvre from east to west and vice versa. To the north of this access the hedgerow will be coppiced to reduce the height to approx. 200mm above ground level for an area 2.4m by 40m to provide visibility of drivers emerging from the access to other road users.

170. Traffic management controls will be imposed on the haul road approaches to the junction to ensure shuttle working across Sandy Lane. No traffic management would be proposed for Sandy Lane.

171. A bellmouth or turning area will be created at the on either side of the access junction comprising geotextile membrane or similar lain directly on top of the subsoil which will have stone spread over the top of it to a depth of approximately 350mm.

172. This access will be removed and reinstated following the completion of the project with the coppiced hedgerow grown back and if required planting to fill in any gaps.

5.6.3.2.4.3 Access 015

173. Access 015 comprises of the construction access for the proposed White Cross Onshore Substation, this will be used to provide access to the Onshore Export Cable Corridor and haul road for all construction traffic in Section 6. This access will also become the permanent access to the White Cross Onshore Substation (see **Section 5.8** below).

174. The access would connect onto an existing private access road running south to the public highway at the B3233 West Yelland. It is not proposed to alter the existing priority junction between the B3233 West Yelland and the private access road, which already accommodates HGVs.

5.6.3.2.4.4 Access 016

175. Access 016 would provide a haul road crossing of the Tarka Trail long distance footpath and cycleway only. The crossing would utilise existing field gates on either side of the Tarka Trail and would be subject to traffic management by banksmen to ensure the safety of pedestrians and cyclists.

176. Some works, including vegetation removal, may be required to widen the access to accommodate the largest anticipated construction vehicles, i.e. a 16.5m maximum legal length articulated HGV.

177. This access will be removed and reinstated following the completion of the project with any removed vegetation replanted or replaced.

5.6.3.2.5 Watercourse crossings

178. Along the Onshore Export Cable Corridor, the haul road will traverse a number of ditches, drains and other watercourses. Access for the haul road needs to be maintained through the onshore cable corridor, therefore crossings will be required of all features for the haul road.

179. Where the cable corridor crosses minor watercourses such as an open ditch or drain an appropriately sized culvert will be installed within the ditch and the haul road would be installed over the top of the culvert (see **Plate 5.6**). The culvert would be installed in the channel bed to avoid upstream impoundment and would be sized to accommodate realistic worst-case water volumes and flows. These culverts will remain in place for the duration of the cable duct installation and subsequent cable pull.

Plate 5.6 Typical culvert crossing for minor watercourse

180. At larger crossings, including the crossing for the haul road of Sir Arthur's Pill (Main River) and Boundary Drain (Ordinary Watercourse) or those managed by the Internal Drainage Board (IDB), temporary bridges (e.g. Bailey bridges or similar) may be employed to allow continuation of the haul road while mitigating impacts to the watercourse (see **Plate 5.7** and **Plate 5.8** below).

Plate 5.7 Typical beam bridge crossing for larger watercourse

Plate 5.8 Bailey bridge crossing for major watercourse

181. Following the completion of all works the culverts, bridges and or any other infrastructure installed for the haul road crossings will be removed and the watercourse reinstated in accordance with the Landscape and Ecology Mitigation Plan.

5.6.3.2.6 Drainage and Dewatering

182. A number of existing field drains and water management systems have been identified across the onshore export cable corridor, and it is therefore possible that as part of the constriction works some of these systems may be severed, and/or that works will be undertaken within the vicinity of the drainage ditches or channels.

183. Therefore, a detailed drainage strategy will be developed post-consent by a specialist drainage engineer, taking into account existing land drainage and will include details of header drains, outfall locations and cross-easement interconnections (if applicable).

184. This strategy will be prepared in consultation with the landowners and the Braunton Marsh Drainage Board (if within the IDB area).

185. This strategy will include measures to be installed pre-construction, dewatering measures to manage the water during construction, and the measures for the reinstatement and reconnection of drainage following completion of construction.

5.6.3.2.6.1 Pre-construction Drainage

186. Pre-construction drainage will be installed by a specialist sub-contractor in accordance with the design developed by the drainage engineer. Following the erection of fences, this work will be carried out as soon as practically possible.

187. Pre-construction drainage is installed to the "High" side of the construction corridor, using a drainage trenching machine. This is in order to provide a cut off or header drain which will divert the drained water from the existing drainage system which may be damaged during trenching operations prior to pipe installation. This prevents the cable trench from being inundated with water when evacuated, and ensures the construction works do not increase the risk of flooding to surrounding land.

Plate 5.9 Pre-construction drainage being installed using drainage trenching machine

188. Additional drainage channels will be installed to intercept water from the cable trench. This will be discharged at a controlled rate into local ditches or drains via temporary interceptor drains. Depending upon the precise location, water from the channels will be infiltrated or discharged into the existing drainage network.

189. A soakaway drainage pit / outfall may be required if no suitable outfall to a nearby watercourse is possible.

190. Drainage for the main site compound, mobilisation areas and off easement accesses will be installed by a specialist sub-contractor in accordance with the design developed by the drainage engineer. This work will be carried out as soon as is practically possible, to prevent deterioration of the working areas.

191. Generally, existing drainage will be repaired where necessary and cleaned out where required. In the event that further drainage is required to provide a drained working area, then this will be installed using either a 360 ° Backhoe or a Drainage trencher, depending upon the size of the area to be drained.

5.6.3.2.6.2 Dewatering

192. To ensure safe working conditions, certain areas along the cable route may require point dewatering depending upon ground conditions and water levels. Pipes will be sunk to a depth dictated by the ground conditions and water pumped out in advance of the works to temporarily lower the surrounding groundwater level. The groundwater produced will be pumped to an adjacent watercourse downstream of

the works and outline pipes will be installed to prevent scouring and disturbance of the watercourse bed. The watercourse will be monitored for sediment disturbance and rate of flow with additional mitigation measures being put in place if required.

193. For the removal of water in the trench or localised ponding on the right of way, the Foreman will be notified of the land are agreed as suitable to pump the water on to. Where any further locations are required as the work continues, these will be directed through the Agricultural Liaison Officer and agreed with the landowners and IDB (if on the Braunton Marshes).

194. Where surrounding land is not available for discharging water, then excess water will pass through a filtration system, such as temporary settlement lagoons, with straw bales and silt netting filtration and then into a watercourse.

195. A water management scheme may also be installed which is formed from a number of lined lagoons with interconnecting spill ways in order to manage any ground water encountered during the dewatering or run off. This water would need testing for contaminants prior to discharge into any adjacent watercourses, if a permit is obtainable from the relevant authorities.

5.6.3.2.6.3 Drainage Reconnections

196. The reconnection of land drains cut by the cable trench, that are not being replaced by an easement or header drain will be carried out as part of the backfill operation. After the installation of the cable the backfill will be compacted in layers up to the underside of the severed drains which are to be permanently reinstated by cross connection. The replacement drain will extend into the virgin/undisturbed ground on each side of the trench width for a minimum of 1m measured at right angles to the trench. The undisturbed ground will be excavated by hand and a good connection formed to the existing drain. The cable trench backfill will then be compacted up to the subsoil surface level.

197. All drainage reconnections across the trench will be carried out in accordance with the requirements of the land drainage specification.

198. Post-construction agricultural drainage will be reinstated including the replacement of any drains that were damaged during the construction process.

5.6.3.2.7 Temporary construction compounds and mobilisation areas

199. There will be one temporary construction compound for the works to install the Onshore Export Cable, this will up to 3,500m^2 and will be located adjacent to Access 003. This will house portable offices, welfare facilities, and stores. The construction compound would be constructed by laying a geotextile membrane or similar directly

on top of the subsoil which will have stone spread over the top of it to a depth of approximately 350mm.

200. Across the route there will also be up to 10 mobilisation areas, these will be used for the localised stores, as well as acting as staging posts for localised secure storage for equipment and component deliveries. This area will also provide additional works space for the stringing out and welding of the ducting to be used for the trenchless crossings of the Golf Course and Taw Estuary. The total area for the mobilisation areas across the Onshore Development Area will be approximately 30,000m^2.

201. In addition, the trenchless crossings and White Cross Onshore Substation works would have their own dedicated construction compounds. The compound for the substation works would also provide the welfare facilities for the works to install the Onshore Export Cable south of the River Taw (Section 5).

Plate 5.10 Typical construction compound welfare cabins and offices

5.6.3.1 Open-cut excavation

202. The Onshore Export Cables in sections 3, 4, and 5 will be mainly laid in open cut trenches following the methodology outlined below.

5.6.3.1.1 Soil management

203. Stripped topsoil and excavated subsoil will be stored separately within the Onshore Export Cable Corridor. The area to be used for storing the topsoil would be cleared

of vegetation and any waste arising from the development (e.g. building rubble and fill materials). Topsoil would also be stripped from any land to be used for storing subsoil.

204. Effective stockpiles would be created by:

- Removing vegetation and waste materials from the area before forming stockpiles
- Storing topsoil and subsoil layers separately
- Locating stockpiles away from trees, hedgerows, drains, watercourses, or excavations
- Managing the site so that soil storage periods are kept as short as possible
- Stockpiling soils in the driest condition possible
- Using tracked equipment wherever possible to reduce compaction
- Protecting stockpiles from erosion by seeding or covering them.

5.6.3.1 Duct installation

205. The Onshore Export Cable will be installed in pre-laid ducts, the HDPE ducting will be laid to the floor of the trench on a minimum of 150mm thick bed of cement bound sand (CBS). There will be three ducts per circuit arranged in a trefoil formation with zip-ties used to hold the three ducts together.

206. Where the ducts require jointing, this work will be undertaken topside of the trench to avoid working in an unsupported trench where possible. The trench will be kept free of water during duct installation and checks will be made for duct damage once the duct is lifted and prior to being lowered into the trench. In the event any defects are discovered, they will be repaired using an approved quick setting repair compound. Two methods will be used for the laying of the ducts.

5.6.3.1.1 Hand laying method

207. Ducts would be palletised and manoeuvred along the easement using a telehandler (or equivalent). Operatives in the trench would lay zip-ties in the base of the trench following the profile of the trench base and sides at predetermined intervals ahead of the ducts being laid.

208. This method would be chosen were there are short strings of 3-4 ducts, the jointed strings will be laid out alongside the trench, then excavators will lift the strings into the trench. When the duct is lowered off in the trench an engineer will check that the required cover has been achieved. Joint bays and link boxes will also be installed at this time (see below).

5.6.3.1.2 Ducting trailer method

209. For longer sections of ducting, a ducting trailer or trenching machine may be used. This enables the ducts to be joined on the trailer platform and lowered directly into the trench as the tractor moves the trailer forward. The ducts are zip-tied into the correct formation prior to leaving the working platform. The use of the duct trailer or duct machine minimises the need for personnel to work in the trench and is a quicker method for installing longer sections of ducting.

5.6.3.1.3 Duct surround and backfill

210. The duct would be buried to a minimum depth of 1.2m (from top of duct to surface). Depending on the thermal resistivity of the soil and the height of the water table, it is likely that a stabilised backfill such as CBS will be required to encase the ducting. This is commonly used to ensure that the thermal conductivity of the material around the cables is of a known consistent value for the length of the installation.

211. The CBS has a low thermal resistance to conduct the heat produced during electricity transmission away from the HV cables. Additionally, as CBS tends to consist of a weak sand to cement ratio (typically 14:1), it is relatively easy to remove if maintenance or removal of cables is required.

212. Once the ducts are encased in CBS (typically covering depth of 75mm above the ducts) a compaction plate would be used until the required level of compaction is achieved. The trench would then be backfilled in stages using the subsoil stored at the side of the trench and compacted using suitable compaction plant. Following construction, the stored topsoil would then be replaced on top of the backfilled subsoil to reinstate the trench to pre-construction condition, so far as reasonably possible.

5.6.3.2 Joint bays

213. Joint bays would be required along the route of the Onshore Export Cables to connect sections of cable, these are typically concrete lined pits (approximately 12m by 4m) that provide a clean and dry environment for jointing sections of cable together.

214. Joint bays are likely to be required every 600 to 1000 m along the export cable for each circuit. The number and placement of the joint bays would be determined as part of the detailed design but indicative locations have been provided in **Appendix 5.D** *Figures 1 to 5*. Joint bays would be installed at least 1.2m below ground and would be of a similar design to the TJB described for the Landfall (**Section 5.4.3.3**). The joint bays would be formed on completion of the duct installation before the cables are installed.

5.6.3.3 Link boxes

215. Each jointing bay associated with a single circuit will require a smaller concrete enclosure known as a link box, to provide connections between cable sheaths essential for the efficient operation of the cable and for fault testing. The link boxes will be a maximum of 3m by 3m, with a height of up to 2m.

216. Link boxes are required to be in proximity of the jointing bay locations and where possible the link boxes will be located within, or at close proximity to the joint bays. The number and placement of the link boxes would be determined as part of the detailed design. But as a worst-case for the assessment is has been assumed there will be one link box located at the same location at the joint bays.

217. The link boxes need to be accessible during the operation and maintenance phase of the project to allow periodic access by technicians for inspection and testing of the cables. They would be buried to ground level with above ground marker posts to locate them and will include a secured access panel.

5.6.3.4 Cable pull

218. Cables would be pulled through the pre-installed ducts later in the construction programme. Trenches would not need to be reopened, and the cable pull would take place from the jointing bays located approximately every 600m to 1,000m along the cable corridor.

219. During the cable pull and jointing works, cable drums would be delivered by HGV low loader to the open joint bay locations using the haul road. The cable would then be winched off the drum from one joint pit to another, through the buried ducts. Cable jointing would be conducted once both lengths of cable have been installed within each joint bay.

220. The cable pulling and jointing process would take approximately eight weeks per 1000m length of cable. However, any one joint bay could be open for up to 16 weeks to allow its neighbouring joint bay to be opened and the cables pulled from one pit to the next, dependant on the level of parallel work being conducted.

221. Once the cables are joined together the jointing bays would be backfilled following a similar methodology to set out about in **Section 5.6.3.1.3** for duct surround and backfill.

5.6.3.5 Crossing methods

222. All crossings are listed within a crossing schedule provided as **Appendix 5.F** to this chapter.

223. During detailed design, contact will be made with all the relevant local and statutory authorities, private companies and agencies to obtain all consents, permits, licences and authorisation necessary to carry out the crossings.

5.6.3.5.1 Major watercourse crossings (trenchless)

224. Where Onshore Export Cable Corridor crosses major watercourses, including Environment Agency Main Rivers or IDB maintained watercourses, trenchless crossing techniques such as a HDD micro rig, will be employed. The crossing of the Taw Estuary is discussed in **Section 5.7** below.

225. The trenchless process involves drilling underneath the feature being avoided. The process uses a drilling head to drill a pilot hole along a predetermined profile based on an analysis of the ground conditions and cable installation requirements. This pilot hole is then widened using larger drilling heads until the hole is wide enough to fit the cable ducts. Bentonite is pumped to the drilling head during the drilling process to remove drill cuttings and to stabilise the hole and ensure that it does not collapse. Once the trenchless drilling has taken place the ducts are pulled through the drilled hole.

226. A detailed method statement will be produced for each crossing, this will include any specific control or mitigation measures such as setback distances from Main Rivers, that are deemed required to mitigate any potential effects from the works.

227. When crossing Main Rivers or IDB maintained watercourses, the cable entry and exit pits will be at least 9m from the banks of the watercourse (18m where they are tidal), and the ducts will be installed at least 2m below the channel bed.

5.6.3.5.2 Minor watercourse crossings (open cut)

228. Where minor watercourses such as open ditches or drains, are to be crossed, the approach will be open cut trenching combined with temporary damming and diverting of the watercourse. The suitability of this method would be agreed at detailed design.

229. The watercourse would be dammed at either side of the cable crossing point, typically using sandbags, straw bales and ditching clay, and the water within the watercourse would be pumped or piped across the dammed section to effectively maintain flow across the dammed section. The cable trenches would then be excavated within the dammed section but ensuring that watercourse bed materials are stored separately to subsoils. Ducts would typically be installed to 2m below the channel bed to avoid impacts to the active channel bed.

230. Reinstatement of the trench would be conducted to the pre-construction depth of the watercourse, taking care to reinstate the channel bed material and subsoils in the order that they were removed.

231. The dams would then be removed. Temporary dam and divert would only be required for the duration of time that duct installation takes place in that location (typically no more than 1-2 weeks for a minor watercourse crossing).

5.6.3.5.3 Road, tracks, public right of way, and service crossings

232. Where the Onshore Export Cable Corridor crosses roads, tracks, public rights of way and services, including Sandy Lane and the Tarka Trail, trenchless techniques such as a HDD micro rig will be used in order to maintain access for the users or mitigate any disruption of or impact to the services.

233. The methodology used for the HDD micro rig is similar to that outlined for the major watercourse crossings in **Section 5.6.3.5.1** above. The ducts will be installed at a suitable depth depending on the type of crossing, but typically will be 2m below the bottom of the constraint.

234. The approach for each crossing would be agreed with the relevant authority prior to works beginning. No temporary closures or diversions would be required, the works in the vicinity of the crossings would be managed to allow safe operation.

5.6.3.5.4 Minor watercourse crossings

235. Where minor watercourses such as open ditches or drains, are to be crossed, the approach will be open cut trenching combined with temporary damming and diverting of the watercourse. The suitability of this method would be agreed at detailed design.

236. The watercourse would be dammed at either side of the cable crossing point, typically using sandbags, straw bales and ditching clay, and the water within the watercourse would be pumped or piped across the dammed section to effectively maintain flow across the dammed section. The cable trenches would then be excavated within the dammed section but ensuring that watercourse bed materials are stored separately to subsoils. Ducts would typically be installed to 2m below the channel bed to avoid impacts to the active channel bed.

237. Reinstatement of the trench would be conducted to the pre-construction depth of the watercourse, taking care to reinstate the channel bed material and subsoils in the order that they were removed.

238. The dams would then be removed. Temporary dam and divert would only be required for the duration of time that duct installation takes place in that location (typically no more than 1-2 weeks for a minor watercourse crossing).

5.7 Taw Estuary Trenchless Crossing (Section 5)

5.7.1.1 Background

239. The installation of the Onshore Export Cable beneath the River Taw Estuary will be undertaken using a trenchless technique likely to be a HDD.

240. The use of a trenchless technique will avoid any direct impacts on the River Taw and Taw-Torridge Estuary SSSI.

241. The choice of a trenchless crossing of the River Taw was the result of a site selection process, considering environmental and technical constraints. The site selection process is described in **Chapter 4: Site Selection and Assessment of Alternatives**.

5.7.1.2 Construction

5.7.1.2.1 Site setup and establishment

242. A temporary compound will be required at each end of the trenchless crossing, at the drilling end to accommodate the drilling rig, materials and welfare facilities and would be up to 50m long by 50m wide (**Appendix 5.D** *Figure 20*). The trenchless exit compound will be located to the west of the river Taw, with the trenchless crossing entry compound located to the east of the river Taw.

243. When the works associated with the Taw Estuary crossing are completed the area will be reinstated to minimise disruption.

244. Access to the compound on the south side will be from the new haul road connecting to the existing private road and then to the highway at the West Yelland Road (B3233), Access 015 on **Appendix 19.A** *Figure 1*. From there access will be along the Onshore Export Cable Corridor, utilising the temporary crossing of the Tarka Trail (Access 016).

245. To gain access to the compound on the north side all traffic will use the haul road within the Onshore Export Cable Corridor in accordance with the onshore access strategy (see **Section 5.3.3.9**).

246. The working hours for the Taw Estuary crossing are the standard working hours for the Onshore Project, Monday to Friday 07.00-19.00, Saturday 07.00-13.00; however

some 24 hour working we be required. A maximum of 14 days of 24 hour working for each drill has been assessed.

5.7.1.2.2 Cable installation

247. Cable installation methodology at the Taw Estuary crossing will be trenchless technique, namely either HDD or direct pipe and will be selected based on a comparative assessment of environmental, commercial, and technical factors.

248. The trenchless technique is drilled from a temporary construction compound located on the south side of the Taw Estuary outside of the Taw-Torridge Estuary SSSI. It will exit at a second temporary construction compound to on the north side of the Taw Estuary, west of the Crow Beach House (the White House). This compound will be outside of the Braunton Burrows SAC, Braunton Burrows SSSI, and the Taw-Torridge Estuary SSSI.

249. The length of the trenchless technique will be approximately 1300 m from the entry point to the exit point. The stringing out of the HDPE ducting to be used for trenchless crossing will undertaken on the north side of the Taw Estuary.

250. Further details of method used for cable instillation at the Golf Course crossing are presented within the **Appendix 5.A: Braunton Burrows and Taw Estuary Crossing Method Statement**. A preliminary profile design for this Taw Estuary crossing is included **Appendix 5.D** *Figure 18*.

5.7.1.2.3 Joint Bay (JB) and Link Boxes (LB)

251. There will be a maximum of two joint bays and link boxes installed at each end of the trenchless crossing, one for each cable circuit. Each joint bay would comprise an excavated area of 12m x 4m with a reinforced concrete floor to allow winching during cable pulling and a stable surface to allow jointing.

252. Following cable pulling and joining activities, the joints would be buried to a depth of up to 1.5m using stabilised backfill, pre-excavated material or a concrete box. The remainder of the joint bay will be backfilled with the pre-excavated material and returned to the pre-construction condition, so far as is reasonably possible.

253. The top of the joint bay would sit flush with the existing ground level, the link boxes will include an access hatch at ground level to provide access during the operations and maintenance phase of the Onshore Project.

5.7.1.3 Taw Estuary crossing parameters

254. **Table 5.4** shows the main construction parameters for the crossing of the Taw Estuary. **Figure 5.6** shows the location of the Taw Estuary crossing.

Table 5.4 Taw Estuary crossing construction parameters

Landfall	Minimum	Maximum
Saunton Golf Club crossing installation method	Trenchless technique such as HDD or Direct Pipe	
Number of Joint Bays	2	4
Number of drills	1	2
Number of days for 24 hour working	n/a	14
Joint Bay dimensions (length x width) (m)	n/a	12 x 4
Joint Bay dimensions depth (m)	n/a	1.5
Crossing construction compound area (length x width) (m)	n/a	50 x 50
No. crossing construction compounds	n/a	2
Trenchless technique horizontal length (m)	n/a	1,200

5.8 Onshore Substation and Grid Connection Point (Section 7)

5.8.1 Background

255. A new Onshore Substation will be required for the Onshore Project to transform the windfarm export voltage to the National Grid Electricity Distribution (NGED) 132kV distribution voltage. The White Cross Onshore Substation will be connected to the existing NGED East Yelland substation via a single 132kV export cable where the Grid Point of Connection is located.

256. The White Cross Onshore Substation will be located in agricultural land and a brownfield site to the east of the NGED East Yelland substation (see **Appendix 5.E Figure 9**). The site is located approximately 250m south of the Taw Estuary and approximately 1km from Yelland.

257. The choice of the location for the White Cross Onshore Substation was the result of a site selection process, considering environmental and technical constraints. The site selection process is described in **Chapter 4: Site Selection and Assessment of Alternatives**.

5.8.2 Onshore substation infrastructure

258. The design of the White Cross Onshore Substation, including the equipment to be installed, will partly depend on the detailed design of the offshore components of the Project. But will also depend on the choice of substation supplier, as much of the technology and equipment for a substation is proprietary. Therefore a series of indicative designs have been developed in line with the principles of the Rochdale Envelope approach (for further information see **Chapter 6: EIA Methodology**).

259. The following components and equipment will be located within the operational footprint for the White Cross Onshore Substation:

- Control building – housing the main switchgear, auxiliary service transformer, and offices
- Substation building – housing the main equipment including:
  - Shunt reactors
  - Static Synchronous Compensators, Static Var Compensator or equivalent
  - Transformers
  - Harmonic filters
- Associated connections between equipment via busbar and cabling, including buried earthing system
- Access road
- Ancillary infrastructure such as a car park and storage areas for other plant/equipment
- Security fence, internal drainage and lighting

260. The White Cross Onshore Substation will either utilise an Air Insulated Switchgear (AIS), which uses air for insulation, or a Gas Insulated Switchgear (GIS), which uses sulphur hexafluoride gas for insulation. Installations for a GIS substation are generally smaller than their AIS counterparts, although a GIS substation will typically have higher upfront cost.

261. Typically an AIS substation will be open to the air (i.e. the equipment will not be contained within a building), while a GIS substation requires that all of the equipment is contained within a building. However the decision has been made to include a building for both of the AIS and GIS options due to the location of the Onshore Substation close to the Taw Estuary in order to provide some protection to the equipment from adverse weather and corrosion from salt air.

262. Based on the above three options have been defined for the White Cross Onshore Substation:

- Option A: Indicative Enclosed Gas Insulated Switchgear Substation
- Option B: Indicative Enclosed Air Insulated Switchgear Substation
- Option C: Indicative Enclosed Air Insulated Switchgear Substation with Additional Equipment Space

263. The indicative designs for the three options are presented in **Appendix 5.E.**

264. Additional land will be required adjacent to the Onshore Substation to accommodate the infrastructure required in order to mitigate the potentially significant effects from the operation phase of the Onshore Project. This includes areas for landscape screening to mitigate landscape and visual impact, see **Chapter 20: Onshore Landscape and Visual Amenity**, and to mitigate flood risk and drainage impacts, see **Chapter 14: Water Resources and Flood Risk**.

265. The total area of additional land required will not be known until the detailed design of the Onshore Substation is completed, and until the mitigation measures are agreed with relevant stakeholders. For the assessments within this ES the mitigation requirements are based on the worst-case design of indicative option, Option C.

266. **Table 5.5** describes the main onshore substation construction parameters, where there is a range the minimum is based on the indicative design for the Option A Onshore Substation, and the maximum is drawn from the indicative design for the Option C Onshore Substation.

Table 5.5 Onshore Substation construction parameters

Onshore Substation Parameters*	Minimum (Option A)	Maximum (Option C)
Construction compound dimensions (length x width) (m)	N/A	100 x 50
Construction compound area (temporary works) (m^2)	N/A	5,000
Substation access road (temporary and permanent) dimensions (length x width) (m)	N/A	250 x 7.5
Substation operational footprint dimensions (length x width) (m)	95 x 50	106 x 50
Substation operational footprint area (m^2)	4,750	5,300
Substation building dimensions (length x width) (m)	59 x 23	71 x 24
Substation building height (m)	N/A	10
Substation building area (m^2)	1,357	1,704

Onshore Substation Parameters*	Minimum (Option A)	Maximum (Option C)
Control building dimensions (length x width) (m)	N/A	35 x 9
Control building height (m)	N/A	8
Control building area (m^2)	N/A	315
External equipment height (m)	N/A	10
Finished Floor Level (m AOD)	N/A	6.73
Building platform area (m^2)	N/A	7,700

267. **Table 5.6** describes the construction parameters for the export cable from the Onshore Substation to the Grid Point of Connection in the existing East Yelland substation.

Table 5.6 Grid Point of Connection construction parameters

Grid Point of Connection Parameters	Minimum	Maximum
Electrical connection	High Voltage Alternating Current 132kV	
Number of cable circuits / trenches	N/A	1
Total cable route length (m)	N/A	300m
Cable route length within East Yelland substation (m)	N/A	130m

5.8.3 White Cross Onshore substation construction method

5.8.3.1 Site setup and establishment

268. At the start of the works the area will be fenced and the site would be stripped, and the ground levels graded as required by the final design. Stripped material would be reused on site where possible, potentially as part of any identified bunding or screening identified through the impact assessment process.

269. A temporary materials storage area, incorporating a construction compound will be established to the south of the proposed substation location. This will be the main compound for all works south of the River Taw and so will also accommodate staff, materials and equipment required for the construction of the Onshore Export Cable in Section 6.

270. Access will be from a new haul road connecting to the existing private road and then to the highway at the West Yelland Road (B3233). This access will also then become the permanent access route to the White Cross Onshore Substation. A short (230m) section of wooden pole mounted overhead power line runs along the route

of the proposed temporary and permanent access, this will be relocated through agreement with the owner and operator, NGED.

5.8.3.2 Civils build

271. In order to mitigate the risk from tidal flooding to the White Cross Onshore Substation the Finished Floor Level (FFL) for the Onshore Substation needs to be raised to a minimum of 300mm above the water level for the 1 in 200 year event for 2075 (assuming a maximum operational lifetime for the Onshore Substation of 50 years). This would result in a FFL of 6.73mAOD, which based on existing ground levels would require the platform for the Onshore Substation to be approximately 1.33m to 1.73m above the existing ground levels. Further details and information on the flood risk and the design of the FFL can be found in **Chapter 14: Water Resources and Flood Risk, Appendix 14.C: Flood Risk Assessment** of this ES.

272. Deeper soils would be excavated from areas where the ground profile needs to be lowered (cut) and moved into the areas where the ground level needs to be raised (fill). The thickness of each fill layer would need to be determined in accordance with the specification of the material and the design of the substation platform. Where the specification of the existing soils is not up to the required load bearing standard additional material may need to be imported to the site. Any excess material would be disposed of at a licenced disposal site.

273. After grading of the site is complete to provide the required FFL, a stoned platform will be constructed, and excavations would then proceed associated with the laying of foundations, trenches and drainage. At this stage it is not known whether the foundations would be ground bearing or piled. This will be determined by geotechnical ground investigation post consent that will inform the detailed design. However, for the purposes of the assessment piled foundations are assumed to be required at the substation.

274. Following completion of the enabling works, installation of drainage and foundations, the substation platform will need to be finished with a layer of imported stone fill combined with a concrete pour. The thickness of this concrete platform would be determined during detailed design based on the geotechnical ground investigation.

5.8.3.3 Building construction

275. To further mitigate the flood risk the exterior of the White Cross Onshore Substation building has been designed using flood resistant materials, to limit flood water

ingress into the building and to provide protection to the electrical equipment and infrastructure contained within it. Therefore the buildings will be constructed on a brick or concrete base lined or coated with a suitable watertight material up to 600mm above the FFL. Access and egress into the buildings will be from steps or ramps in order that the threshold will also be raised.

276. The upper structure of the buildings would likely be constructed from a steel frame with cladding panels. The steel frame would be fabricated off site and then erected at the substation location with the use of cranes. The cladding would be fitted once the framework is in place.

277. The final design of the substation and control buildings, including the choice of building materials, form, colour, and finish will be completed as part of the detailed design for the project.

278. A **Substation Design Code** (**Design and Access Statement: Appendix B**) has been prepared to provide further details on the design and appearance of the Onshore Substation, including its architectural form, orientation, façade design, materials, and colours. The Design Code seeks to minimise potentially adverse impacts, as well as creating development which is sympathetic to its local context.

5.8.3.4 Mechanical and electrical build

279. Once the civil and buildings works are completed the substation electrical equipment would then be delivered to site and installed. Due to the size and weight of assets such as the transformers, specialist delivery methods would be employed, and assets would be offloaded at site with the use of a mobile gantry crane.

280. The electrical build process is set out methodically, building each part of the structure piece by piece, including cable connections to the automatic control and protection equipment.

281. All other equipment and plant required for the operation of the Onshore Substation, such as control room equipment, lighting, and heating, ventilation and air conditioning (HVAC) system will be installed.

5.8.3.5 Commissioning

282. Following installation commissioning will be undertaken to test the equipment to ensure that it is connected correctly. This includes both hot and cold commissioning.

283. Some of the commissioning works will need to be undertake simultaneously and retrospectively with the offshore commissioning of the WTGs, and Offshore

Substation (if required). Therefore, the final commissioning will need to align with the programme for the offshore works.

5.8.3.6 Reinstatement

284. Following the construction much of the area will become part of the permanent area for the Onshore Substation. This includes the operational footprint of the Onshore Substation, and the associated infrastructure such as the access road, landscaping areas and drainage.

285. Those areas not required for either the operational footprint of the associated infrastructure will be reinstated in accordance with the Landscape and Ecology Mitigation Plan to be produced as part of the detailed design.

5.8.4 Lighting, heating, ventilation and air conditioning

286. The final requirements for lighting, heating, ventilation and air conditioning for the Onshore Substation will not be known until the detailed design of the substation is completed. But an indicative design with worst case parameter, based on final design for other similar sized substations for offshore windfarms is provided below and assessed within this ES.

5.8.4.1 Lighting

287. The final design of the lighting for the White Cross Onshore Substation will be completed as part of the detailed design for the substation, and will follow all appropriate guidance. The final design of all exterior lighting will be completed in accordance with the Institution of Lighting Professionals Guidance Note 01/21: The Reduction of Obtrusive Light, and will incorporate appropriate measures to mitigate lighting impacts.

288. Internal lighting will be designed to allow safe movement of personnel and safe operation of equipment, where practicable all of the lights will be LED type with the lighting levels in accordance with British Standard EN12464-1:2021. They will be operated by wall switches positioned adjacent to doorways, including outside at the entrance to rooms and/or at more than one doorway if appropriate, and will incorporate a 4-hour timer manual override switch. All emergency lighting will be designed in accordance with British Standard EN5266-1:2016.

289. Exterior lighting, including perimeter and site lighting, will be required to allow safe access and emergency egress for personnel (including from buildings) and safe operation of equipment during the winter months. A lower level of lighting will also be required to remain overnight for security purposes.

- Maintained average illuminance 6.0 lux at ground level
- Minimum maintained point illuminance 2.5 lux at ground level.

290. For the perimeter lighting the luminaires shall, where practicable, be LED type with directable light output to minimise light pollution. Exterior site lighting to buildings shall incorporate IP65 wall mounted LED luminaires which will be controlled via integral PIR motion detectors.

5.8.4.2 Heating, ventilation and air conditioning

291. A HVAC system may be required for the substation building in order to dissipate the heat produced by transformers and other equipment, and to allow drying after particularly wet or humid periods.

292. The design of this system will be determined in part by the selection of the type of switchgear cooling used for the White Cross Onshore Substation. The indicative design shows, as a worst case scenario, a maximum of 15 vents around the substation building which would be required if a forced air cooling system using fans or blowers was employed.

293. The substation control building may also require a HVAC system in the form of a small commercial air conditioning unit. Modern units, such as those typically employed for small commercial or industrial buildings such as the White Cross Onshore Substation control building, are now all-in-one with no need for external units.

294. The final design of the HVAC system for the substation and control buildings will be designed in order to minimise and mitigate the noise impacts.

5.8.5 Drainage

295. A surface water drainage system will be required for the operational Onshore Substation and would be designed to meet the technical requirements set out in the National Planning Policy Framework. An Outline Drainage Strategy Report has been prepared (**Appendix 5.C**) which provides an outline drainage strategy and design, the final design of the drainage system will be completed as part of the detailed design for the White Cross Onshore Substation and agreed with Devon County Council as the Lead Local Flood Authority.

296. Surface water from across the substation site will be collected and routed via a treatment system to an attenuation pond located to the south of the substation building. The water will then channelled to an existing drainage ditch located to the northwest of the White Cross Onshore Substation. A hydrobrake flow control system

at the downstream end of the attenuation pond will ensure that the water is discharged at the greenfield run-off rate of 3.87l/s.

297. The combination of the attenuation pond and controlled discharge will ensure that there will be no increase in flood risk from the Onshore Substation to the surrounding area.

298. The White Cross Onshore Substation will not be manned and the design does not incorporate any toilet or welfare facilities. Therefore, there is no requirement for a foul drainage connection.

5.8.6 Landscape Screening

299. The site selected for the White Cross Onshore Substation already benefits from existing landscape screening from the north and northwest. But in order to mitigation the potentially significant visual effects from the west and south (see **Chapter 20: Onshore Landscape and Visual Amenity**) further planting will be undertaken to provide additional landscape screening.

300. The proposed woodland would be located around the Onshore Substation enclosing the infrastructure apart from the access and cable ingress points. Native hedgerows and scrub vegetation would be located along the Onshore Export Cable Corridor around the White Cross Onshore Substation to increase connectivity between the woodland blocks and to the existing woodland and hedgerows.

301. The indicative mitigation woodland planting would be designed to comprise a mix of faster growing 'nurse' species and slower growing 'core' species. Nurse species, such as alder and pine would grow quicker so that after 15 years they would be approximately 7.5m in height. They would provide shelter to bring on core, canopy species, such as oak. Whilst the nurse species would be sufficiently fast growing to provide substantial screening of the onshore substation after 15 years, the core species would outlive the nurse species and provide a preferred native woodland with a more robust structure closer in character to other nearby woodlands.

302. The location of the screening is set out in the Outline Landscape & Ecology Mitigation Plan (OLEMP), see **Figure 20.13** within **Chapter 20: Onshore Landscape and Visual Amenity**. The OLEMP will be further developed as part of the detailed design with the measures agreed with relevant stakeholders and consultees as appropriate.

5.8.7 Onshore substation to grid point of connection

303. The 132kV interconnecting cable from the White Cross Onshore Substation to the Grid Point of Connection will be installed within ducts using a combination of open-cut and trenchless techniques similar to those outlined in **Section 5.6**. A trenchless technique will be used for the crossing of the Tarka Trail in order to ensure there is no closure of the Traka Trail.

304. The final 130m of the interconnecting cable will be within the perimeter of the East Yelland substation, it is expected that this will be installed within or adjacent to the existing internal road within the substation. The final routing within the East Yelland substation will be agreed NGED.

305. Construction works within the East Yelland substation will be undertaken by NGED and will include the instillation of sealing end compounds, and circuit breakers for the grid connection. It is not anticipated that any changes or extension to the existing substation boundary or buildings will be required to accommodate the grid connection. Should they be required it will be the responsibility of NGED to secure all of the required permissions and consents.

5.9 Operations and Maintenance

306. The operational life of the Offshore Project is 25 years based on the proposed Agreement for Lease (AfL) with The Crown Estate (TCE). Therefore the operational lifetime for the Onshore Project is expected to also be 25 years. However, for some assessments a longer operational lifetime of 50 years has been used for the assessment as the decommissioning policy for the Project is not yet known (see **Section 5.10** below).

307. The overall Operations and Maintenance strategy will be finalised once the detailed design of the whole project is completed, including electrical export option and final project layout.

308. Maintenance activities can be categorised into two levels: preventative and corrective maintenance. Preventative maintenance is according to scheduled services whereas corrective maintenance covers unexpected repairs, component replacements, retrofit campaigns and breakdowns.

5.9.1 Onshore Export Cables

309. There is expected to be minimal maintenance of the Onshore Export Cables during the operational phase, with any operation and maintenance requirements largely

corrective with infrequent on-site inspections of the onshore transmission infrastructure undertaken through the operational lifetime.

310. Typically, every two to five years, there will be periodic testing of the cable which involves access to the link boxes along the entire onshore route. With regards to equipment, access can be achieved using lightweight vehicles and existing highways or farm access tracks.

5.9.2 White Cross Onshore Substation

311. The White Cross Onshore Substation would not be manned; however, access would be required for routine maintenance activities, estimated at an average of one visit per week during normal daytime working hours. There would likely also be annual maintenance and servicing of equipment, with more major servicing activities undertaken every four years. These works would take up to a week and would normally be undertaken in the summer to coincide with low wind speeds.

312. The normal operating conditions would not require lighting at the Onshore Substation, although low level movement detecting security lighting may be utilised for health and safety purposes. Temporary lighting during working hours will be provided during maintenance activities where those activities are undertaken during the winter months.

5.10 Decommissioning

313. No decision has been made regarding the final decommissioning policy for the Onshore Project, as it is recognised that industry best practice, rules and legislation change over time. The decommissioning methodology would need to be finalised nearer to the end of the lifetime of the Offshore Project so as to be in line with current guidance, policy and legalisation at that point. Any such methodology would be agreed with the relevant authorities and statutory consultees. The decommissioning could be subject to a separate consenting approach.

5.10.1 Onshore Export Cables

314. Onshore there are two main options with regards to decommissioning of the Onshore Export Cable Corridor. The cables can be left buried in-situ with the cable ends cut, sealed and securely buried. Alternatively, the cables can be removed by pulling them through the ducts. It is likely that the cables would be pulled through the ducts and removed, with the ducts themselves left in situ.

315. The TJB, jointing bay and link boxes would also likely be capped and left in-situ. If removal is required the method would be the reverse of construction with the

infrastructure excavated and all materials taken off site for recycling or disposal in accordance with the legislative requirements at the time.

5.10.2 Onshore Substation

316. The White Cross Onshore Substation site may be kept operational and upgraded accordingly for other potential electrical use or fully decommissioned (performed in the reverse of the construction works utilising similar types of equipment). To decommission the White Cross Onshore Substation, all electric plant is removed from their foundations and transported to a facility for processing for reuse, recycling, or disposal. The foundations may be pulled out and disposed of and any holes refilled with earth, if required. The substation and control building can be demolished, and all materials disposed of.

WHITE CROSS

White Cross Offshore Windfarm Environmental Statement

Appendix 5.A: Taw Estuary and Braunton Burrows Crossing Method Statement

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Glossary of Acronyms

Acronym	Definition
AOD	Above Ordnance Datum
BGL	Below Ground Level
BGS	British Geological Survey
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Construction Environmental Management Plans
COSHH	Control of Substances Hazardous to Health
CTMP	Construction Traffic Management Plan
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ES	Environmental Statement
FEED	Front-End Engineering Design
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
IAQM	Institute of Air Quality Management
IDB	Internal Drainage Board
kV	Kilovolt
km	Kilometre
MCAA	Maritime and Coastguard Agency Act
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
mm	Millimetre
MW	Megawatt
NE	Natural England
NGC	National Grid
OFTO	Offshore Transmission Owner
OSP	Offshore Substation Platform
OWL	Offshore Wind Ltd
PLONAR	Pose Little or No Risk to the Environment
SAC	Special Area of Conservation
SHW	Specification For Highway Works
SSSI	Site of Special Scientific Interest
SUDS	Sustainable Urban Drainage Schemes
TBM	Tunnel Boring Machine
TCPA	Town and Country Planning Act
TJB	Transition Joint Bay
TMCo	Traffic Management Coordinator
UXO	Unexploded Ordnance

Acronym	Definition
WSI	Written Scheme of Investigation
WTG	Wind Turbine Generators

Glossary of Terminology

Defined Term	Description
Applicant	Offshore Wind Limited
Environmental Impact Assessment (EIA)	Assessment of the potential impact of the proposed Project on the physical, biological and human environment during construction, operation and decommissioning.
Generation Assets	The infrastructure of the Project related to the generation of electricity within the windfarm site, including wind turbine generators, substructures, mooring lines, seabed anchors and inter-array cables
Mitigation	Mitigation measures have been proposed where the assessment identifies that an aspect of the development is likely to give rise to significant environmental effects, and discussed with the relevant authorities and stakeholders in order to avoid, prevent or reduce impacts to acceptable levels. For the purposes of the EIA, two types of mitigation are defined: • Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIA • Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or eliminate any predicted significant effects. Additional mitigation is therefore subsequently adopted by OWL as the EIA process progresses.
Offshore Wind Limited	Offshore Wind Ltd (OWL) is a joint venture between Cobra Instalaciones Servicios, S.A., and Flotation Energy Ltd
the Project	the Project is a proposed floating offshore windfarm called White Cross located in the Celtic Sea with a capacity of up to 100MW. It encompasses the project as a whole i.e. all onshore and offshore infrastructure and activities associated with the Project
White Cross Offshore Windfarm	Up to 100MW capacity offshore windfarm including associated onshore and offshore infrastructure
Wind Turbine Generators (WTG)	The wind turbine generators convert wind energy into electrical power. Key components include the rotor blades, nacelle (housing for electrical generator and other electrical and control equipment) and tower. The final selection of project wind turbine model will be made post-consent application
Windfarm Site	The area within which the wind turbines, Offshore Substation Platform and inter-array cables will be present

Appendix 5.A: Taw Estuary and Braunton Burrows Crossing Method Statement

1. Introduction

1.1 Overview

1. White Cross Offshore Windfarm is a proposed floating offshore windfarm located in the Celtic Sea with a capacity of up to 100MW (hereafter referred to as 'the Project'. The Project is split into 'the Offshore Project' and 'the Onshore Project'.

2. The Offshore Project requires Section 36 consent and Marine Licences for all components seaward of Mean High Water Springs (MHWS). This includes the infrastructure within the Windfarm Site (e.g., wind turbine generators, substructures, mooring lines, seabed anchors, inter-array cables and Offshore Substation Platform (as applicable)) and all infrastructure associated with the offshore export cable, Landfall (up to MHWS) and the crossing underneath the Taw Estuary (between MHWS on the northern edge to MHWS on the southern edge).

3. The Onshore Project is a separate Town and Country Planning Act 1990 (TCPA) application to the Offshore Project components. The Onshore Project includes the infrastructure associated with the Landfall at Saunton Sands (to MLWS) where the onshore components connect to the Offshore Project infrastructure, Onshore Export Cable (including joint bays and link boxes), Taw Estuary Crossing, a new White Cross Onshore Substation, and an Interconnecting Cable to the Grid Connection Point at the existing East Yelland Substation.

4. An overview of the Project infrastructure is illustrated in **Plate 1.1**. A full project description of the Offshore Project can be found in **Chapter 5: Project Description** of the Offshore Environmental Statement (ES), and a full project description of the Onshore Project can be found in **Chapter 5: Project Description** of the Onshore ES.

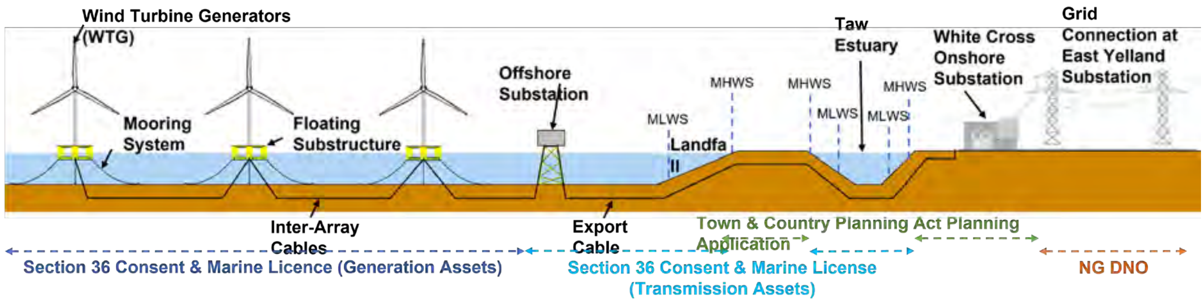


Plate 1.1 The Project Infrastructure

5. The set of consents/permission required in order for the Project as a whole to proceed are outlined below:

- Consent under the Section 36 of the Electricity Act 1989 and a Marine Licence under the Marine and Coastal Access Act 2009 (MCAA 2009) are required for the following generation assets (within the Windfarm Site):
    - Wind Turbine Generators
    - Semi-submersible floating platforms
    - Subsea catenary mooring lines
    - Anchoring solutions (drag embedment anchors, suction anchor or pin piles)
    - Inter-array cables and associated protection
    - Other associated offshore infrastructure, such as navigational markers.
- A second Marine Licence is required to enable the option for an Offshore Transmission Owner (OFTO) to be appointed under The Electricity (Competitive Tenders for Offshore Transmission Licences) Regulations 2015 for the following transmission assets:
    - OSP Platform (OSP)
    - Offshore export cable (to Mean High Water Springs (MHWS) at Landfall)
    - Other associated offshore infrastructure, such as navigational markers
    - Taw Estuary Crossing (between MHWS on the northern edge to MHWS on the southern edge).
- A separate planning permission under the Town and Country Planning Act 1990 (TCPA 1990) is required for the Onshore (landward of Mean Low Water Springs (MLWS)) transmission assets:
    - Onshore export cables
    - White Cross Onshore Substation
    - Onshore export cables (66kV from Landfall to onshore substation and 132kV from the White Cross Onshore Substation to NGC Grid Connection Point)
    - Temporary main construction compound and temporary construction compounds

- Transition Joint Bay (TJB), jointing bays, link boxes, access roads and haul roads.

6. Further detail on the consenting regime and relevant legislation is presented in **Chapter 3: Policy and Legislative Context** of the Offshore ES for the Offshore Project and in **Chapter 3: Policy and Legislative Context** of the Onshore ES for the Onshore Project.

7. This Braunton Burrow and Taw Estuary Crossing Method Statement (hereafter referred to as 'the Method Statement') presents information related to the two crossings (Landfall and Saunton Golf Course) crossings at Braunton Burrows (hereafter referred to as 'the Braunton Burrows Crossings') and Taw Estuary (MHWS north of the estuary to MHWS south of the estuary) (hereafter referred to as 'the Taw Estuary Crossing') by the onshore export cables and its associated construction activities and requirements.

1.2 Site Description

1.2.1 Braunton Burrows Crossing

8. The Braunton Burrows Crossing is proposed within two different sections, one is intertidal at landfall (to MLWS) and the other crossing the Saunton Golf Club. The Braunton Burrows Crossing at landfall (to MLWS), is from the Transition Joint Bay (TJB) at Saunton Sands car park out to offshore. The Braunton Burrows Crossing at Saunton Golf Club is from Saunton Sands car park to the east side of Saunton Golf Club. The location of the Braunton Burrow Crossings is shown in **Figure 1.1**.

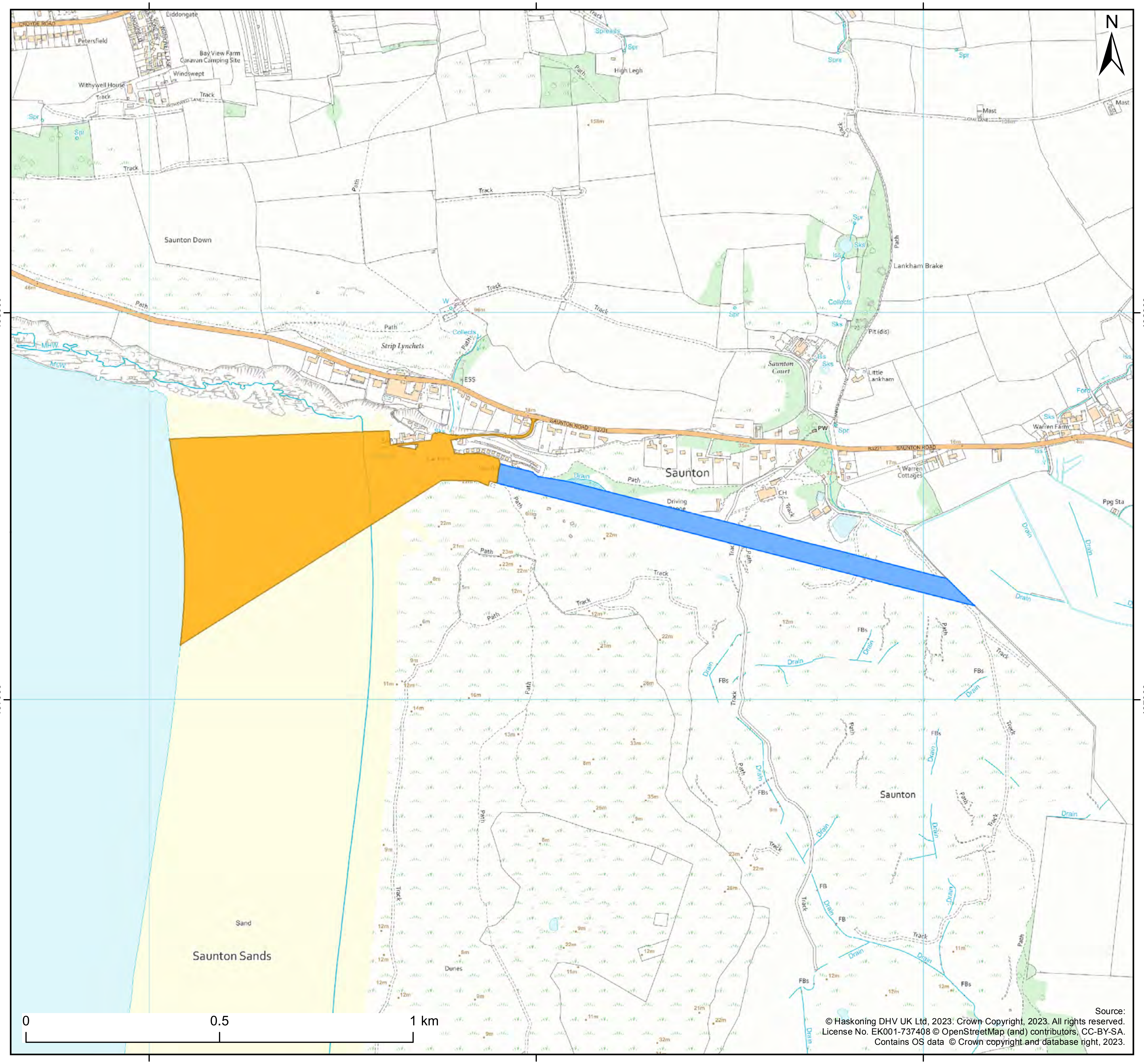
9. This site was determined based on an appraisal of constraints and engineering feasibility from both offshore and onshore perspectives. A full discussion of the process undertaken to identify the Offshore and Onshore Export Cable Corridors for the Offshore Project is laid out in **Chapter 4: Site Selection and Assessment of Alternatives** of the ES.

10. The techniques that have been proposed for the Braunton Burrows Crossing at landfall (to MLWS) are either open-trenching or a trenchless technique. Or a combination of the two. Following consultation, Natural England (NE) recognise that trenchless techniques are generally a 'preferred method' as it is considered the impact to the intertidal is significantly reduced if trenching is not required (i.e. trenchless technique is used). The potential options include:

- Option 1 – Piperam duct (trenchless) and open cut in intertidal zone. This option consists of a combination of a trenchless technique to cross the dunes at the edge of the Saunton Sands carpark, with open cut used across the beach and into the intertidal zone

- Option 2 – HDD duct with intertidal exit. This option will utilise Horizontal Directional Drilling (HDD) to install a maximum of two ducts from the carpark to the intertidal zone at a depth of 0m Above Ordnance Datum (A.O.D)
- Option 3 – HDD duct with offshore exit. This option will utilise Horizontal Directional Drilling (HDD) to install a maximum of two ducts from the carpark to exit offshore at a depth of -5m A.O.D.

11. Whichever option is selected for the landfall (to MLWS) a section of open cut trench will be required to connect the TJB to the exit point for the trenchless crossing of the Saunton Golf Club. This will be located entirely within the carpark and will have a maximum length of 200m.
12. The technique proposed for the cable installation for the Braunton Burrows Crossing at Saunton Golf Club is a trenchless technique, either Horizontal Directional Drilling (HDD) or Direct Pipe. Both options will utilise the same location for the entry and exit points and involve a drill length of approximately 1.3km.
13. The crossing site runs through the Braunton Burrows SSSI and Special Area of Conservation (SAC), however both launch pits and the reception pit for the golf course crossing are located outside of the SSSI and SAC boundary. Braunton Burrows is characterised by an extensive system of coastal sand dunes and variably flooded slacks, grassland and scrub. The estuary is also designated as a shellfish water protected area under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (as amended) and a coastal sensitive area (eutrophic).



Legend:
- Braunton Burrows Crossing
- Landfall Crossing

Client:	Project:
Offshore Wind Ltd.	White Cross Offshore Windfarm

Title:

Braunton Burrows Crossing Location

Figure:	1.1	Drawing No:	PC2978-RHD-ZZ-XX-DR-Z-0724		
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Co-ordinate system: British National Grid

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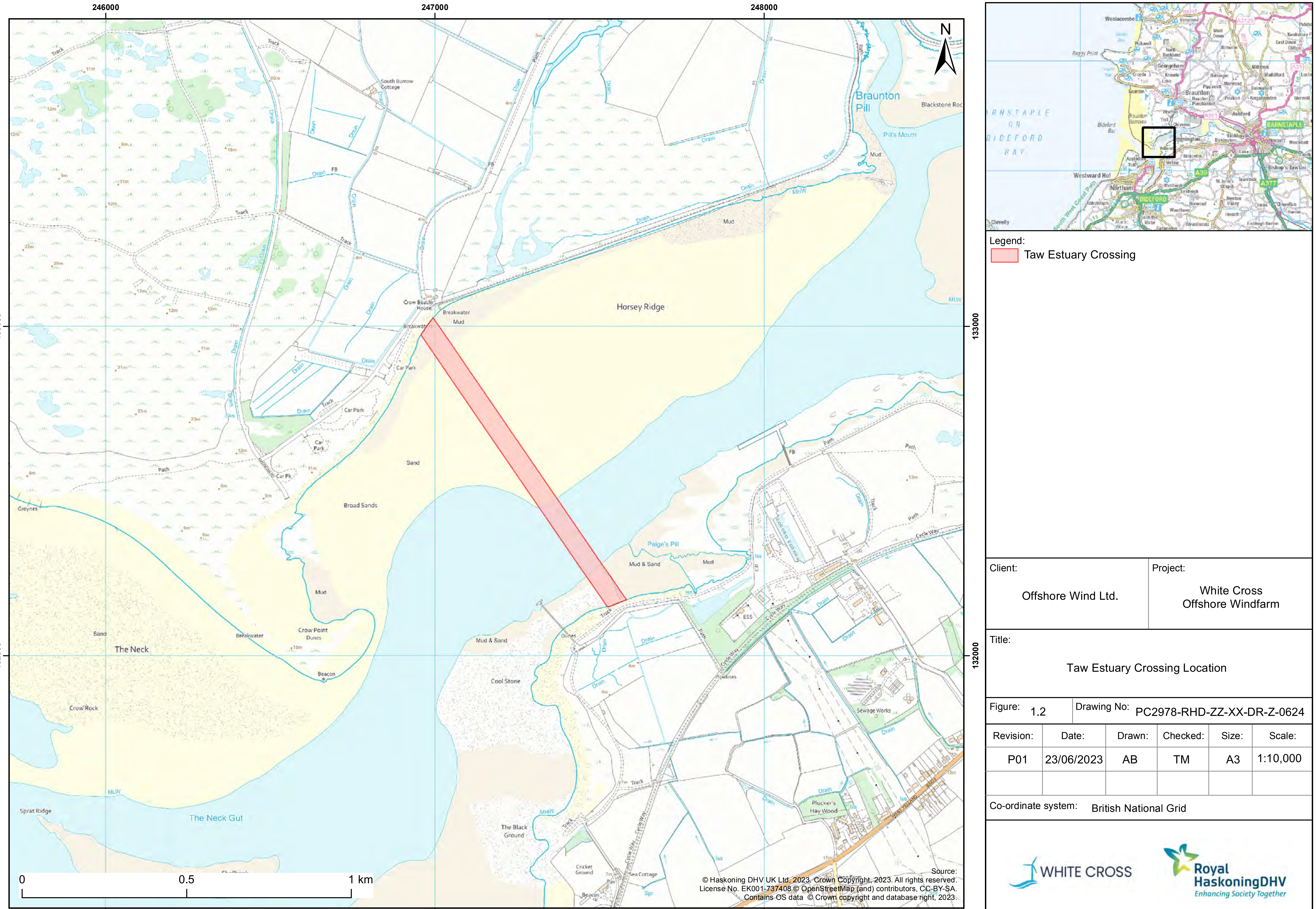
1.2.2 Taw Estuary Crossing

14. The Taw Estuary Crossing is proposed between an entry point on the south bank and an exit point on the north bank of the River Taw. The entry and exit compounds and pit locations will be set a minimum of 16m from the River Taw. The crossing site is located at a natural narrowing of the River Taw.

15. This site was determined based on an appraisal of constraints and engineering feasibility from both offshore and onshore perspectives. The location of the Taw Estuary Crossing is shown in **Figure 1.2**. A full discussion of the process undertaken to identify the Offshore Export Cable Corridor for the Offshore Project is laid out in **Chapter 4: Site Selection and Assessment of Alternatives** of the Offshore ES. A full discussion of the process undertaken to identify the Onshore Export Cable Corridor for the Onshore Project is laid out in **Chapter 4: Site Selection and Assessment of Alternatives** of the Onshore ES.



Legend:

Taw Estuary Crossing

Client: Offshore Wind Ltd.	Project: White Cross Offshore Windfarm

Title: Taw Estuary Crossing Location

Figure:	1.2	Drawing No:	PC2978-RHD-ZZ-XX-DR-Z-0624		
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Co-ordinate system: British National Grid

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16. Trenchless crossing techniques have been proposed for the Taw Estuary Crossing, with two options being considered, namely Horizontal Directional Drilling (HDD) and Direct Pipe. Both options will utilise the same location for the entry and exit points and involve a drill length of approximately 1.3km below the River Taw. Cable installation works will be undertaken from south to north, with temporary compound area and access requirements for the entry and exit points.

17. The area surrounding the crossing site and the River Taw form part of the Taw-Torridge Estuary Site of Special Scientific Interest (SSSI), which is of major importance for its overwintering and migratory populations of wading birds and rare plants that grow along the shores of the river.

18. In addition, the crossing site is also located in the vicinity of Braunton Burrows SSSI and Special Area of Conservation (SAC). Braunton Burrows is characterised by an extensive system of coastal sand dunes and variably flooded slacks, grassland and scrub. The estuary is also designated as a shellfish water protected area under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (as amended) and a coastal sensitive area (eutrophic).

19. The Taw Estuary Crossing lies within the Taw/Torridge operational catchment. At this location, the estuary channel has an asymmetrical cross-section at low tide. A geomorphology baseline survey (**Appendix 14.A: Geomorphology Baseline Survey)** was undertaken on 29th April 2022 and 17th August 2022 for the Onshore Project. The recorded channel width was around 1,000m, a wetted channel width at low water at around 250m and tidal range between 4m immediately downstream of Barnstaple and 8m at the estuary mouth. The channel bed substrates were characterised as sandy in the main channel and as finer silts in lower energy areas. The entry and exit points will be located on the adjacent floodplains of the Taw Estuary (Sir Arthur's Pill catchment) and coastal catchment (Braunton Burrows).

1.3 Rationale

1.3.1 Rationale for the Use of Trenchless Crossing underneath the Taw Estuary

20. OWL's commitment to the use of trenchless crossing techniques at the Taw Estuary Crossing ensures that potential impacts on designated sites and the wider estuarine and riverine environment are avoided as part of the Offshore and Onshore Project's embedded mitigation. All commitments laid out within the Onshore and Offshore ESs are set out in **Appendix 6.B: Mitigation Register** of the Onshore ES. This commitment is anticipated to:

- Avoid direct physical disturbance to the natural environment and non-statutory and statutory designated sites of ecological importance, including the Taw-Torridge Estuary SSSI and Braunton Burrows SSSI and SAC (which are considered further in **Chapter 16: Onshore Ecology and Ornithology** of the ES for the Onshore Project)
- Mitigate disturbance or harm to species such as waterfowl and migratory salmon and potential destruction, damage or disturbance to priority habitats such as coastal grazing marsh and mudflats
- Avoid direct disturbance to the River Taw's sediment transport pathways
- Avoid direct disturbance of the Taw/Torridge surface water catchment and the potential to alter the geomorphology and hydrology of the watercourse
- Mitigate increased sediment supply to the Taw/Torridge surface water catchment
- Mitigate the risk of contaminants supply to the Taw/Torridge surface water catchment and the River Taw and North Devon Streams groundwater catchment
- Avoid direct disturbance to surface drainage patterns and surface flows of the Taw/Torridge surface water catchment and therefore its associated flood risk
- Avoid the need for cable protection measures across the river bed.

1.3.2 Rationale for the Use of Trenchless Crossing underneath the Braunton Burrows

21. OWL's commitment to the use of trenchless crossing techniques at the Braunton Burrows Crossing ensures that potential impacts on designated sites and the wider environment are avoided as part of the Onshore and Offshore Project's embedded mitigation. All commitments laid out within the Onshore and Offshore ESs are set out in **Appendix 6.B: Mitigation Register** of the Onshore ES. This commitment is anticipated to:

- Avoid direct physical disturbance to the natural environment and non-statutory and statutory designated sites of ecological importance, including the Braunton Burrows SSSI and SAC (which are considered further in **Chapter 16: Onshore Ecology and Ornithology** of the ES for the Onshore Project)
- Mitigate disturbance or harm to species such as whitethroat and skylark and potential destruction, damage or disturbance to priority habitats such as shifting and fixed coastal dunes
- Avoid direct physical disturbance of Saunton Golf Club
- Avoid direct disturbance to surface drainage patterns and surface flows of the surface water catchment and therefore its associated flood risk
- Avoid the need for cable protection measures across the Braunton Burrows.

1.4 Consultation

22. OWL notes the interests of Natural England (NE) and other stakeholders regarding the Taw Estuary Crossing and Braunton Burrows Crossing and its associated construction activities. This Method Statement has been prepared to demonstrate how the Offshore and aspects of the Onshore Project will avoid, minimise or mitigate environmental effects associated with the export cables crossing the Braunton Burrows and between the north and south bank of the River Taw.

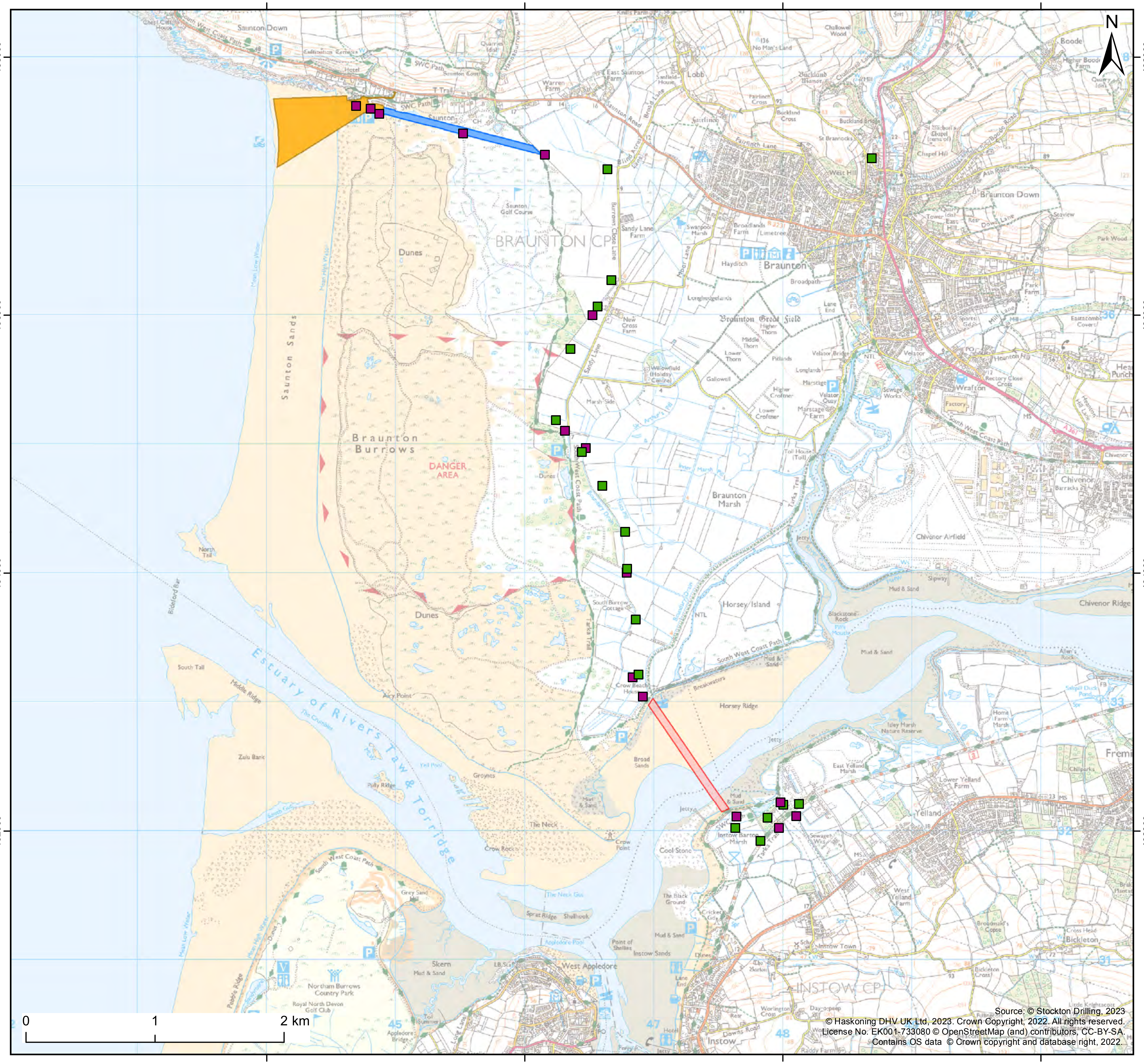
23. OWL will consult these stakeholders and seek agreement on the design and methodology set out in this document prior to the commencement of construction works at the Taw Estuary and Braunton Burrows Crossing. Where conflict arises between environmental constraints or obligations, OWL will liaise with the relevant stakeholders to determine the optimal, acceptable solution for the crossing and would not proceed where reasonable concern from stakeholders was not being addressed.

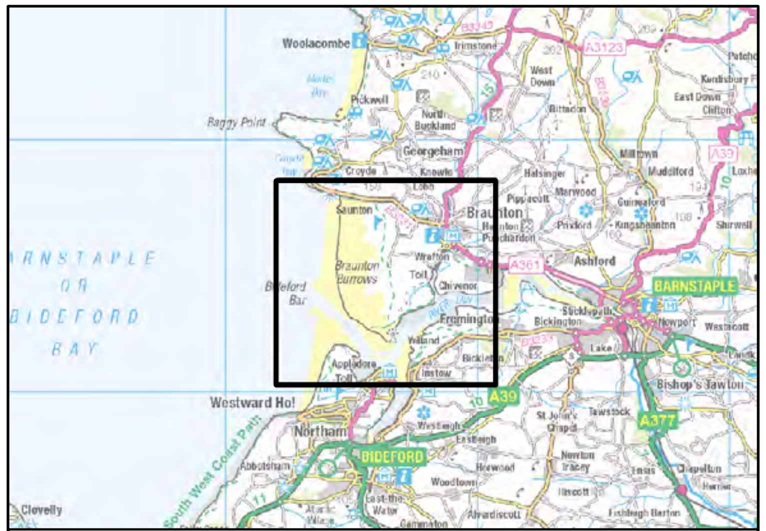
2. Geotechnical Investigation

24. Key to ensuring that the design is appropriate for the location and that it can be constructed safely is understanding the ground and river conditions on-site. Detailed geotechnical investigations will be conducted to characterise ground conditions, establish the chemical and mechanical properties of the ground, map water depths and topography of the river bed and identify the hydrology and hydrogeology of the Taw Estuary Crossing and Braunton Burrows Crossing site. It is proposed that full geotechnical investigations and production of a subsequent report should be a post-consent planning condition that must be adhered to prior to any trenchless crossing works commencing.

25. Geotechnical investigations will be undertaken for the Taw Estuary and Braunton Burrows Crossing, this will include boreholes as a minimum and other surveys where deemed necessary.

26. Geological desk-based studies have been undertaken as part of an Onshore Export Cable Corridor feasibility assessment. Analysis of a total of 11 historic boreholes identified within the vicinity of Onshore Export Cable Corridor were identified and are shown in **Figure 2.1**.





Legend:

- Taw Estuary Crossing
- Braunton Burrows Crossing
- Landfall Crossing
- Boreholes
- Trial holes

Client:	Project:
Offshore Wind Ltd.	White Cross Offshore Windfarm

Title:

BGS Historic Ground Investigation Locations

Figure: 2.1 | Drawing No: PC2978-RHD-ZZ-XX-DR-Z-0542

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Co-ordinate system: British National Grid

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2.1 Hydrofracture Assessment

27. The preliminary hydrofracture assessment has been undertaken to determine the risk of drill fluid breakout to the surface at the Taw Estuary and Braunton Burrows trenchless crossings (Waterman Infrastructure & Environment Ltd, 2023). Hydrofracture occurs if during the drilling process the drilling fluid pressure in the borehole exceeds the resistance of the overburden soils resulting in a breakout at the surface.

28. Hydrofracture was one of Natural England's (NE) specific concerns raised about the project having dealt with similar projects where HDD in fluvial systems where silty sediments and air pockets exist has failed, including hydrofracture.

29. NE highlighted that the Taw Estuary trenchless crossing goes beneath the Taw-Torridge Estuary SSSI which is designated due to its overwintering and migratory populations of wading bords and in addition rare plants grow along the shores within wide areas of saltmarsh, mudflats and sandbanks. The Estuary also supports typical estuarine species such as mullet, flat fish, bass, pollack, migratory salmon, sea trout and eels along with many invertebrates.

30. Therefore, a hydrofracture assessment has been undertaken to determine the risk of drill fluid breakout to the surface at the Taw Estuary and Braunton Burrows Crossings.

2.1.1 Analysis Methodology

31. The preliminary hydrofracture assessment has been undertaken prior to the Geotechnical Investigation. Therefore, the assessment relies on a conservative assumption that the ground conditions are made up of granular materials (rather than firm to stiff clays or competent rock). The geotechnical analysis parameters are shown in **Annex 1: Hydrofracture Assessment**.

32. The groundwater level has been conservatively assumed as commensurate with the ground surface throughout the analysis. The groundwater level assumption is likely to be relaxed following the completion of ground investigation with associated groundwater monitoring.

33. The bore diameters are yet to be confirmed. It is anticipated that there will be a TJB between the onshore and offshore cables within Saunton Sands Car Park. The landfall calculations therefore assume an offshore cable specification within the golf course crossing and the Taw Estuary Crossing assumes an onshore cable specification (with a consequent reduction in likely cable and duct diameter).

2.1.2 Assessment Results

34. At each of the assessed trenchless crossings (Taw Estuary, Golf Course and Landfall), the assessment demonstrates that there is no significant risk of hydrofracture along the bore profiles with the exception of the final stages of the bore where the profiles begin to rise resulting in loss of cover. This is unavoidable but can easily be controlled by site measures such as sandbagging and casing in line with general working methodologies. Hydrofracture calculations and further information is set out within **Annex 1: Hydrofracture Assessment**.

35. The design will incorporate measures to address hydrofracture, ensuring sufficient depth of cover for the bore path. This approach minimises the hydrofracture risk through increased overburden pressure.

36. The risk of drilling fluid breakout is considered to be very low based on analysis of historical borehole and desk-based assessment of the geology present in the area. However, this cannot be fully assessed beforehand. Substantial decreases in the volume of returning drilling fluid to the entry pit will trigger the need for site personnel to assess the situation and respond accordingly. Therefore, a close watching brief during drilling activities and a detailed contingency plan are essential to ensure that any drilling fluid breakout is contained, bunded and pumped back to the entry pit with minimum disturbance to the surrounding environment.

2.2 Braunton Burrows Historical Borehole Analysis

37. A programme of geotechnical works are being undertaken for the offshore components of the Project, and this includes a Phase 2: Reconnaissance Geotechnical Investigation. The desk-based analysis undertaken as part of these works were reviewed to inform the preliminary design for the Landfall Crossing.

38. This indicated that within the nearshore area of the offshore export cable route (i.e. at landfall), the top of the Pilton Shales Formation, consists of Devonian and Carboniferous rocks of mudstone, sandstone, and limestone nature. The only layer observed below this unit was bedrock. Overlying this horizon, a continuous layer of sediments (Unit E) mainly composed of fine sand, is prominent.

39. Unit E has a thickness of around 7m at the landfall approach. Then, approximately 1 km away from the shoreline, the Unit thickness decreases rapidly to 2-3 m. From there, an unconformity within the seabed and underlying R1 is recognizable. During the following four kilometres, the thickness ranges from 2 to 5 m on the average.

40. It is recommended that further site investigation is undertaken to determine the Marine sediments present at the HDD Exit points, and that a Seismic/Mag survey

should be undertaken to provide sediment depth/depth to rockhead data across the intertidal area. But from this analysis **Table 2.1** suggests that a trenchless crossing is not precluded by the geology present, the cables can be installed, and the chosen methodology is relatively low risk.

Table 2.1 Braunton Burrows Landfall Crossing Conceptual Ground Model Stratum Depths

Location	Stratum	Depth (m bgl)	Thickness (m)
Entry Point	Blown Sand	0.00	0.00 to 10
	Marine Beach Deposits (Unit E)	10.00	7.00
	Rock (Pilton Shales Formation)	17	-
Exit Point (Option 2 1850m)	Blown Sand	-	-
	Marine Beach Deposits (Unit E)	0.00	2.00
	Rock (Pilton Shales Formation)	2.00	-

41. The analysis of historical borehole located onshore indicates within Braunton Burrows Blown Sands are likely to be present, overlying Holocene Estuarine Alluvium and Marine Beach Deposits and or Pleistocene/Fluvial Sands and Gravels. Superficial deposits and bedrock beneath the Saunton Golf Club Crossing are expected to be encountered up to 15m bgl at the eastern side of the golf course and 5m bgl at Saunton Sands carpark.

42. A conceptual ground model was developed as part of the feasibility assessment to provide information on the composition and depths likely to be encountered at the crossings of the Braunton Burrow. It is assumed that the entry point is underlain by a layer of Blown Sand and Marine Beach Deposits, overlaying rock. This strata composition continues to the exit point. It is noted that at this location, the Blown Sands are vegetated suggesting a more mature state and likely of increased density/cohesion, however, this would require confirmation via ground investigation. **Table 2.2** suggests that a trenchless crossing is not precluded by the geology present, the cables can be installed, and the chosen methodology is relatively low risk. Similarly, to in **Section 2.3,** this will be confirmed prior to commencement of drilling activity via appropriate and agreed geotechnical investigations.

Table 2.2 Braunton Burrows Golf Course Crossing Conceptual Ground Model Stratum Depths

Location	Stratum	Depth (m bgl)	Thickness (m)
Entry Point	Blown Sand	0.00	0.00 to 10
	Marine Beach Deposits	10.00	5.00
	Rock	15	-
Exit Point	Blown Sand	-	-

Location	Stratum	Depth (m bgl)	Thickness (m)
	Marine Beach Deposits	0.00	5.00
	Rock	5.00	-

2.3 Taw Estuary Crossing Historical Borehole Analysis

43. The historical borehole analysis indicates that the drift geology of the site is predominantly underlain by Marine or Estuarine Alluvium, Blown Sand and Tidal Flat Deposits, while its solid geology is predominantly underlain by Ashton Mudstone Member and Crackington Formation (Undifferentiated) and is typically presented as Mudstone and Siltstone.

44. It was noted that bedrock may be visible at the surface on the south bank of the River Taw but is expected to deepen substantially within the area to the north. However, ground investigation is required to confirm this observation. A borehole (SS43SE/25) drilled in 1963 was also noted east of the proposed entry point, where groundwater was encountered at a depth of 8.53m below ground level (bgl).

45. In addition, a conceptual ground model was developed as part of the feasibility assessment to provide information on the composition and depths likely to be encountered at the crossing site. This was informed by the geological desk-based studies and aerial images and topographic/bathymetric data (**Appendix 8.B: Geophysical Survey Results** of the Offshore ES) collected for the Offshore Project. The model shown in **Table 2.3** suggests that a trenchless crossing is not precluded by the geology present, the cables can be installed, and the chosen methodology is relatively low risk. This will be confirmed prior to commencement of drilling activity via appropriate and agreed geotechnical investigations.

Table 2.3 Taw Estuary Crossing Conceptual Ground Model

Location	Stratum	Depth (m bgl)	Thickness (m)
Entry Point	Drift (Tidal Flats Deposit)	0.00	0.00 to 6.40
	Rock	6.40	-
River Crossing	Drift (Tidal Flats Deposit)	0.00	3.50
	Marine or Estuarine Alluvial Deposits	3.50	-
Exit Point	Drift (Tidal Flats Deposit)	0.00	3.30
	Marine or Estuarine Alluvial Deposits	3.30	13.00
	Rock	16.30	-

3. Design

46. The crossing design will be refined and finalised post-consent and will rely on inputs from onshore and offshore pre-construction site investigations, as well as

information from the detailed cable system design. Awaiting these pre-construction site investigations will ensure that the most appropriate design is selected in order to minimise impact to the surrounding environment. Site characterisation data of the entry and exit points and potential drill paths will inform the detailed design of the selected crossing technique.

47. Sufficient flexibility exists in the capabilities of modern trenchless technologies such as the capacity of drill rigs and range of drill heads available, to ensure a suitable solution can be delivered at the site within the parameters assessed within the ES.

48. The two trenchless crossing techniques being investigated for the Braunton Burrows: Saunton Golf Course Crossing (if a trenchless technique is applicable) and Taw Estuary Crossing to minimise disturbances to the physical and natural environment are:

- Option 1 - HDD: a construction technique whereby a tunnel is drilled below ground to avoid obstacles such as waterways and designated sites, and a pipeline, cable or other conduit is pulled through the drilled tunnel
- Option 2 - Direct Pipe: a construction technique that combines HDD and micro-tunnelling whereby the drilling of the underground tunnel and the installation of the pipeline, cable or other conduit occurs simultaneously in a one-pass operation.

49. Indicative drawings of the two options are shown in **Figure 3.1** and **Figure 3.2**. respectively. Key advantages and disadvantages associated with HDD and Direct Pipe are compared in **Table 3.1**.

Table 3.1 Trenchless Crossing Technique Comparisons

Trenchless Crossing Technique Option	Advantages	Disadvantages
HDD	• Relatively economical trenchless option • Fast mobilisation and site setup • No requirement for large entry or exit pits.	• Borehole only supported by bentonite, potential for collapse • Not suitable for non-supporting ground due to a high risk of tool snapping or loss of control during push reaming • Potential to lose tools downhole.

Trenchless Crossing Technique Option	Advantages	Disadvantages
Direct Pipe	• Able to retract the assembly to the entry pit and change cutting tools if required • Relatively low pressure used at the cutting face, enabling shallower drill depths • Suitable for superficial geology such as fluvial and alluvial • Borehole permanently supported, very low risk of collapse.	• Longer mobilisation and site setup time than HDD • More expensive than HDD.

50. Three techniques being investigated for the Braunton Burrows: Landfall Crossing:

- Option 1 – Piperam duct (trenchless) and open cut in intertidal zone: combination of a trenchless technique to cross the dunes at the edge of the Saunton Sands carpark (approx. 60m), with open cut used across the beach and into the intertidal zone using a cable plough (approx. 700m)
- Option 2 – HDD duct with intertidal exit: HDD will be used to install ducts from the carpark to the intertidal zone at a depth of 0m A.O.D., with a length for the drill of approximately 650m to MLWS
- Option 3 – HDD duct with offshore exit: HDD will be used to install ducts from the carpark to exit offshore at a depth of -5m A.O.D., with a length for the drill of approximately 1850m.

51. Only Options 2 and 3 for Landfall Crossing are discussed further in this document as they are the major trenchless techniques similar in design and methodology to the HDD option being considered for the crossings of the Golf Course and Taw Estuary.

52. A full description of Option 1 is provided in **Chapter 5: Project Description**.

This drawing should not be scaled. Dimensions to be verified on site.
Any discrepancies should be referred to the Engineer prior to work being put in hand.

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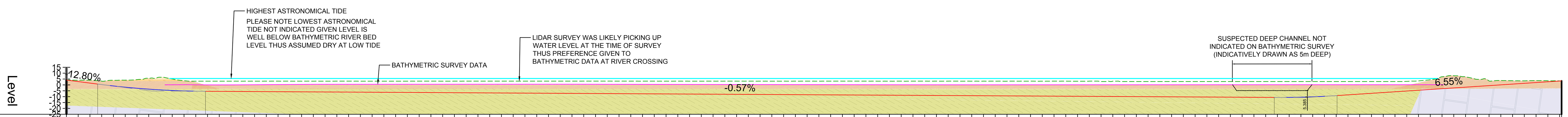
5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

SITE COMPOUND LAYOUT KEY:
1. 50 KVA GENERATOR 2M X 2M
2. TOILET BLOCK 6M X 2M
3. DRY/CHANGE ROOM 6M X 2M
4. CANTEEN 6M X 2M
5. OFFICE 6M X 2M
6. OFFICE 6M X 2M
7. 21 TON TRACKED 360 EXCAVATOR
8. DRILL PIPE STORAGE 10M X 2M
9. HDD DRILL RIG 16M X 2M
10. POWER PACK 6M X 2M
11. CONTROL CABIN 6M X 2M
12. MUD LAB 3M X 2M
13. MUD ENTRY PIT 3M X 4M
14. HIGH PRESSURE MUD PUMP 6M X 2M
15. MUD MIXING TANK 7M X 2M
16. 350 KVA GENERATOR 5M X 2M
17. RECYCLING UNIT 6M X 2M
18. WATER STORAGE TANK 6M X 2M
19. DRY DRILLING FLUID STORAGE 4M X 10M
20. WORKSHOP 6M X 2M
21. STORES 6M X 2M

ILFRACOMBE TIDE GAUGE SITE	
TIDE LEVELS	ORDNANCE DATUM NEWLYN (mAOD)
HIGHEST ASTRONOMICAL TIDE	5.46
MEAN HIGH WATER SPRINGS	4.47
MEAN HIGH WATER NEAPS	2.19
MEAN LOW WATER NEAPS	-1.69
MEAN LOW WATER SPRINGS	-3.94
LOWEST ASTRONOMICAL TIDE	-4.89

RIVER CROSSING - LONGSECTION
SCALE: H 1:2000,V 1:2000. DATUM: -25.000



Chainage	Existing Levels	Level Difference
0.000	0.033	
10.000	0.081	1.202
20.000	0.123	2.208
30.000	0.165	2.960
40.000	0.186	4.634
50.000	0.150	5.569
60.000	0.141	7.331
70.000	0.119	9.231
80.000	0.097	10.751
90.000	0.108	9.764
100.000	0.139	8.697
110.000	0.094	8.496
120.000	0.025	8.594
130.000	0.000	8.661
140.000	0.013	8.721
150.000	0.032	8.783
160.000	0.150	8.849
170.000	0.219	8.912
180.000	0.288	8.984
190.000	0.356	9.018
200.000	0.425	9.058
210.000	0.483	9.139
220.000	0.507	9.191
230.000	0.511	9.261
240.000	0.516	9.328
250.000	0.521	9.367
260.000	0.525	9.419
270.000	0.530	9.459
280.000	0.535	9.528
290.000	0.539	9.595
300.000	0.544	9.671
310.000	0.549	9.739
320.000	0.553	9.762
330.000	0.558	9.832
340.000	0.563	9.890
350.000	0.567	9.980
360.000	0.572	10.020
370.000	0.577	10.081
380.000	0.581	10.151
390.000	0.586	10.202
400.000	0.590	10.244
410.000	0.595	10.328
420.000	0.598	10.374
430.000	0.579	10.443
440.000	0.560	10.511
450.000	0.541	10.551
460.000	0.521	10.615
470.000	0.502	10.650
480.000	0.483	10.715
490.000	0.464	10.765
500.000	0.445	10.823
510.000	0.426	10.867
520.000	0.406	10.946
530.000	0.387	10.955
540.000	0.368	11.034
550.000	0.349	11.099
560.000	0.330	11.193
570.000	0.318	11.212
580.000	0.305	11.296
590.000	0.292	11.323
600.000	0.279	11.381
610.000	0.266	11.444
620.000	0.253	11.519
630.000	0.240	11.560
640.000	0.227	11.629
650.000	0.215	11.688
660.000	0.202	11.758
670.000	0.189	11.805
680.000	0.177	11.866
690.000	0.167	11.889
700.000	0.156	11.948
710.000	0.149	12.037
720.000	0.138	12.088
730.000	0.134	12.152
740.000	0.123	12.190
750.000	0.102	12.271
760.000	0.086	12.299
770.000	0.088	12.354
780.000	0.090	12.425
790.000	0.093	12.488
800.000	0.095	12.497
810.000	0.097	12.550
820.000	0.100	12.689
830.000	0.102	12.673
840.000	0.104	12.781
850.000	0.107	12.840
860.000	0.109	12.815
870.000	0.111	12.940
880.000	0.114	12.690
890.000	0.116	13.015
900.000	0.118	12.807
910.000	0.121	12.862
920.000	0.123	12.920
930.000	0.125	12.977
940.000	0.128	13.035
950.000	0.130	13.092
960.000	0.132	13.150
970.000	0.135	13.207
980.000	0.137	13.264
990.000	0.139	13.322
1000.000	0.141	13.380
1010.000	0.144	13.437
1020.000	0.146	13.494
1030.000	0.148	13.547
1040.000	0.151	13.502
1050.000	0.153	13.323
1060.000	0.155	13.012
1070.000	0.158	12.567
1080.000	0.160	11.988
1090.000	0.162	11.334
1100.000	0.165	10.680
1110.000	0.167	10.025
1120.000	0.169	9.371
1130.000	0.172	8.716
1140.000	0.174	8.176
1150.000	0.176	7.906
1160.000	0.179	8.286
1170.000	0.181	10.151
1180.000	0.183	10.371
1190.000	0.186	8.801
1200.000	0.188	5.996
1210.000	0.190	3.972
1220.000	0.193	3.677
1230.000	0.195	2.811
1240.000	0.197	2.091
1250.000	0.199	1.680
1260.000	0.202	0.844
1270.000	0.204	0.090
1271.719	0.205	

Horizontal Geometry: L =1271.719

Vertical Geometry: G =12.799% L =26.583 | R =750.000 K =7.500 L =91.681 | G =-0.574% L =909.051 | R =750.000 K =7.500 L =53.399 | G =6.545% L =190.892

GEOLOGY KEY
BLOWN SANDS (SAND DUNES)
DRIFT DEPOSITS
ESTUARINE DEPOSITS
ROCK

1:2000 0 20m 40m 60m 80m 100m 120m 140m 160m 180m 200m
1:1 0 10 20 30 40 50 60 70 80 90 100

Rev	Date	Description	By	Chk
P03	11.08.23	SITE COMPOUND LAYOUTS REMOVED. RE-ISSUED FOR INFORMATION AS PART OF PLANNING SUBMISSION	LP	CG
P02	10.03.23	TITLE UPDATED & DRAFT BANNER REMOVED	LP	CG
P01	23.05.22	DRAFT ISSUE FOR INFORMATION ONLY	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
RIVER TAW OUTLINE HDD PLAN AND PROFILE

Client
FLOTATION ENERGY LTD

waterman
STOCKTON

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t: 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability
FOR PLANNING SUBMISSION

Designed By LP	Director CG	Waterman Ref WIE12731-135
Drawn By LP	Date 20.05.22	Scales @ A0 AS NOTED
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number | Revision
12731-135-WIE-ZZ-XX-M3-C-91003 | P03
110-099-DRG-022 | A01
FLO-WHI-LAY-0019 | A1

File Path
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ONSHORE

OFFSHORE

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Rev	Date	Description	By	Chk
P02	11.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	28.07.23	ISSUED AS DRAFT FOR INFORMATION	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
CABLE LANDFALL OUTLINE HDD PLAN AND PROFILE

Client
FLOTATION ENERGY LTD

waterman STOCKTON

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability
FOR PLANNING SUBMISSION

Designed By LP	Director CG	Waterman Ref WIE12731-153
Drawn By LP	Date JULY 23	Scales @ A0 1:1250
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-LF-XX-M3-C-91001	P02
110-099-DRG-020	A01
FLO-WHI-LAY-0017	A1

A0-Wat-SDL-S

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11. CONTROL CABIN 6M X 2M
12. MUD LAB 3M X 2M
13. MUD ENTRY PIT 3M X 4M
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15. MUD MIXING TANK 7M X 2M
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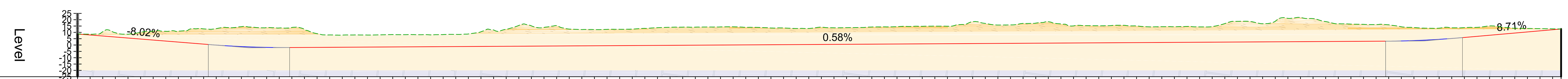
18. WATER STORAGE TANK 6M X 2M
19. DRY DRILLING FLUID STORAGE 4M X 10M
20. WORKSHOP 6M X 2M
21. STORES 6M X 2M

GOLF COURSE CROSSING - LONGSECTION
SCALE: H 1:2000,V 1:2000. DATUM: -25.000



Chainage	Existing Levels	Level Difference
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10.000	8.569	0.614
20.000	10.513	3.360
30.000	9.745	3.394
40.000	8.543	2.994
50.000	10.018	5.271
60.000	11.081	7.136
70.000	10.848	7.706
80.000	10.998	8.657
90.000	12.770	11.233
100.000	12.756	12.020
110.000	12.944	12.984
120.000	13.763	14.455
130.000	14.512	15.723
140.000	14.023	15.619
150.000	13.739	15.587
160.000	13.453	15.421
170.000	13.887	15.842
180.000	12.436	14.333
190.000	8.995	10.835
200.000	7.997	9.779
210.000	7.882	9.606
220.000	7.975	9.641
230.000	7.907	9.516
240.000	8.065	9.616
250.000	8.261	9.755
260.000	8.198	9.633
270.000	8.138	9.516
280.000	8.022	9.343
290.000	8.258	9.520
300.000	8.405	9.610
310.000	8.761	9.909
320.000	10.486	11.576
330.000	11.898	12.931
340.000	12.385	13.359
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630.000	14.248	13.550
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690.000	14.877	13.833
700.000	16.152	15.050
710.000	18.458	17.299
720.000	17.079	15.862
730.000	15.813	14.538
740.000	15.873	14.540
750.000	17.068	15.678
760.000	17.302	15.854
770.000	18.433	16.928
780.000	16.645	15.082
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810.000	15.206	13.469
820.000	15.406	13.612
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880.000	14.672	12.532
890.000	14.318	12.121
900.000	14.550	12.295
910.000	16.951	14.638
920.000	18.731	16.361
930.000	18.609	16.181
940.000	16.851	14.365
950.000	18.812	16.269
960.000	21.090	18.489
970.000	21.760	19.101
980.000	20.882	18.166
990.000	18.539	15.765
1000.000	16.761	13.930
1010.000	16.551	13.662
1020.000	16.336	13.389
1030.000	16.163	13.158
1040.000	15.989	12.923
1050.000	14.429	11.205
1060.000	13.817	10.303
1070.000	13.331	9.393
1080.000	13.353	8.857
1090.000	13.624	8.437
1100.000	13.759	7.750
1110.000	13.961	7.081
1120.000	15.095	7.344
1130.000	14.112	5.491
1140.000	13.297	3.805
1150.000	13.097	2.735
1160.000	12.951	1.718
1170.000	12.796	0.692
1176.745	12.740	0.649

Horizontal Geometry

L =1176.745

Vertical Geometry

G =-8.022% L =103.742	R =750.000 K =7.500 L =64.488	G =0.577% L =869.295	R =750.000 K =7.500 L =60.976	G =8.707% L =78.827

GEOLOGY KEY
BLOWN SANDS (SAND DUNES)
DRIFT DEPOSITS
ROCK

1:2000 0 20m 40m 60m 80m 100m 120m 140m 160m 180m 200m
1:1 0 10 20 30 40 50 60 70 80 90 100

Rev	Date	Description	By	Chk
P03	11.08.23	SITE COMPOUND LAYOUTS REMOVED. RE-ISSUED FOR INFORMATION AS PART OF PLANNING SUBMISSION	LP	CG
P02	10.03.23	TITLE UPDATED AND DRAFT BANNER REMOVED	LP	CG
P01	20.05.22	DRAFT ISSUE FOR INFORMATION ONLY	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
SAUNTON GOLF CLUB OUTLINE HDD PLAN AND PROFILE

Client
FLOTATION ENERGY LTD

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Suitability
FOR PLANNING SUBMISSION

Designed By LP	Director CG	Waterman Ref WIE12731-135
Drawn By LP	Date 20.05.22	Scales @ A0 AS NOTED
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-135-WIE-ZZ-XX-M3-C-91006	P03
110-099-DRG-021	A01
FLO-WHI-LAY-0018	A1

File Path
N:\Projects\WIE12731_Stockton_HDD\135 - White Cross Floating Windfarm\10016_Design\C3D\ALIGNMENTS & PROFILE\

3.1 Braunton Burrows Crossing design parameters

3.1.1 Landfall Crossing

53. Preliminary engineering appraisal was undertaken regarding the Landfall constructability. The following parameters are indicated for HDD components of Options 2 and 3, it should be noted these parameters will be refined, as a preferred trenchless crossing technique is determined for the final design:

54. The proposed cable landing is located in Saunton Sands car park, which is approximately 1km to the west of Saunton village.

55. It is assumed that offshore cable with a maximum outside diameter of 294mm will be required for the landfall crossing, this will typically require a duct with a minimum diameter of 458mm, or 1.56 times the cable diameter.

56. Due to available duct sections it is assumed a 560mm HDPE SDR 11 pipe diameter duct will be required. This size ducting requires a minimum diameter 914mm reamed borehole to install it. The initial trenchless pilot hole would therefore be reamed out to circa 312mm diameter prior to the 250mm duct being pulled through the bore.

57. Where two ducts are to be installed a minimum 10m separation will be required between the ducts.

58. As the HDD approaches the exit point, a reception pit will be excavated to clear the exit zone of beach/marine sediments, in order to prevent debris ingress into the bore.

59. It is proposed to install the ducts from offshore to onshore. This will require remote fabrication of the HDD ducts, either offsite at a local port or at the onshore compound. Marine support to install the ducts, such as floating on barges to the exit point, will also be required.

60. The proposed entry compound will be located within the Saunton Sands car park, and it is anticipated that this should be sufficient for the compound setup without any earthworks required.

61. Construction works at this location are to be completed during the off season between September and April. Movements to site for plant and materials should be optimised in order to minimise project traffic movements wherever possible. Due to the proximity of dwellings to the proposed construction compound, due consideration should be given to minimising noise, emissions, and light pollution wherever possible.

62. Access the HDD compound will be via the B3231 (Saunton road) and via the Car park access road. Due to the seasonal constraints and proximity to a public car park, and dwellings, it is proposed to install the landfall HDD from the west side of the HDD compound, and when complete, reposition the HDD rig to the east side of the HDD compound, in readiness for the HDD installation of the Golf course crossing to the east.

63. A Transition Joint Bay (TJB) will be required where the offshore cable is connected to the onshore cable. Typically a TJB will consist of precast reinforced concrete units to create an approximate 20m x 8m x 2m concrete box, infilled with a sand / gravel surround. These can be installed at depth such that they are trafficable with incorporation of vehicle rated covers.

3.1.2 Saunton Golf Course Crossing

64. Preliminary engineering appraisal undertaken as part of the Onshore Export Cable Corridor feasibility assessment indicates the following parameters. However, it should be noted these parameters will be refined, as a preferred trenchless crossing technique is determined for the final design:

65. The crossing is located from Saunton Sands car park to the east of Saunton Golf Club, with an approximate crossing length of 1.2 km.

66. At the Saunton Golf Course Crossing, it has been assumed that an onshore cable with a maximum outside diameter of 165mm will be required, which will typically require a duct with a minimum diameter of 225mm, or 1.5 times the cable diameter.

67. Due to available duct sections, and assuming HDPE SDR 21, a nominal 250mm diameter duct will be required. The initial trenchless pilot hole would therefore be reamed out to circa 312mm diameter prior to the 250mm duct being pulled through the bore.

68. The proposed entry compound will be located within the Saunton Sands car park, and it is anticipated that this should be sufficient for the compound setup without any earthworks required.

69. For a typical trenchless application, an ideal compound size of 50m x 50m will typically be required with level and stable terrain. The compound is required to site a variety of containers which contain welfare, offices, storage, mud labs, mud mixing, mud recycling units and workshops.

70. An entry pit should be formed for the containment of drill fluids and may require temporary support. Given that the overburden at site consists of Blown Sand

deposits and groundwater is considered likely to be shallow, there may be issues with leakage of the drill fluid which should be overcome through lining the pit with an impermeable barrier such as visqueen sheeting, so as to form a sump.

71. The exit compound is located within an area of arable farmland to the east of Saunton Golf Club. In typical HDD applications a minimum area of 100m length by 20m width behind the exit pit is used to facilitate stringing out the product pipe with the support of stilts and rollers. In this instance if HDD is the selected method of installation, it is anticipated that the product pipe will be pulled from the exit compound to the entry compound.

72. The Exit Compound will typically be required with level and stable terrain which will require minor earthworks on site. It is not anticipated that earthworks will require substantial excavation of solid deposits, the drilling contractor should be consulted during this aspect of the design.

73. A 3.5m to 4.0m wide temporary access track suitable for the equipment to be employed will need to be formed through the fields from the access off the Burrows Lane to the exit compound. This will require the placing of a suitable depth of imported clean angular stone, such as SHW Type A to Clause 801, placed on top of a geotextile separation membrane. Alternatively, temporary metal roadway could be used.

74. Depending on the location of the TJB a short section of onshore cable, installed in an open cut trench, may be required to connect the cable for the Golf Course Crossing to the TJB and the Landfall Crossing.

75. Joint bays will be required at either end of the trenchless crossing. Joint bays typically consist of precast reinforced concrete units, which create a box of approximately 12m by 4m by 1.5m infilled with a sand/gravel surround. The joint bays within the Saunton Sands car park will also incorporate vehicle rated covers.

76. The final design will be included within the final Method Statement to be produced pre-construction and will identify the following:

- Entry pit and exit pit locations and their surrounding compounds. When crossing Internal Drainage Board (IDB) maintained watercourses, the entry and exit pits will be located at least 16m from the banks of the watercourse
- Drill paths between the entry and exit pit locations, with the separation between drill lines being dictated by parameters from the cable design
- Drill profiles based on an analysis of the site conditions and cable installation requirements.

77. Output from the design phase will provide recommendations on the drilling methodology to be adopted to best suit the selected crossing technique and the site conditions.

78. No ongoing requirement for regular maintenance of the onshore export cables following installation is anticipated. However, access would be required to conduct emergency repairs, if necessary.

79. No decision has been made regarding the final decommissioning policy for the onshore export cables, as it is recognised that industry best practice, rules and legislation change over time. It is likely the cables would be removed from the ducts and recycled, with the joint bays and ducts capped, sealed and left in situ.

3.2 Taw Estuary Crossing design parameters

80. Preliminary engineering appraisal undertaken as part of the Onshore Export Cable Corridor feasibility assessment indicates the following parameters. However, it should be noted these parameters will be refined, as a preferred trenchless crossing technique is determined for the final design.

81. At the Taw Estuary Crossing, it has been assumed that an onshore cable with a maximum outside diameter of 165mm will be required, which will typically require a duct with a minimum diameter of 255mm, or 1.5 times the cable diameter.

82. Due to the available duct sections and assuming HDPE SDR 21, a nominal 250mm diameter duct is assumed. This will require an initial pilot hole to be reamed out to 312mm diameter prior to the pull back operation for the HDD option. For the Direct Pipe option, the duct would be installed within the Direct Pipe Casing prior to the annulus being grouted up, which will likely require a Direct Pipe diameter of 1,422mm, subject to ground investigation.

83. Both options will likely require a drill length of 1.3km and will use the same entry and exit point locations.

84. Joint bays will be required at either end of the trenchless crossing. Joint bays typically consist of precast reinforced concrete units, which create a box of approximately 12m by 4m by 1.5m infilled with a sand/gravel surround.

85. The final design will be included within the final Taw Estuary Crossing Method Statement to be produced pre-construction and will identify the following:

- Entry pit and exit pit locations and their surrounding compounds. When crossing main rivers or IDB maintained watercourses, the entry and exit pits will be located at least 16m from the banks of the watercourse

- Drill paths between the entry and exit pit locations, with the separation between drill lines being dictated by parameters from the cable design. The depth of the drill path below the channel bed at the Taw Estuary Crossing will be confirmed following completion of hydrofracture (the inadvertent loss of drilling fluid from the borehole annulus to the surrounding soil due to excess fluid pressure) calculations and geotechnical investigations
- Drill profiles based on an analysis of the site conditions and cable installation requirements.

86. Output from the design phase will provide recommendations on the drilling methodology to be adopted to best suit the selected trenchless crossing technique and the site conditions.

87. No ongoing requirement for regular maintenance of the onshore export cables following installation is anticipated. However, access would be required to conduct emergency repairs, if necessary.

88. No decision has been made regarding the final decommissioning policy for the onshore export cables, as it is recognised that industry best practice, rules and legislation change over time. It is likely the cables would be removed from the ducts and recycled, with the joint bays and ducts capped, sealed and left in situ.

4. Drilling Methodology

4.1 Site Set Up

4.1.1 General Set Up

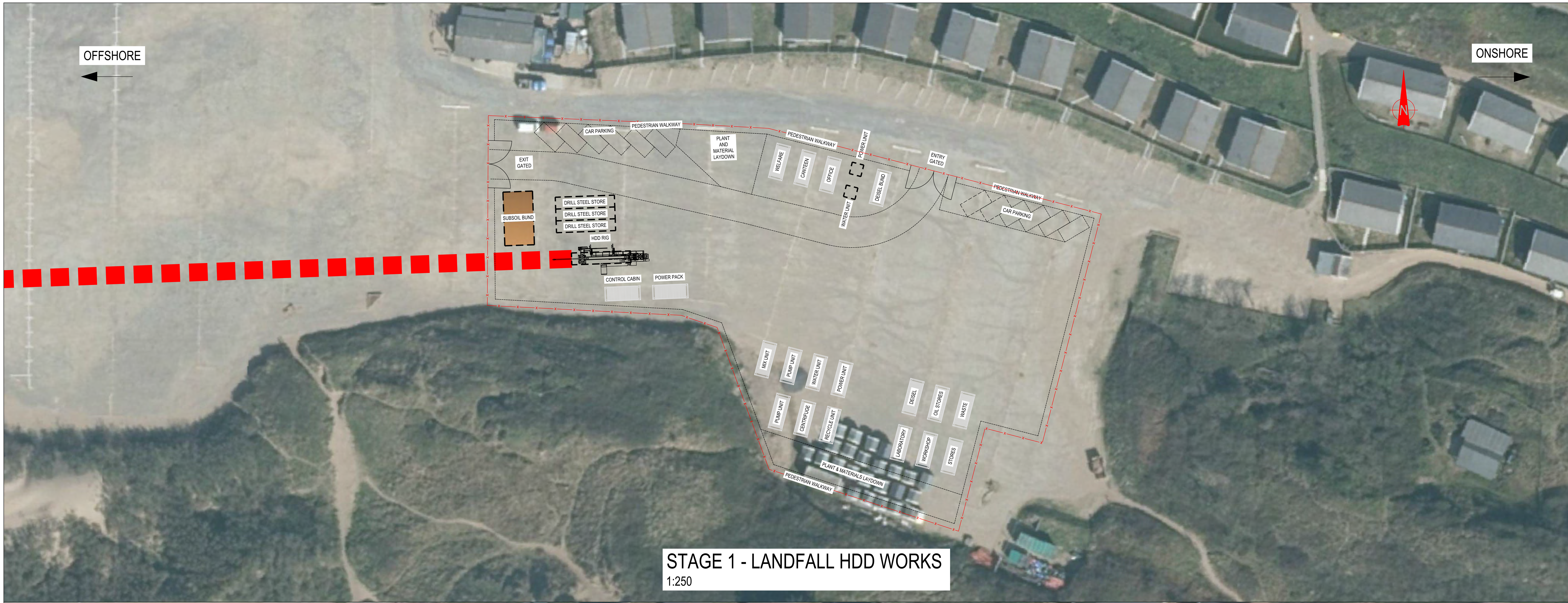
89. Prior to commencement of construction works at the Crossings, the general site area will be prepared to a suitable level to ensure construction safety and good operating conditions for drilling works.

90. Access will be required to allow the establishment of temporary compounds around the entry and exit points. The entry point compounds will also include a control cabin and welfare facilities for site personnel, including connection of utilities such as water, power, lighting and telecommunications services. Other plant and equipment anticipated within the compound include storage containers, power packs, mud labs, recycling units, mud mixing units, mud pumps, hydraulic excavators, power generators and other construction vehicles and machinery.

91. Temporary site lighting will also be installed and assessed for effectiveness ahead of starting construction activities. The compounds will be enclosed in temporary Heras fencing, and 24-hour security will be present until site reinstatement and demobilisation is complete. Information on existing underground utilities will also be obtained, and their location will be located and marked to ensure adequate separation distances. Any utilities that conflict with the proposed drill paths or site operations will be exposed to confirm their exact location, and appropriate measures will be taken to protect them from damage and ensure construction safety.

4.1.1.1 Braunton Burrows Crossing (Landfall and Saunton Golf Course Crossings)

92. A single temporary onshore compound will be required for the entry point for both the landfall and Saunton golf course crossings, which will be set within the car park at Saunton Sands. This would be up to 100m long by 50m wide for the landfall (Stage 1 **Figure 4.1**), reduced to 50m long by 50m wide (Stage 2 **Figure 4.1**) for the crossing of the golf course. This location is outside of the Braunton Burrows SAC.



GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
2. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO PREPARING ANY WORKING DRAWINGS OR COMMENCING ON SITE.
3. THE CONTRACTOR MUST ENSURE AND WILL BE HELD RESPONSIBLE FOR THE OVERALL STABILITY OF THE BUILDING/STRUCTURE/EXCAVATION AT ALL STAGES OF THE WORK.
4. ALL WORK BY THE CONTRACTOR MUST BE CARRIED OUT IN SUCH A WAY THAT ALL REQUIREMENTS UNDER THE HEALTH AND SAFETY AT WORK ACT ARE SATISFIED.
5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

Rev	Date	Description	By	Chk
P02	11.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	21.07.23	ISSUED FOR INFORMATION	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
HDD SITE COMPOUND LAYOUT (LANDFALL / GOLF COURSE CROSSINGS)

Client
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Suitability
INFORMATION S2

Designed By LP	Director CG	Waterman Ref WIE12731-153
Drawn By LP	Date JULY 23	Scales @ A0 1:250
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-GC-XX-DR-C-90001	P01
110-099-DRG-013	A01
FLO-WHI-LAY-0013	A1

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93. Access to the entry point compound will be from Saunton Road (B3231) using the existing car park access road. It is not anticipated that any major works will be needed to improve this access for the Onshore Project.

94. The initial site setup and establishment will be undertaken outside of the peak summer holiday season, defined as July – August in order to mitigate any impacts on either the local highways or the users of the car park. Movement to site for plant and materials will be optimised in order to minimise traffic movements from the Onshore Project wherever possible.

95. When the works associated with the crossings are completed the area will be reinstated and the areas with the carpark returned to the operator.

96. The temporary exit compound for the Saunton golf course crossing will be located within the fields to east, outside of the Braunton Burrows SAC. There will be no exit compound for the landfall crossing as the exit location will be below MLWS.

97. Access to the exit point compound for the Saunton golf course crossing will be through the Onshore Export Cable Corridor using the temporary main access from Saunton Road (B3231) and the Onshore Project haul road.

98. For the landfall crossing the ducts would be fabricated onshore, either at a local port or at the onshore compound, and then floated out to the exit point on barges to be installed from offshore to onshore. The stringing and welding of the ducts for the Saunton golf course crossing will be undertaken in the fields to the east of the golf course within the Onshore Export Cable Corridor, therefore the ducts would be pulled from the exit to the entry compound.

4.1.1.2 Taw Estuary Crossing

99. The entry compound will be located within an area of farmland adjacent to the East Yelland substation on the south bank of the River Taw. Minor earthworks will be required to level the working area, which typically involve stripping and storing the topsoil, installing geotextile membranes to the sub-surface and laying and compacting suitable hard material to form a firm working platform, although substantial excavation of solid deposits is not anticipated.

100. Preliminary engineering appraisal indicates that a compound area of 50x50m is considered ideal for a typical trenchless application. In addition, for the HDD option, a cast in-situ reinforced concrete anchor block would be installed adjacent to the entry point as an anchor for the HDD rig. For the Direct Pipe option, a sheet pile launch pit would be required.

101. Access to the entry compound on the south bank will be from the new haul road connecting to the existing private road and then to the highway at the West Yelland Road (B3233).

102. The entry compound would be located outside of the Taw-Torridge Estuary SSSI.

GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
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5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

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P01	24.07.23	ISSUED FOR INFORMATION	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
HDD SITE COMPOUND LAYOUT (RIVER TAW CROSSING)

Client
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Suitability
INFORMATION S2

Designed By LP	Director CG	Waterman Ref WIE12731-153
Drawn By LP	Date JULY 23	Scales @ A0 1:200
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-RT-XX-DR-C-90001	P02
110-099-DRG-014	A01
FLO-WHI-LAY-0014	A1

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103. The exit compound will be located within an area of farmland adjacent to the Crow Point Carpark. The stringing-out and welding of the HDPE ducts (for the HDD option) would be undertaken on the north side of the Taw Estuary within the Onshore Export Cable Corridor, therefore the ducts would be pulled from the exit to the entry compound. Similar minor earthworks are anticipated for the exit compound.

104. Access to the exit point compound for the Taw Estuary crossing will be through the Onshore Export Cable Corridor using the temporary main access from Saunton Road (B3231) and the Onshore Project haul road.

105. The exit compound would be located outside of the Braunton Burrows SAC, Braunton Burrows SSSI, and the Taw-Torridge Estuary SSSI.

4.1.2 Construction Environmental Controls

106. All construction activities at the Taw Estuary and Braunton Burrows Crossing will observe the best practice measures and conditions documented in **Appendix 5.C: Outline Construction Environmental Management Plan** and other relevant management plans submitted in support of the Offshore and Onshore Project's consenting and planning permission applications. Works will also be carried out in accordance with the contractor's own site management plan, risk assessments and method statements.

107. Prior to the commencement of construction works at the Taw Estuary and Brunton Burrows Crossings, OWL will consult NE and other stakeholders and seek agreement on the design and methodology set out in this document.

108. Within **Sections 4.1.2.1** to **4.1.2.12,** relevant construction environmental controls are laid out.

4.1.2.1 Noise and Vibration

109. Construction environmental controls relevant to noise and vibration anticipated for the site include but are not limited to:

- Adequate control measures to minimise noise and vibration impacts will include temporary screening and traffic management measures specified the Construction Traffic Management Plan (CTMP).

4.1.2.2 Terrestrial Ecology

110. Construction environmental controls relevant to terrestrial ecology anticipated for the site include but are not limited to:

- Adequate control measures to avoid and minimise impacts on flora and fauna and any protected species
- Consents/licences may also be required in relation to protected species and habitats
- Specific measures to mitigate impacts on wintering birds (including high tide roosts), such as screening, minimising the movement of personnel and timing of the works.

4.1.2.3 Terrestrial Archaeology and Cultural Heritage

111. Construction environmental controls relevant to terrestrial archaeology and cultural heritage anticipated for the site include but are not limited to:

- Sites of archaeological importance will be identified in the Written Scheme of Investigation (WSI) and appropriate environmental control measures such as the establishment of exclusion and buffer zones will be implemented where required.

4.1.2.4 Wastewater Discharges

112. Construction environmental controls relevant to wastewater discharges anticipated for the site include but are not limited to:

- Relevant permits will be obtained by the principal contractor from the regulator associated with the use of septic tanks for other effluent/washout water treatment facilities
- Wastewater management through the use of septic tanks or other effluent/washout water treatment facilities. In addition, monitoring and recording specified volumetric, quality or reference conditions to demonstrate compliance will be undertaken
- Waste sludge from septic tanks and effluents from cesspits and sewage holding tanks must be removed by a suitably licenced and registered waste carrier in accordance with Duty of Care requirements
- Monitoring records in relation to the disposal of grey water, foul water, bilge water or ballast water during the construction phase must be retained.

4.1.2.5 Oils, Fuels and Chemicals

113. Construction environmental controls relevant to oils, fuels and chemicals anticipated for the site include but are not limited to:

- Ensure adequate controls for the delivery, storage and use of fuels, oils and chemicals on site

- Oils and chemicals must be clearly labelled and a up-to-date hazardous substance register must be retained
- The principal contractor will wherever possible use drilling fluids that are on the PLONAR (Poses Little Or No Risk), the list is controlled and maintained by The Centre for Environment, Fisheries and Aquaculture Science (CEFAS)
- Activities involving the handling of large quantities of hazardous materials, such as deliveries and refuelling, should have detailed method statements and be undertaken by designated and trained personnel
- Oil and fuel storage must be robust and provide adequate secondary containment and be located in designated areas taking into account security, the location of sensitive receptors and pathways such as drains and watercourses, and safe access for plant and manual handling
- Spill response materials should be provided nearby an be readily accessible, with project personnel trained in spill response
- All materials ordered or brought to site listed as hazardous under the Control of Substances Hazardous to Health (COSHH) Regulations are accompanied with hazardous information sheet.

4.1.2.6 Waste Management and Circular Economy

114. Construction environmental controls relevant to waste management and circular economy anticipated for the site include but are not limited to:

- The waste reduction hierarchy (Avoid, Reuse, Recycle or Recover) should be considered where practical and economically feasible prior to considering disposal
- The principal contractor is required to prepare a Waste Management Plan to record the following information, as a minimum:
    - The types and quantities of waste generated
    - The management approach for each waste type (Reuse, Recycle, Recover, Dispose) including any treatment
    - The storage arrangements for each waste type
    - The site waste monitoring and reporting arrangements.
    - Waste carrier details and waste management/disposal facilities.
- Duty of care requirements in relation to the storage, transfer and disposal of waste must be complied with
- Circular economy principles should be considered, where practical and economically feasible, specifically the priority area of circular construction and adopting circular economy interventions such as:

  - adopting circular design principles and construction processes, particularly the opportunity to create a physical and virtual resource recovery and material exchange hub to make better use of material wasted in construction
  - supporting the growth of regional specialist circular products and services in the construction industry.

4.1.2.7 Traffic Management

115. Construction environmental controls relevant to traffic management anticipated for the site include but are not limited to:

- Appointment of a Traffic Management Coordinator (TMCo)
- Obtain technical approval for construction of accesses and crossings
- Implement direction signing
- Establish monitoring systems
- Agree scope of and undertake pre-commencement highway condition surveys
- Agree and implement measures for each access to control the deposition of detritus on the public highway
- Inspect the highway for detritus and request regular cleansing as required
- Monitoring of CTMP measures
- Produce monthly monitoring reports
- Update condition surveys and agree any remedial works.

4.1.2.8 Surface Water Management

116. Construction environmental controls relevant to surface water management anticipated for the site include but are not limited to:

- A detailed surface water management design/drainage plan for the site included in the CEMP. The plan should detail the surface water management measures to be implemented during the works. The detailed design should be supported by the rationale for selecting the chosen mitigation measures, together with associated calculations and methodologies for sizing. Where appropriate, the principles of Sustainable Urban Drainage Schemes (SUDS) should be applied
- Mitigation measures must be maintained and monitored on a regular basis. A record of inspections of mitigation measures and any required maintenance carried out must be maintained.

4.1.2.9 Water Abstraction

117. Construction environmental controls relevant to water abstraction anticipated for the site include but are not limited to:

- Abstraction of water may be required for potable supply or for use during site activities, such as concrete batching or washing. Where this is required, any permits for the use of abstracted water during the construction related activities must be obtained
- Monitoring and recording associated abstraction rates or other licence requirements to demonstrate compliance.

4.1.2.10 Emissions to the Air

118. Construction environmental controls relevant to emissions to the air anticipated for the site include but are not limited to:

- Measures recommended by the Institute of Air Quality Management (IAQM)
- Appropriate mitigation measures to suppress dust and minimise emissions to the air during the construction works.

4.1.2.11 UXO Risk

119. Construction environmental controls relevant to UXO risk anticipated for the site include but are not limited to:

- Surveys and assessments of the construction site, identifying potential UXO presence or historical activities should be undertaken by the Principal Contractor. In the event of any suspected or confirmed UXO findings, Principal Contractor will be required to implement appropriate measures, such as notifying relevant authorities, establishing exclusion zones, and engaging specialised personnel for safe removal and disposal.

4.1.2.12 Project Programme and Working Hours

120. Construction environmental controls relevant to project programme and working hours anticipated for the site include but are not limited to:

- Working times will be restricted to 12-hour shifts, except for circumstances in which longer periods are required due to the nature of works, to avoid night time working. However, in exceptional circumstances longer periods may be required due to the nature of works. These will be agreed in advance with the relevant authorities.

4.2 HDD

121. The description provided within this appendix is an indicative description applicable to all of the crossings.

4.2.1 Drill Rig Set Up

122. For the HDD options, a 1.5m deep entry pit would be excavated adjacent to the entry point, measuring approximately 4m by 4m. This pit would be surrounded by the excavated subsoil and enclosed using barrier fencing to prevent access by unauthorised personnel and provide a safe working environment. Given that the overburden around the entry point location consists of Tidal Flat deposits and groundwater is considered likely to be shallow, the entry pit may require temporary support and would be lined with an impermeable membrane such as plastic sheeting to form a sump and containment of drilling fluids. Excavated topsoil will be stored in a designated area and kept separate from the subsoil to prevent contamination.

123. The HDD rig, control cabin, power packs, mud labs, recycling units, mud mixing units, mud pumps, hydraulic excavators and other equipment will be delivered to the site via heavy goods vehicles, offloaded and assembled on the working platform. A slurry pump will be installed adjacent to the excavated entry pit to pump the drilling fluid-laden cuttings to the recycling units.

124. A steel casing pipe will be installed by an excavator as a guide pipe at the entry point. The HDD rig and ancillary equipment will be positioned at their working positions, and all necessary connections and checks will be made. The rig will be anchored to the concrete anchor block and adjusted vertically to the correct ground entry angle in accordance with the HDD design.

125. An indicative layout for the HDD rig set up will be presented at a later stage to reflect the final design and the nature of equipment and machinery to be used on-site.

4.2.2 Pilot Hole

126. Following all site preparation works, the pilot hole will be drilled through the ground following the predetermined profile trajectory to the exit point on the other side of the river bank. The HDD rig uses a drill string, which comprises of a drill bit connected to a gyroscope and magnetic steering system and a series of drill pipes. Drilling fluid is jetted through the centre of the drill string and out through nozzles within the drill bit to provide hydraulic power to a steerable mud motor. The drilling fluid-laden cuttings are transported back through the drilled hole to the surface and into the entry pit where the mixture is constantly pumped through the mud separation and recycling system and reused as drilling fluid, with the addition of new water and bentonite clay as needed.

127. Directional guidance is achieved via a signal transmitted from the gyroscope and magnetic steering system in the first drill pipe to the drilling control unit in the control room. The guidance engineer uses the directional data and records of the length of the drill pipe to calculate the progress and position of the drill bit. Such calculations will be performed at regular intervals, typically at every point the drill advances one drill pipe length, and steering corrections will be made when necessary.

128. The pilot hole will stop a short distance from exiting the bedrock at the exit point location, also known as the stop short point, to contain the drilling fluid within the bore during the reaming phase. The drill string will then be retracted back through the hole to the entry point by the HDD rig.

4.2.3 Reaming

129. After the pilot drill string has been withdrawn from the bore, an opener reamer will be assembled onto the drill string at the entry point in order to increase the pilot hole diameter. A bull nose and stabilisers attached to the front and back of the reamer respectively will help centralise the reamer within the pilot hole. The reamer is rotated and advanced along the pilot hole whilst pumping drilling fluid through the reamer nozzles. As with the pilot hole drilling, drilling fluid-laden cuttings are transported to the entry point to be recycled.

130. Upon reaching the stop short point, the drill string will be retracted, and the next-sized reamer will be assembled onto the string and re-deployed to continue widening the hole. This process will continue until the hole is large enough to accommodate the size of the cable duct assembly.

131. A final jetting and steering assembly are then installed to the drill string at the entry point and advanced through the reamed bore to punch out at pre-determined exit point. The final assembly will be removed from the drill string and replaced with a pull back assembly to facilitate the cable duct installation.

4.2.4 Pull Back

132. The cable duct to be installed will be positioned at the exit compound. The drill string with the pull back assembly will be attached to the cable duct at the swivel, and the HDD rig will then pull the drill string along with the cable duct through the reamed bore through to the entry point, at which point the installation process is complete.

4.2.5 Demobilisation

133. Once quality and safety checks have been performed and the HDD operations have fully concluded, the contents of the entry pit along with all drilled cuttings, drilling fluid, buffer tank mixture and other construction waste will be disposed of via a registered waste carrier to a licenced facility. All geotextile membranes will be removed, and the entry pit will be backfilled with its original soil. The HDD rig will be de-rigged, and all ancillary equipment and structures will be disassembled on the working platform and transported back, allowing the site to be cleared.

4.3 Direct Pipe

134. The description provided within this appendix is an indicative description applicable to all of the crossings.

4.3.1 Pipe Thruster and Tunnel Boring Machine Set Up

135. For the Direct Pipe option, an entry pit would be excavated adjacent to the entry point in line with the approved temporary compound design. Calculations will be undertaken as part of the design to ensure that the entry pit and the required anchoring system are capable of withstanding the horizontal and vertical thrust forces generated by the Pipe Thruster within acceptable safety margins.

136. The Pipe Thruster, control cabin, and ancillary equipment and structures will be delivered to the site via heavy goods vehicles, offloaded and assembled on the working platform. After securing the launch cradle to the underlying geology where the entry pit is excavated, the base frame of the Pipe Thruster, which comprise two separate parts, will be lifted into place at the base of the pit and securely fixed to the launch cradle. Hydraulic thrust cylinders will then be positioned in the pit and securely fixed to the thruster base at the correct ground entry angle.

137. Securing ports on each side of the base frame parts will be used to secure the thruster base to the launch cradle, providing both horizontal and vertical mechanical anchoring. Once the anchoring system is installed, the Pipe Thruster can then be lowered into position and secured. A launch seal will also be mechanically secured to the entry pit headwall to prevent the ingress of groundwater, cuttings and drilling fluid returns into the pit.

138. In general, the minimum width of the entry pit is determined by the width of the base frame, the maximum width of the opened clamping unit and a minimum of 1 m clearance on each side for safety purposes. The minimum length of the entry pit is determined by the maximum length of the Pipe Thruster unit and the minimum distance of the unit from the front face of the entry pit, which is dependent upon

the ground entry angle and the size of the Pipe Thruster. The typical entry pit size is 6.3m width by 20m length. The depth of the entry pit is determined by the minimum required cover over the launch seal. A minimum of 1.5 times the outer diameter of the tunnel boring machine (TBM) is recommended for cover above the launch seal.

139. The TBM and its associated components will be lifted into position centred on the launch seal, at the correct ground entry angle and parallel to the thrust cylinders of the Pipe Thruster. An antiroll unit will be secured to the launch cradle and Pipe Thruster to prevent the potential rotating of the clamping unit and subsequently the TBM assembly and the attached pipeline. The TBM assembly contains the cutting head at the front, power packs, feed and slurry lines for drilling fluid transport and a conical interface ring at the rear.

4.3.2 Pipe String Preparation

140. The pipeline may be strung out and welded onto the TBM assembly as a single continuous pipe string, sufficient to complete the installation from the entry to the exit pit in a single operation. Alternatively, should the site have working space limitations, it is possible to weld the pipeline and perform the installation in sections. Typically, the pipe string will be welded with a set back from the rear of the entry pit and subsequently placed on rollers to allow the pipe string to travel linearly into the borehole. Roller cradles and a ramp may also be needed at the rear of the entry pit to align with the ground entry angle of the TBM assembly and account for the difference in elevation.

141. In addition, supply lines will also be installed externally and/or internally to the pipe string, connecting into the control cabin and the mud separation and recycling system. These supply lines include electric and data cables, slurry and discharge hoses and drilling fluid hoses. Slurry pumps and feed line coolers will also be inserted into pipe string. In order to reduce the required length of the feed and slurry lines, it is recommended that the mud separation and recycling plant and drilling fluid injection pump are located close to the midpoint of the pipe string.

142. Once the welding, testing and coating operations are completed on the pipe string and all ancillary equipment has been installed, the front of the pipe string will be secured to a weld-on adaptor, which is then connected to the rear of the TBM assembly at the conical interface ring. All supply lines inside the pipe string will also be connected to the corresponding inlets inside the TBM assembly.

143. The clamping unit of the Pipe Thruster will then be opened to a sufficient width and positioned above the pipe string using a mobile lifting appliance. Once the clamping

unit is lowered into the entry pit and seated over the pipe string, the clamp will be closed, and the clamping plates will be hydraulically extended until the clamp is securely holding the pipe string. Hydraulic thrust cylinders on the Pipe Thruster will then be extended to the clamping unit and connected mechanically to finalise the site setup.

4.3.3 Pipe Thrust and Insertion

144. Prior to tunnelling works, the hydraulic, electric and pneumatic systems of the entire assembly will be activated and tested to confirm correct functionality. Once a functional test is complete, the TBM assembly is then inserted through the launch seal at the front of the entry pit. The cutting head on the TBM will then continue to drill forward along the predetermined profile trajectory to the exit point on the other side of the river bank. The pipe string, which is connected to the TBM assembly, will also be thrusted into the borehole and transported along the drill path, allowing the pipeline to be installed simultaneously with the drilling operations.

145. If required, the pipe string may also be installed in multiple sections. After the TBM assembly and initial pipe string is inserted into the borehole, a new pipe string can be lowered into the entry pit and welded to the rear end of the already inserted pipe string. The process is then repeated until the full length of the pipeline is achieved.

4.3.4 Demobilisation

146. Once the TBM assembly reaches the exit point on the other side of the river bank, the components of the assembly will be disconnected either individually or together in one piece. The dimensions of the exit pit would need to provide sufficient length for the disassembly. The supply lines, slurry pumps and feed line coolers within the installed pipe string will also be disassembled by retracting the wheeled carrier racks. Supply lines are then disconnected, cleaned and inspected for damage prior to storage.

147. Once quality and safety checks have been performed and all Direct Pipe operations have fully concluded, the contents of the entry pit along with all drilled cuttings, drilling fluid, buffer tank mixture and other construction waste will be disposed of via a registered waste carrier to a licenced facility. All geotextile membranes will be removed, and the entry pit will be backfilled with its original soil. The Pipe Thruster and anchoring system will be de-rigged, and all ancillary equipment and structures will be disassembled on the working platform and transported back, allowing the site to be cleared.

4.4 Working Hours

148. The typical working hours expected at the Braunton Burrows and Taw Estuary Crossing are 07:00 to 19:00 Monday to Friday, Saturday 07:00 – 13:00; however some 24 hour working we be required for the drilling associated with the trenchless cable installation methods. A maximum of 14 days of 24 hour working for each drill has been assessed. Continuous periods of construction may be required depending on the nature of works and where these are required they will be agreed in advance with the relevant authorities. Supervision will not be reduced when night shifts are undertaken. All site housekeeping checks and refuelling will be scheduled during daylight hours.

5. Drilling Fluid Management

5.1 Purpose of Drilling Fluid

149. Trenchless crossing techniques are undertaken with the aid of a viscous drilling fluid, typically a mixture of water, polymers and ground and refined bentonite clay (a non-toxic clay commonly used in agricultural practices). Bentonite clay is typically delivered to site as a dried and finely ground powder, which is then rehydrated in a mix tank with water. Bentonite clay is included on the OSPAR Commission's List of Substances Used and Discharged Offshore which are Considered to Pose Little or No Risk to the Environment (PLONOR) (OSPAR Commission, 2021).

150. Drilling fluid serves many purposes such as providing hydraulic cutting action to any alluvial geology, providing hydraulic power to the downhole mud motor, transporting cuttings out of the bore, keeping cuttings in suspension when drilling operations are halted and cooling and lubricating the drill string and product pipe. It also gives support to the borehole and equalises pressure differences between the borehole and the geological formation by building a filter cake (a thin layer of drilling fluid that lines and seals the borehole to prevent fluids from permeating to the surrounding soil).

151. The general approach to drilling fluid management and preventive and corrective measures to drilling fluid breakout, as outlined below, are applicable to both the HDD and Direct Pipe option.

5.2 General Management Approach

152. Drilling fluid will be recycled as far as practicable by separating out the solid drill cuttings, which the fluid recovers from the cutting head or drill bit and transports to the surface via the borehole. The recycling system conveys the dirty drilling fluid upon return through a loop, which is capable of removing large solid particles such as gravel and finer particles such as sand through a variety of mechanical techniques. The cleaned drilling fluid is then pumped to the drill rig for reuse after adding new water and bentonite clay to maintain the right consistency and volume. This reduces raw material consumption, in particular water and bentonite clay, the time taken for the drilling process to be completed and the amount of waste produced.

153. The spoil from the drilling and recycling process will be collected, stored and disposed of in line with the approved Site Waste Management Plan (as part of a CEMP) at the end of operations. Likewise, excess drilling fluid will be stored in tanks to manage the expected volumes and removed from site when necessary.

5.3 Measures to Prevent Drilling Fluid Breakout

154. Trenchless crossing techniques carry a potential risk of drilling fluid breakout. This may occur when the fluid is forced through highly fissured ground at pressure or where there are large, interconnected fissures in the ground or other man-made features such as old boreholes. However, drilling fluid breakouts are rare, given that bentonite clay is a thixotropic fluid of high viscosity, which enters and seals fissures within the borehole. Under these circumstances, it is only likely that the drilling fluid would reach ground level where there is a continuous path available to the surface. **Section 2.1** details the hydrofracture assessment and identifies the level of risk of drilling fluid breakout for the Project.

155. The geotechnical investigations undertaken on-site prior to drilling operations will help establish site conditions along the drill profile, allowing a suitable trenchless crossing design to be developed. Findings from these investigations will provide critical information such as the equipment to be used, the entry and exit points, drill profile, drill depth below ground, drilling fluid viscosity and borehole diameter, all of which will minimise the risk of drilling fluid breakout during drilling operations. The review of historical borehole data suggests that the overall risk of drilling activity is low and that the probability of drilling fluid breakout during drilling operations is unlikely. This will be confirmed prior to commencing activity through targeted geotechnical investigations and through agreement with the relevant authorities.

156. During drilling, site monitoring will be carried out by dedicated personnel, which will include monitoring of the annular pressure and the drilling fluid levels. The site to be monitored will include an area of 100m in front or behind the drill head and 25m on either side of the centre line of the drill path. The site will be divided into separate areas which will be monitored regularly, and inspection records shall be maintained. In addition, a down hole annular pressure sensor will be installed to the drill string. The maximum allowable annular pressure according to the design calculations will be plotted on screen for the guidance engineer in the control cabin, with an alarm sounding when 90% of the allowable limit is reached. In this event, drilling operations will be immediately halted, and the drill string will be retracted until an all clear has been given to resume drilling.

157. A key component of preventing drilling fluid breakout is the effective removal of drill cuttings from the borehole (see **Section 5.2** for details of the drill cuttings removal process). If cuttings are not removed, they may form cutting beds at the base of the borehole, which decreases the hole's cross-sectional area and increases the annular pressure. Cutting beds may also lead to increased drilling forces, which can eventually cause equipment to be lost or stuck downhole.

158. It is anticipated that the following equipment (or equivalent alternatives) will be available on-site at all times to respond to drilling fluid breakout:

- Silt fencing
- Mobile suction pumps
- Seal pups (large cylinder-shaped containment and absorption pads)
- Straw bales
- Timber stakes
- Sand bags
- Tools for erecting temporary bunds.

159. The risk of drilling fluid breakout is considered to be very low based on analysis of historical borehole and desk-based assessment of the geology present in the area. Refer to **Section 2.1** for further information.

5.4 Drilling Fluid Breakout Response Planning

160. Contingency measures to be adopted at the Braunton Burrows and Taw Estuary Crossing will be agreed before drilling operations commence. Possible containment and clean-up steps are provided below. These measures will form part of the CEMP and/or a specific EMP for the crossings.

161. This is additional mitigation included in the unlikely event that a breakout occurs.

5.4.1 Breakout on Land

- Report immediately to the control cabin using the site two-way radio
- Stop drilling immediately
- Contain the drilling fluid by constructing a bund with sandbags
- Recover the drilling fluid from the bund by using 4in pump sets and 4in hoses
- Discharge the drilling fluid into the recycling pit for recycling
- Watch the area closely to check if breakout channel has sealed when pumping
- Pump lost circulation material or cement grout into the borehole and allow to swell in the fracture
- Continue pumping drilling fluid after waiting for lost circulation material to set according to the manufacturer's recommendations. If the fracture cannot be sealed, continue to recover drilling fluid from the bunded area using 4in pumps
- For containment of breakouts on land, sandbags will be stored where they can be easily and quickly brought to the breakout point. Personnel monitoring the site will be equipped with radios for instant communication with the driller.

5.4.2 Breakout under Water

- Any loss of drilling fluid in the entry pit is reported immediately to the driller
- Stop drilling immediately
- Pump lost circulation material to seal the fissure
- Wait for the lost circulation material to swell in the fracture
- Pump a mixture of 'Pure Bore' to see if circulation can be maintained
- If not, repeat the process with lost circulation material
- If the fracture cannot be sealed, either a cement grout will be pumped to the end of the bore, or the drill string will be withdrawn by an appropriate distance and a new profile drilled to avoid the problem area. This is dependent upon the rate of fluid loss and the geology encountered.

162. Fast and essential reporting is an essential component of the contingency plan. Emergency telephone numbers will be available to all the appropriate parties. Contact details of the relevant authority and Statutory Nature Conservation Body will also be provided for ease of reference.

163. In the unlikely event of drilling fluid breakout, an investigation will be conducted by the designated personnel, and the trenchless crossing design parameters will be reviewed to determine whether any modifications to the design or Method Statement are needed to reduce the risk of further breakouts.

6. References

British Geological Survey. GeoIndex Onshore. [Online]. [Accessed 30 January 2023]. Available from: http://mapapps2.bgs.ac.uk/.

Electricity Act 1989. (c. 29). [Online]. London: The Stationary Office. [Accessed 27 January 2023]. Available from: https://www.legislation.gov.uk/.

Marine and Coastal Access Act 2009. (c. 23). [Online]. London: The Stationary Office. [Accessed 27 January 2023]. Available from: https://www.legislation.gov.uk/.

Natural England. Designated Sites View. [Online]. [Accessed 30 January 2023]. Available from: https://designatedsites.naturalengland.org.uk/.

OSPAR Commission. (2021) The OSPAR List of Substances Used and Discharged Offshore which are Considered to Pose Little or No Risk to the Environment (PLONOR) – Update 2021. [Online]. [Accessed 7 February 2023]. Available from: https://www.ospar.org/.

Town and Country Planning Act 1990. (c. 8). [Online]. London: The Stationary Office. [Accessed 27 January 2023]. Available from: https://www.legislation.gov.uk/.

The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (as amended). SI 2017/407. [Online]. London: The Stationary Office. [Accessed 27 January 2023]. Available from: https://www.legislation.gov.uk/.

Waterman Infrastructure & Environment Ltd (2023). White Cross Wind Farm: Export Cable Landfall and Onshore Crossings HDD Hydrofracture Assessment – Feasibility Stage.

WHITE CROSS

Annex 1 HDD Hydrofracture Assessment

Export Cable Landfall and Onshore Crossings (Feasibility Stage)

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White Cross Wind Farm: Export Cable Landfall and Onshore Crossings

HDD Hydrofracture Assessment – Feasibility Stage

Date: 11th August 2023

Client Name: Stockton Drilling Ltd (on behalf of Flotation Energy Ltd)

Document Reference: WIE12731-153-TN-2-2-3

Issue	Prepared by	Checked & Approved by
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1. Background

Waterman Infrastructure & Environment Ltd ('WIE') have been appointed by Stockton Drilling Limited ('SDL') to provide support of the onshore cable route Front-End Engineering Design (FEED) for the proposed White Cross Offshore Wind Farm, located approximately 50km off the Devon Coast. The 8 No. Wind Turbine Generators will comprise innovative floating substructure technology that is anchored to the seabed. The maximum capacity of the completed windfarm will be 100MW. Power will be exported by means of a subsea cable(s) that will make landfall on the Devon coast at Saunton Sands before running generally south to either a new or the existing sub-station at East Yelland.

As part of the cable route, 3 No. trenchless drills, by Horizontal Directional Drilling (HDD) methodology, are required for passing constraints. These drills are denoted as the 'Landfall', 'Golf Course Crossing' and 'River Taw Crossing'.

Within the HDD process, there can be a risk of drill fluid breakout to the surface, which is a phenomenon known as Hydrofracture, commonly termed 'frac-out'. In support of the FEED design, WIE have completed a preliminary assessment of the likelihood of hydrofracture based on the feasibility stage crossing profiles developed. The assessment should be revised on completion of ground investigation and finalisation of design profiles.

This Technical Note presents the results of the hydrofracture assessment. The crossing profile drawings and hydrofracture calculations are appended.

1.1 Limitations

A number of assumptions have been made to undertake these calculations including but not limited to, ground conditions, bore dimensions and bore profiles. Whilst WIE have endeavoured to make assumptions conservatively and realistically, we can accept no liability for any inaccuracies. The calculations should be treated as preliminary until such time the variables become more defined whereby the calculations should be revised accordingly.

2. Analysis Methodology

2.1 General

Hydrofracture occurs if during the drilling process the drilling fluid pressure in the borehole exceeds the resistance of the overburden soils resulting in a breakout at the surface. In this instance, there is a potential risk that this could occur within the intertidal zone, on the golf course, or within the River Taw leading to a potential pollution incident.

The HDD designer typically accounts for hydrofracture by ensuring that there is adequate cover depth of the bore path, which in turn provides a larger overburden pressure, and best mitigates hydrofracture. In granular soils, casing is typically used over the initial length of the bore to assist with mitigating the risk.

There are several possible methodologies for assessing the likelihood of hydrofracture, but this analysis has been based upon the widely used 'Dutch' method which was developed by Luger & Hergarden (1988) assuming a cavity expansion.

2.2 Geotechnical Parameters

The geology beneath the site is to be confirmed following a campaign of ground investigation, but expected to consist of superficial deposits, in the form of blown sand or marine beach deposits, overlying Mudstone, Slate or Shale bedrock.

It is anticipated that the bores would be cased through loose superficial deposits into more competent clays / weathered rock.

Due to the lack of Ground Investigation data, this preliminary hydrofracture assessment conservatively assumes granular materials (i.e. rather than firm to stiff clays or competent rock). The geotechnical parameters considered in all analysis are presented in Table 1.

Table 1: Analysis Parameters

Parameter	Assumed Value
Gravity (m/s/s)	9.81
Density of Water (kg/m^3)	1000
Density of Drilling Mud (kg/m^3)	1300
Soil Density (kg/m^3)	1950
Cohesion (kN/m^2)	2
Friction Angle (°)	25
Poission's Ratio	0.3
Elasticity Modulus (kPa)	40000
Allowable Plastic Radius Factor	0.50

2.3 Groundwater

The groundwater level has been conservatively assumed as commensurate with the ground surface throughout the analysis. It is likely that this assumption could be relaxed after completion of ground investigation with associated groundwater monitoring.

2.4 Bore Diameters

The bore diameters for the HDD crossings are to be confirmed as part of detailed design once all cable specifications are confirmed and ground conditions proven. It is anticipated that there will be a transition joint bay between the offshore and onshore cable(s) within the vicinity of the Staunton Sands beach car park. The landfall calculations therefore assume an offshore cable specification, with the Golf Course and River Taw calculations assuming an onshore cable specification (with a consequent reduction in likely cable and duct diameter).

The diameters assumed within the preliminary calculations, based on the feasibility stage designs, are summarised in Table 2.

Table 2: Bore Diameters

Cable Specification	Pilot Hole Diameter (m)	Reamed Hole Diameter (m)
Onshore (River Taw / Golf Course)	0.305 (12”)	0.610 (24”)
Offshore (Landfall)	0.305 (12”)	1.118 (44”)

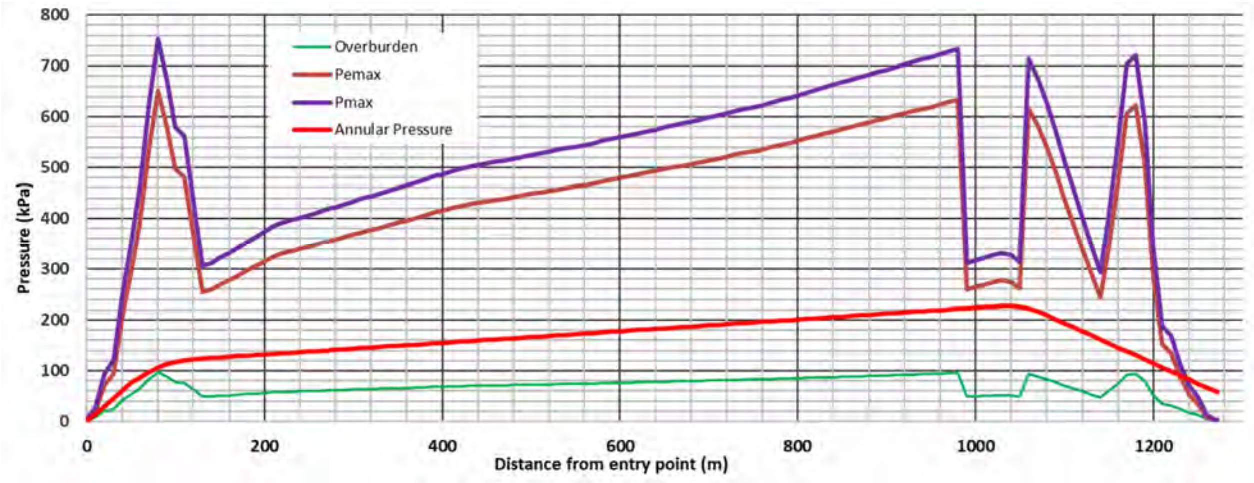
3. Assessment Results

3.1 River Taw Crossing

Under WIE’s original appointment for the Pre-FEED Study of the onshore cable route a bore profile for crossing the River Taw was developed. This profile is presented on drawing 12731-135-WIE-ZZ-XX-M3-C-91003 included in Appendix A and is discussed within the Onshore Cable Route Feasibility Assessment (WIE12731-135-R-1-2-4, June 2022). Considering the profile developed in terms of hydrofracture, results in estimates as presented in Figure 1.

Calculations are presented in Appendix B.

Figure 1: River Taw Crossing - Hydrofracture and Annular Pressure Estimates



The variation in pressures along the borehole are shown in Figure 1, where it can be seen the permissible boreholes pressures P_{emax} and P_{max} graphs initially vary due to cover depth changes where the topography rises before trending downwards into the river channel. The deepened channel that is indicatively drawn on the profile drawing (not picked up by bathymetric survey) results in a loss of cover depth and thus a drop in permissible pressure and then the point where the profile passes back of the river channel creates some varation in the cover and hence an erratic permissible pressure.

Another feature to note on this graph is that the permissible pressures are significantly larger than the overburden pressure and this is due to the nature of the assumptions in the 'Dutch' model. The difference between P_{emax} and P_{max} arises from consideration of the water table level and the added confinement pressure due to its hydrostatic effect.

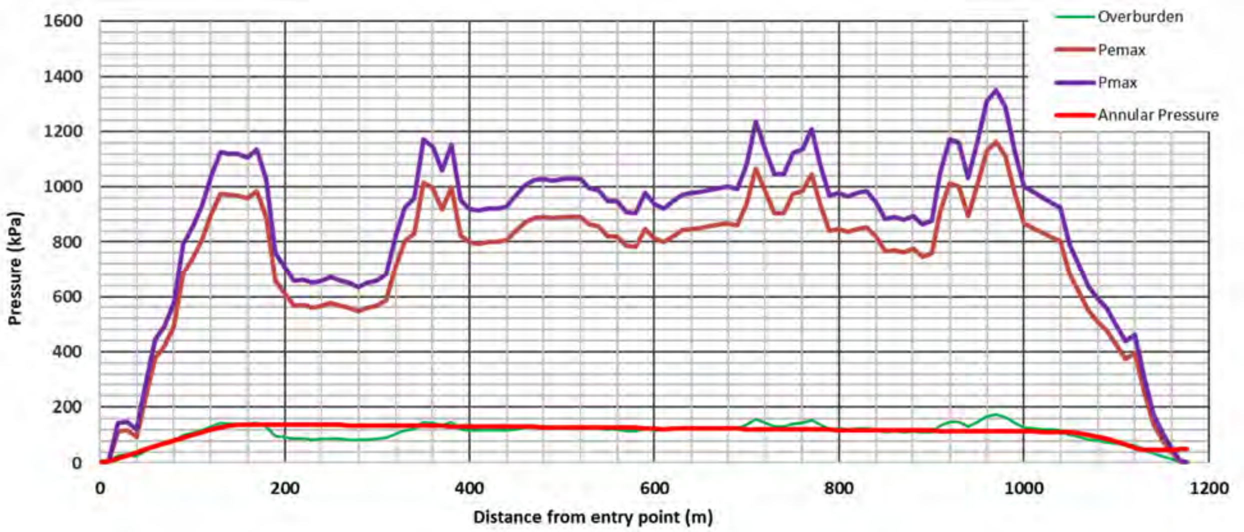
The most significant line on Figure 1 is the Annular Pressure which is the pressure in the borehole due to the drill fluid return flow. This pressure varies as the borehole progresses and is the sum of the static head and friction (flow) head. For most of the distance the annular pressure is well below P_{emax} and thus hydrofracture is not considered a concern. In the final stages of the bore profile the calculations show hydrofracture is likely as the profile begins to lose cover depth shortly before punch-out at CH1250. This is unavoidable but the effects can be easily controlled / mitigated onshore by putting appropriate site measures in place such as sandbagging and/or casing, to reduce and contain any hydrofracture. All drill fluids used should also be self-flocculating, environmentally inert and CEFAS approved.

3.2 Golf Course Crossing

Under WIE's original appointment for the Pre-FEED Study of the onshore cable route a bore profile for crossing the Golf Course was developed. This profile is presented on drawing 12731-135-WIE-ZZ-XX-M3-C-91006 included in Appendix A and is discussed within the Onshore Cable Route Feasibility Assessment (WIE12731-135-R-1-2-4, June 2022). Considering the profile developed in terms of hydrofracture, results in estimates as presented in Figure 2.

Calculations are presented in Appendix B.

Figure 2: Golf Course Crossing - Hydrofracture and Annular Pressure Estimates



The variation in pressures along the borehole are shown in Figure 2, where it can be seen the permissible boreholes pressures P_{emax} and P_{max} graphs vary due to topography changes across the golf course causing cover depth alterations.

Another feature to note on this graph is that the permissible pressures are significantly larger than the overburden pressure and this is due to the nature of the assumptions in the 'Dutch' model. The difference between P_{emax} and P_{max} arises from consideration of the water table level and the added confinement pressure due to its hydrostatic effect.

The most significant line on Figure 2 is the Annular Pressure which is the pressure in the borehole due to the drill fluid return flow. This pressure varies as the borehole progresses and is the sum of the static head and friction (flow) head. For most of the distance the annular pressure is well below P_{emax} and thus hydrofracture is not considered a concern. In the final stages of the bore profile the calculations show hydrofracture is likely as the profile begins to lose cover depth shortly before punch-out at CH1130. As with the River Taw crossing, this is unavoidable but the effects can be easily controlled / mitigated onshore by putting appropriate site measures in place such as sandbagging and/or casing, to reduce and contain any hydrofracture. All drill fluids used should also be self-flocculating, environmentally inert and CEFAS approved.

3.3 Landfall

In support of the cable route FEED study, WIE have developed an indicative profile for the cable landfall in order to demonstrate that an HDD methodology is feasible and to form the basis of preliminary hydrofracture calculations.

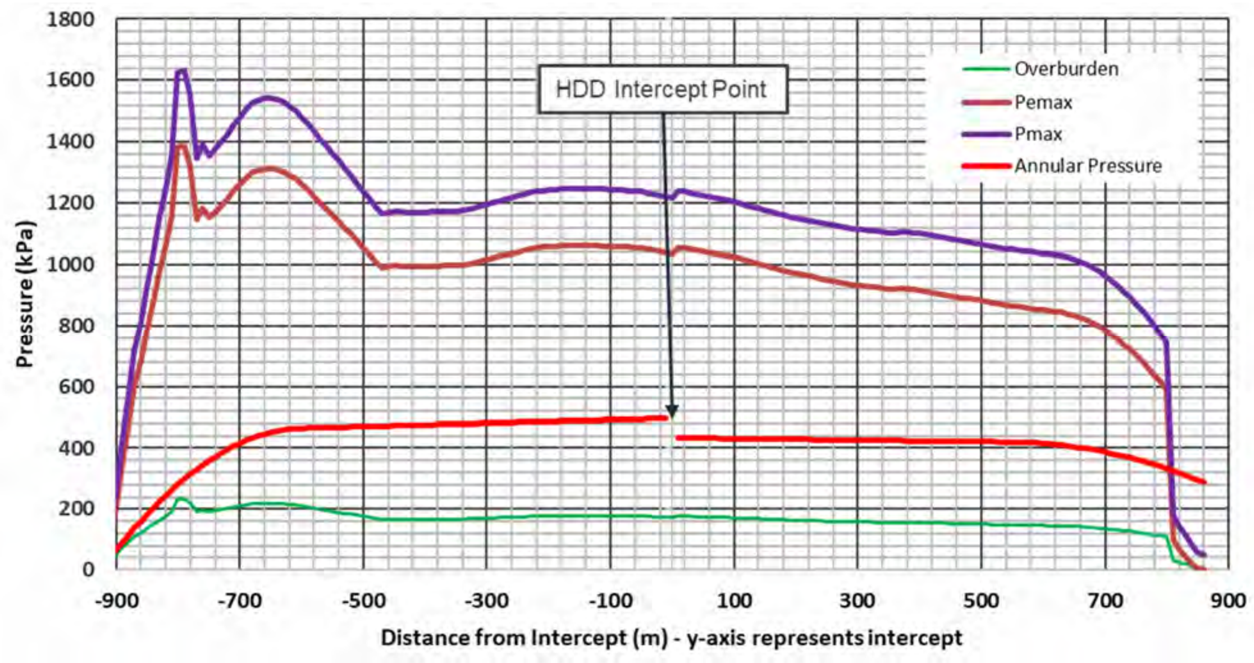
The preliminary profile design is presented on Drawing 12731-153-WIE-LF-XX-M3-C-91001 included in Appendix A. This indicative concept design has considered an entry point within the Saunton Sands beach car park extending out to a minimum water depth of -5m LAT, which is considered a likely minimum water depth for the follow-on cable installation works. This results in a bore length of circa 1860m.

Owing to the length of bore, and required ream size, at this stage it is considered likely that an intercept HDD methodology would be required with an onshore and offshore spread drilling pilot holes to 'intercept' at a point approximately mid-way along the bore. The bore would then be reamed by push-pull reaming from the onshore and offshore spreads. The offshore spread would require a Jack-Up Barge (JUB).

On this basis, considering a hydrofracture calculation requires consideration of the pressure head at both the onshore end, denoted by the entry hole level, and also the level of the jack-up barge sitting offshore. This would be determined by the HDD contractor at detailed design stage, thus, for the purpose of these calculations an arbitrary level of 8m AOD has been assumed based on a typical JUB deck height and allowing for wave clearance.

Calculations are presented in Appendix B.

Figure 3: Landfall - Hydrofracture and Annular Pressure Estimates



The variation in pressures along the borehole are shown in Figure 3, where it can be seen the permissible boreholes pressures P_{emax} and P_{max} initially vary due to cover depth changes within the sand dunes before trending gently downwards as per the seabed profile and subsequent cover depth.

Another feature to note on this graph is that the permissible pressures are significantly larger than the overburden pressure and this is due to the nature of the assumptions in the 'Dutch' model. The difference between P_{emax} and P_{max} arises from consideration of the water table level and the added confinement pressure due to its hydrostatic effect.

The most significant line on Figure 3 is the Annular Pressure which is the pressure in the borehole due to the drill fluid return flow. This pressure varies as the borehole progresses and is the sum of the static head and friction (flow) head. For most of the distance the annular pressure is well below P_{emax} and thus hydrofracture is not considered a concern. In the final stages of the bore profile the calculations show hydrofracture is likely as the profile begins to lose cover depth shortly before punch-out at CH1860. This is unavoidable, but would be mitigated through use of casing which will be required in any case to support the bore between the JUB deck and the seabed. All drill fluids used should also be self-flocculating, environmentally inert and CEFAS approved.

4. Conclusions & Recommendations

This preliminary hydrofracture assessment demonstrates that there is no significant risk of frac-out along the bore profiles with the exception of the final stages of the bore where the profile begins to rise resulting in loss of cover. This is unavoidable, but can be easily controlled onshore by site measures such as sandbagging and casing, in line with general HDD working methodologies. For the landfall, and assuming an intercept methodology, the risk will be controlled by the use of casing extending from the JUB deck down to the seabed (which is required regardless, to support the bore over this length).

These preliminary calculations should be updated as the design process develops and the variables become more known, such as bore diameters, ground conditions and groundwater levels. This will increase the accuracy of the assessment and inform any required design amendments, such as deepening of bore profiles, to mitigate risk should such be identified.

A. Design Drawings

GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
2. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO PREPARING ANY WORKING DRAWINGS OR COMMENCING ON SITE.
3. THE CONTRACTOR MUST ENSURE AND WILL BE HELD RESPONSIBLE FOR THE OVERALL STABILITY OF THE BUILDING/STRUCTURE/EXCAVATION AT ALL STAGES OF THE WORK.
4. ALL WORK BY THE CONTRACTOR MUST BE CARRIED OUT IN SUCH A WAY THAT ALL REQUIREMENTS UNDER THE HEALTH AND SAFETY AT WORK ACT ARE SATISFIED.
5. ALL WORK IS TO BE CARRIED OUT IN ACCORDANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

SITE COMPOUND LAYOUT KEY:
1. 50 KVA GENERATOR 2M X 2M
2. TOILET BLOCK 6M X 2M
3. DRY/CHANGE ROOM 6M X 2M
4. CANTEEN 6M X 2M
5. OFFICE 6M X 2M
6. OFFICE 6M X 2M
7. 21 TON TRACKED 360 EXCAVATOR
8. DRILL PIPE STORAGE 10M X 2M
9. HDD DRILL RIG 16M X 2M
10. POWER PACK 6M X 2M
11. CONTROL CABIN 6M X 2M
12. MUD LAB 3M X 2M
13. MUD ENTRY PIT 3M X 4M
14. HIGH PRESSURE MUD PUMP 6M X 2M
15. MUD MIXING TANK 7M X 2M
16. 350 KVA GENERATOR 5M X 2M
17. RECYCLING UNIT 6M X 2M
18. WATER STORAGE TANK 6M X 2M
19. DRY DRILLING FLUID STORAGE 4M X 10M
20. WORKSHOP 6M X 2M
21. STORES 6M X 2M

ILFRACOMBE TIDE GAUGE SITE	
TIDE LEVELS	ORDNANCE DATUM NEWLYN (mAOD)
HIGHEST ASTRONOMICAL TIDE	5.46
MEAN HIGH WATER SPRINGS	4.47
MEAN HIGH WATER NEAPS	2.19
MEAN LOW WATER NEAPS	-1.69
MEAN LOW WATER SPRINGS	-3.94
LOWEST ASTRONOMICAL TIDE	-4.89

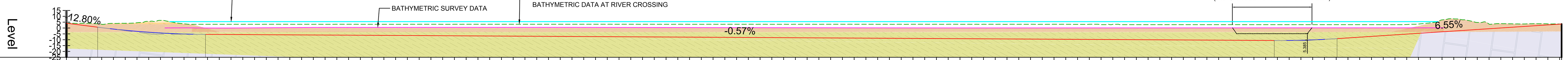
RIVER CROSSING - LONGSECTION
SCALE: H 1:2000,V 1:2000. DATUM: -25.000

HIGHEST ASTRONOMICAL TIDE
PLEASE NOTE LOWEST ASTRONOMICAL TIDE NOT INDICATED GIVEN LEVEL IS WELL BELOW BATHYMETRIC RIVER BED LEVEL THUS ASSUMED DRY AT LOW TIDE

BATHYMETRIC SURVEY DATA

LIDAR SURVEY WAS LIKELY PICKING UP WATER LEVEL AT THE TIME OF SURVEY THUS PREFERENCE GIVEN TO BATHYMETRIC DATA AT RIVER CROSSING

SUSPECTED DEEP CHANNEL NOT INDICATED ON BATHYMETRIC SURVEY (INDICATIVELY DRAWN AS 5m DEEP)



Chainage	Existing Levels	Level Difference
0.000	0.033	
10.000	0.081	1.202
20.000	0.123	2.508
30.000	0.165	2.960
40.000	0.186	4.834
50.000	0.163	5.969
60.000	0.141	7.331
70.000	0.119	9.231
80.000	0.097	10.751
90.000	0.108	9.764
100.000	0.139	8.697
110.000	0.094	8.496
120.000	0.025	8.594
130.000	0.000	8.661
140.000	0.013	8.721
150.000	0.082	8.782
160.000	0.150	8.849
170.000	0.219	8.912
180.000	0.288	8.984
190.000	0.356	9.018
200.000	0.425	9.068
210.000	0.493	9.139
220.000	0.507	9.191
230.000	0.511	9.261
240.000	0.516	9.328
250.000	0.521	9.367
260.000	0.525	9.419
270.000	0.530	9.459
280.000	0.535	9.528
290.000	0.539	9.595
300.000	0.544	9.671
310.000	0.549	9.739
320.000	0.553	9.762
330.000	0.558	9.832
340.000	0.563	9.890
350.000	0.567	9.980
360.000	0.572	10.020
370.000	0.577	10.081
380.000	0.581	10.151
390.000	0.586	10.202
400.000	0.590	10.244
410.000	0.595	10.328
420.000	0.598	10.374
430.000	0.579	10.443
440.000	0.560	10.511
450.000	0.541	10.551
460.000	0.521	10.615
470.000	0.502	10.650
480.000	0.483	10.715
490.000	0.464	10.765
500.000	0.445	10.823
510.000	0.426	10.867
520.000	0.406	10.946
530.000	0.387	10.955
540.000	0.368	11.034
550.000	0.349	11.099
560.000	0.330	11.193
570.000	0.318	11.212
580.000	0.305	11.296
590.000	0.292	11.323
600.000	0.279	11.381
610.000	0.266	11.444
620.000	0.253	11.519
630.000	0.240	11.560
640.000	0.227	11.629
650.000	0.215	11.688
660.000	0.202	11.758
670.000	0.189	11.805
680.000	0.177	11.866
690.000	0.167	11.889
700.000	0.156	11.948
710.000	0.149	12.037
720.000	0.138	12.088
730.000	0.134	12.152
740.000	0.123	12.190
750.000	0.102	12.271
760.000	0.086	12.299
770.000	0.088	12.354
780.000	0.090	12.425
790.000	0.093	12.488
800.000	0.095	12.497
810.000	0.097	12.550
820.000	0.100	12.689
830.000	0.102	12.673
840.000	0.104	12.781
850.000	0.107	12.840
860.000	0.109	12.815
870.000	0.111	12.940
880.000	0.114	12.690
890.000	0.116	13.015
900.000	0.118	12.807
910.000	0.121	12.862
920.000	0.123	12.920
930.000	0.125	12.977
940.000	0.128	13.035
950.000	0.130	13.092
960.000	0.132	13.150
970.000	0.135	13.207
980.000	0.137	13.264
990.000	0.139	13.322
1000.000	0.141	13.380
1010.000	0.144	13.437
1020.000	0.146	13.494
1030.000	0.148	13.547
1040.000	0.151	13.502
1050.000	0.153	13.323
1060.000	0.155	13.012
1070.000	0.158	12.567
1080.000	0.160	11.988
1090.000	0.162	11.334
1100.000	0.165	10.680
1110.000	0.167	10.025
1120.000	0.169	9.371
1130.000	0.172	8.716
1140.000	0.174	8.176
1150.000	0.176	7.906
1160.000	0.179	8.286
1170.000	0.181	10.151
1180.000	0.183	10.371
1190.000	0.186	8.801
1200.000	0.188	5.996
1210.000	0.190	3.972
1220.000	0.193	3.677
1230.000	0.195	2.811
1240.000	0.197	2.091
1250.000	0.199	1.680
1260.000	0.202	0.844
1270.000	0.204	
1271.719	0.205	0.000

Horizontal Geometry: L =1271.719

Vertical Geometry:
G =-12.799% L =26.583
R =750.000 K =7.500 L =91.681
G =-0.574% L =909.051
R =750.000 K =7.500 L =53.399
G =6.545% L =190.892

GEOLOGY KEY
BLOWN SANDS (SAND DUNES)
DRIFT DEPOSITS
ESTUARINE DEPOSITS
ROCK

Rev	Date	Description	By	Chk
P03	11.08.23	SITE COMPOUND LAYOUTS REMOVED. RE-ISSUED FOR INFORMATION AS PART OF PLANNING SUBMISSION	LP	CG
P02	10.03.23	TITLE UPDATED & DRAFT BANNER REMOVED	LP	CG
P01	23.05.22	DRAFT ISSUE FOR INFORMATION ONLY	LP	CG

Amendments

Project: WHITE CROSS FLOATING WINDFARM

Title: RIVER TAW OUTLINE HDD PLAN AND PROFILE

Client: FLOTATION ENERGY LTD

waterman
STOCKTON

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
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Suitability: FOR PLANNING SUBMISSION

Designed By: LP	Director: CG	Waterman Ref: WIE12731-135
Drawn By: LP	Date: 20.05.22	Scales @ A0: AS NOTED
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number | Revision
12731-135-WIE-ZZ-XX-M3-C-91003 | P03
110-099-DRG-022 | A01
FLO-WHI-LAY-0019 | A1

1:2000 0 20m 40m 60m 80m 100m 120m 140m 160m 180m 200m
1:1 0 10 20 30 40 50 60 70 80 90 100

This drawing should not be scaled. Dimensions to be verified on site.
Any discrepancies should be referred to the Engineer prior to work being put in hand.

Pickfords Wharf, Clink Street, London SE1 9DG t 020 7928 7888 f 03333 444 501

GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
2. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO PREPARING ANY WORKING DRAWINGS OR COMMENCING ON SITE.
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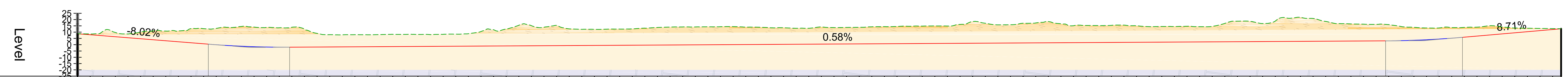
5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

SITE COMPOUND LAYOUT KEY:
1. 50 KVA GENERATOR 2M X 2M
2. TOILET BLOCK 6M X 2M
3. DRY/CHANGE ROOM 6M X 2M
4. CANTEEN 6M X 2M
5. OFFICE 6M X 2M
6. OFFICE 6M X 2M
7. 21 TON TRACKED 360 EXCAVATOR
8. DRILL PIPE STORAGE 10M X 2M
9. HDD DRILL RIG 16M X 2M
10. POWER PACK 6M X 2M
11. CONTROL CABIN 6M X 2M
12. MUD LAB 3M X 2M
13. MUD ENTRY PIT 3M X 4M
14. HIGH PRESSURE MUD PUMP 6M X 2M
15. MUD MIXING TANK 7M X 2M
16. 350 KVA GENERATOR 5M X 2M
17. RECYCLING UNIT 6M X 2M
18. WATER STORAGE TANK 6M X 2M
19. DRY DRILLING FLUID STORAGE 4M X 10M
20. WORKSHOP 6M X 2M
21. STORES 6M X 2M

GOLF COURSE CROSSING - LONGSECTION
SCALE: H 1:2000,V 1:2000. DATUM: -25.000

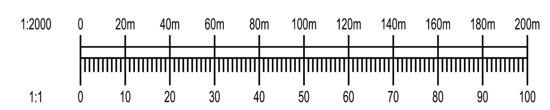


Chainage	Existing Levels	Level Difference
0.000	8.743	-0.014
10.000	8.569	0.614
20.000	10.513	3.360
30.000	9.745	3.394
40.000	8.543	2.994
50.000	10.018	5.271
60.000	11.081	7.136
70.000	10.848	7.706
80.000	10.998	8.657
90.000	12.770	11.233
100.000	12.756	12.020
110.000	12.944	12.984
120.000	13.763	14.455
130.000	14.512	15.723
140.000	14.023	15.619
150.000	13.739	15.587
160.000	13.453	15.421
170.000	13.887	15.842
180.000	12.436	14.333
190.000	8.995	10.835
200.000	7.997	9.779
210.000	7.882	9.606
220.000	7.975	9.641
230.000	7.907	9.516
240.000	8.065	9.616
250.000	8.261	9.755
260.000	8.198	9.633
270.000	8.138	9.516
280.000	8.022	9.343
290.000	8.258	9.520
300.000	8.405	9.610
310.000	8.761	9.909
320.000	10.486	11.576
330.000	11.898	12.931
340.000	12.385	13.359
350.000	15.458	16.375
360.000	15.163	16.022
370.000	13.924	14.725
380.000	15.365	16.108
390.000	12.590	13.276
400.000	12.258	12.886
410.000	12.220	12.790
420.000	12.362	12.875
430.000	12.430	12.886
440.000	12.577	12.975
450.000	13.165	13.505
460.000	13.695	13.977
470.000	14.033	14.258
480.000	14.138	14.305
490.000	14.137	14.246
500.000	14.269	14.320
510.000	14.310	14.304
520.000	14.392	14.329
530.000	13.997	13.876
540.000	13.935	13.756
550.000	13.460	13.223
560.000	13.519	13.225
570.000	13.047	12.695
580.000	13.073	12.663
590.000	14.098	13.631
600.000	13.629	13.104
610.000	13.735	13.152
620.000	13.853	13.212
630.000	14.248	13.550
640.000	14.366	13.610
650.000	14.493	13.680
660.000	14.647	13.776
670.000	14.796	13.867
680.000	14.929	13.943
690.000	14.877	13.833
700.000	16.152	15.050
710.000	18.458	17.299
720.000	17.079	15.862
730.000	15.813	14.538
740.000	15.873	14.540
750.000	17.068	15.678
760.000	17.302	15.854
770.000	18.433	16.928
780.000	16.645	15.082
790.000	15.133	13.512
800.000	15.299	13.621
810.000	15.206	13.469
820.000	15.406	13.612
830.000	15.583	13.731
840.000	15.103	13.194
850.000	14.361	12.394
860.000	14.491	12.467
870.000	14.441	12.359
880.000	14.672	12.532
890.000	14.318	12.121
900.000	14.550	12.295
910.000	16.951	14.638
920.000	18.731	16.361
930.000	18.609	16.181
940.000	16.851	14.365
950.000	18.812	16.269
960.000	21.090	18.489
970.000	21.760	19.101
980.000	20.882	18.166
990.000	18.539	15.765
1000.000	16.761	13.930
1010.000	16.551	13.662
1020.000	16.336	13.389
1030.000	16.163	13.158
1040.000	15.989	12.923
1050.000	14.429	11.205
1060.000	13.817	10.303
1070.000	13.331	9.393
1080.000	13.353	8.857
1090.000	13.624	8.437
1100.000	13.759	7.750
1110.000	13.961	7.081
1120.000	15.095	7.344
1130.000	14.112	5.491
1140.000	13.297	3.805
1150.000	13.097	2.735
1160.000	12.951	1.718
1170.000	12.796	0.692
1176.745	12.740	0.049

Horizontal Geometry	
	L =1176.745

Vertical Geometry				
G =-8.022% L =103.742	R =750.000 K =7.500 L =64.488	G =0.577% L =869.295	R =750.000 K =7.500 L =60.976	G =8.707% L =78.827

GEOLOGY KEY
BLOWN SANDS (SAND DUNES)
DRIFT DEPOSITS
ROCK



Rev	Date	Description	By	Chk
P03	11.08.23	SITE COMPOUND LAYOUTS REMOVED. RE-ISSUED FOR INFORMATION AS PART OF PLANNING SUBMISSION	LP	CG
P02	10.03.23	TITLE UPDATED AND DRAFT BANNER REMOVED	LP	CG
P01	20.05.22	DRAFT ISSUE FOR INFORMATION ONLY	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
SAUNTON GOLF CLUB OUTLINE HDD PLAN AND PROFILE

Client
FLOTATION ENERGY LTD

waterman
STOCKTON
Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
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Suitability
FOR PLANNING SUBMISSION

Designed By LP	Director CG	Waterman Ref WIE12731-135
Drawn By LP	Date 20.05.22	Scales @ A0 AS NOTED
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-135-WIE-ZZ-XX-M3-C-91006	P03
110-099-DRG-021	A01
FLO-WHI-LAY-0018	A1

File Path
N:\Projects\WIE12731_Stockton_HDD\135 - White Cross Floating Windfarm\1006_Design\C3D\ALIGNMENTS & PROFILE\

ONSHORE

OFFSHORE

CHAINAGE (m)	ONSHORE EXISTING LEVELS (m AOD)	OFFSHORE EXISTING LEVELS (m AOD)	BORE PROFILE LEVEL (m AOD) (TOP OF PIPE)
0+000	12.966		12.966
0+010	13.080		11.208
0+020	13.181		9.450
0+030	13.580		7.692
0+040	14.118		5.935
0+050	14.147		4.177
0+060	13.984		2.419
0+070	13.739		0.661
0+080	13.452		-1.061
0+090	13.362		-2.717
0+100	13.277		-4.306
0+110	13.223		-5.829
0+120	13.372		-7.284
0+130	16.245		-8.674
0+140	15.014		-9.996
0+150	12.462		-11.252
0+160	8.021		-12.441
0+170	7.558		-13.563
0+180	5.960		-14.619
0+190	5.286		-15.608
0+200	4.717		-16.531
0+210	4.298		-17.387
0+220	3.972		-18.176
0+230	3.662		-18.898
0+240	3.393		-19.554
0+250	3.174		-20.143
0+260			-20.666
0+270			-21.122
0+280			-21.511
0+290			-21.833
0+300			-22.089
0+310			-22.278
0+320			-22.401
0+330			-22.456
0+340			-22.468
0+350			-22.480
0+360			-22.491
0+370			-22.502
0+380			-22.513
0+390			-22.524
0+400			-22.535
0+410			-22.546
0+420			-22.557
0+430			-22.568
0+440			-22.579
0+450			-22.590
0+460		-4.792	-22.601
0+470		-4.746	-22.612
0+480		-4.718	-22.624
0+490		-4.739	-22.635
0+500		-4.760	-22.646
0+510		-4.780	-22.657
0+520		-4.800	-22.668
0+530		-4.800	-22.679
0+540		-4.800	-22.690
0+550		-4.800	-22.701
0+560		-4.800	-22.712
0+570		-4.800	-22.723
0+580		-4.800	-22.734
0+590		-4.800	-22.745
0+600		-4.749	-22.756
0+610		-4.681	-22.768
0+620		-4.612	-22.779
0+630		-4.544	-22.790
0+640		-4.476	-22.801
0+650		-4.407	-22.812
0+660		-4.339	-22.823
0+670		-4.270	-22.834
0+680		-4.202	-22.845
0+690		-4.134	-22.856
0+700		-4.065	-22.867
0+710		-4.003	-22.878
0+720		-3.992	-22.889
0+730		-3.981	-22.900
0+740		-3.970	-22.912
0+750		-3.959	-22.923
0+760		-3.949	-22.934
0+770		-3.940	-22.945
0+780		-3.957	-22.956
0+790		-3.973	-22.967
0+800		-3.989	-22.978
0+810		-4.011	-22.989
0+820		-4.041	-23.000
0+830		-4.070	-23.011
0+840		-4.100	-23.022
0+850		-4.124	-23.033
0+860		-4.146	-23.044
0+870		-4.167	-23.056
0+880		-4.215	-23.067
0+890		-4.287	-23.078
0+900		-4.359	-23.089
0+910		-4.431	-23.100
0+920		-4.503	-23.111
0+930		-4.575	-23.122
0+940		-4.627	-23.133
0+950		-4.707	-23.144
0+960		-4.790	-23.155
0+970		-4.888	-23.166
0+980		-4.989	-23.177
0+990		-5.089	-23.188
1+000		-5.189	-23.200
1+010		-5.290	-23.211
1+020		-5.390	-23.222
1+030		-5.490	-23.233
1+040		-5.591	-23.244
1+050		-5.691	-23.255
1+060		-5.778	-23.266
1+070		-5.851	-23.277
1+080		-5.927	-23.288
1+090		-6.003	-23.299
1+100		-6.079	-23.310
1+110		-6.155	-23.321
1+120		-6.231	-23.332
1+130		-6.303	-23.344
1+140		-6.367	-23.355
1+150		-6.450	-23.366
1+160		-6.501	-23.377
[illegible]	[illegible]	[illegible]	[illegible]

BORE VERTICAL GEOMETRY

G =-17.577% L =69.709m	R =1500.000m K =15.000 L =262.001m	G =-0.111% L =1148.071m	R =5000.000m K =50.000 L =357.981m	G =7.049% L =30.231m

GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
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5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

Rev	Date	Description	By	Chk
P02	11.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	28.07.23	ISSUED AS DRAFT FOR INFORMATION	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
CABLE LANDFALL OUTLINE HDD PLAN AND PROFILE

Client
FLOTATION ENERGY LTD

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Suitability
FOR PLANNING SUBMISSION

Designed By LP	Director CG	Waterman Ref WIE12731-153
Drawn By LP	Date JULY 23	Scales @ A0 1:1250
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-LF-XX-M3-C-91001	P02
110-099-DRG-020	A01
FLO-WHI-LAY-0017	A1

File Path N:\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\91\

A0-Wat-SDL-S

B. Hydrofracture Calculations

Hydrofracture - Longitudinal Profile Check

[redacted]

$$Pmax = Pemax + U$$ ***Eqn(1)***

$$Pemax = (Pf + c.cot\varnothing).\left\{\left(\frac{Ro}{Rpmax}\right)^2 + Q\right\}^{\frac{-sin\varnothing}{1+sin\varnothing}} - c.cot\varnothing$$ ***Eqn(2)***

$$Q = \frac{(\sigma o.sin\varnothing + c.cos\varnothing)}{G}$$ ***Eqn(3)***

$$Pf = \sigma o\,(1 + sin\varnothing) + c.cos\varnothing$$ ***Eqn(4)***

$$G = \frac{E}{2}\,(1 + \vartheta)$$ ***Eqn(5)***

Where:

Pmax	maximum allowable mud pressure
U	initial in-situ pore pressure
Pemax	maximum allowable effective mud pressure
σ_o	initial effective stress
ϕ	internal angle of friction
c	cohesion
Ro	internal radius of borehole
Rpmax	maximum allowable radius of plastic zone
G	shear modulus
E	elasticity modulus
N	Poisson's ratio

[redacted]

General variables

Gravity (m/s/s):	**g**	9.81		
Density of water (kg/m3):	**ɣw**	1000		
Density of drilling mud (kg/m3):	**ɣm**	1300		
Soil density (kg/m^3):	**ɣs**	1950		*Soil characteristic values are all assumed and should be confirmed by Intrusive Ground Investigation.*
Cohesion (kN/m^2):	**Coh**	2		
Friction angle (deg):	**Φ**	25	Radians Φr = 0.4363	
Poission's ratio :	**v**	0.3		
Elasticity modulus (kPa):	**Emod**	40000		
Shear modulus (kPa):	Gmod =	15385		

Product pipe OD (m):					
Drill bit diameter (inch):	24.00 inch	**Do**	0.610 m		*Diameters assumed at feasibility stage.*
Drill pipe OD (inch):	12.00 inch	**Di**	0.305 m		

Initial radius of borehole (m):	**Ro**	0.305	*Equal half drill bit diameter*	*Rpmax usually assumed between 1/2 and 2/3 depth, assumed 1/2 as worst case scenario*
Allowable plastic radius factor	**Rpmax**	0.50		

Consider lateral soil pressure: **No** ***Use drop-down to select Y/N***

Passive coefficient **ko** = IF(Y_N = "Yes", 1 - SIN(Φr), 0)
= IF(= "Yes", 1 - SIN(0.43633), 0)
= **0**

Conservative to not consider lateral soil pressures

Annular pressure calculations

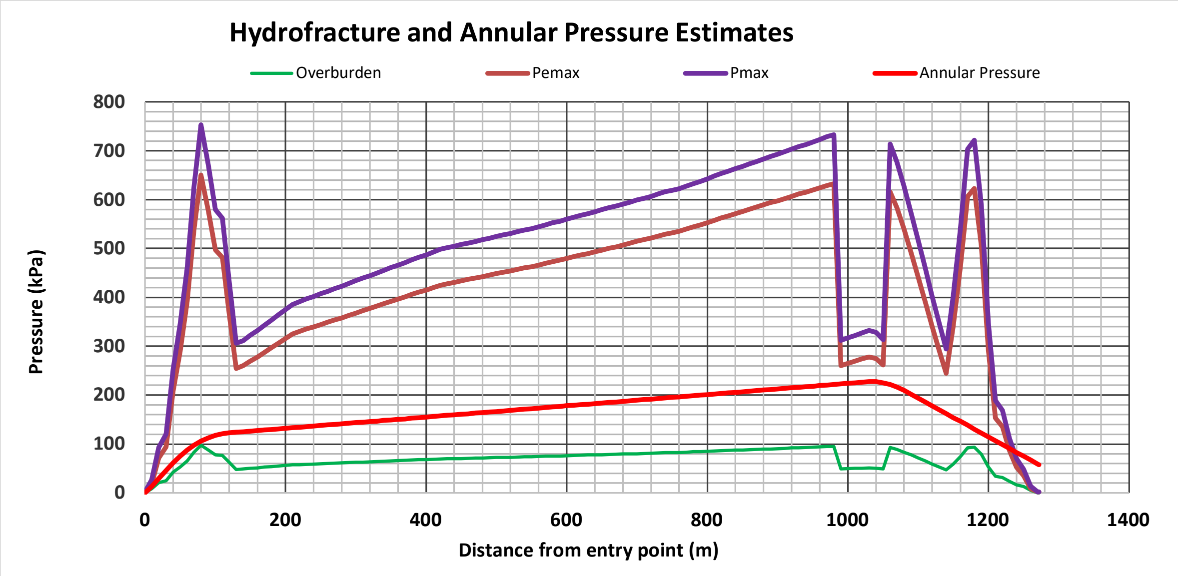
Darcy Weisbach equation for flow in an annulus is: H = f(L/Dh)(V^2/2g), where Dh is the hydraulic diameter, V the flow velocity, L flow pipe length and f is a friction factor. In the case of co-centered circular pipes Dh = Do - Di. The exact drilling operational parameters, such as flow rate are unknown, but some estimated values have been applied - but require verification. The total head is the flow head plus the static head.

Assumed flow velocity (m/s):	V	0.50
Assumed friction coefficient:	f	1.00

The calculations at each chainage location are performed in the frac-out table

Summary Figures

Elevation of entrance hole mOD =	**4.11 mOD**		
Elevation of exit hole mOD =	**3.44 mOD**	***Diff =***	***0.67*** m
Maximum cover to HDD borehole =	**10.4 m**		
Maximum overburden pressure =	**97.3 kN/m^2**		***1.0 Bar***
Maximum safe effective stress **Pemax** =	**650 kN/m^2**		***6.5 Bar***
Maximum safe stress **Pmax** =	**753 kN/m^3**		***7.5 Bar***



Expressions used in hydrofracture calculations

In the tabulation below the following functions are applied

Saturated Layer **Sat'd**: IF (WTL<=HDD, Elevn-HDD, Max(Elevn-WTL, 0))

Bouyant Layer **Bou't**: IF (WTL<=HDD, 0, Min(WTL-HDD, Elevn-HDD))

σv = (ɣs*Satd+(ɣs-ɣw)*Bout)*g/1000

σo = SQRT((ɣs*Satd+(ɣs-ɣw)*Bout)^2 + (ko * (ɣs*Satd + (ɣs-ɣw)*Bout))^2))

Q = (σo*SIN(Φr) + Coh*COS(Φr)) / Gmod

Pf = (σo * (1+SIN(Φr))) + (Coh * COS(Φr))

Pemax = (Pf + Coh*COT(Φr)) * (((Ro/Rpmax)^2 + Q)^(-SIN(Φr)/(1+SIN(Φr)))) - Coh*COT(Φr)

Pelim = (Pf + Coh*COT(Φr)) * (Q^(-SIN(Φr)/(1+SIN(Φr)))) - Coh*COT(Φr)

LAT

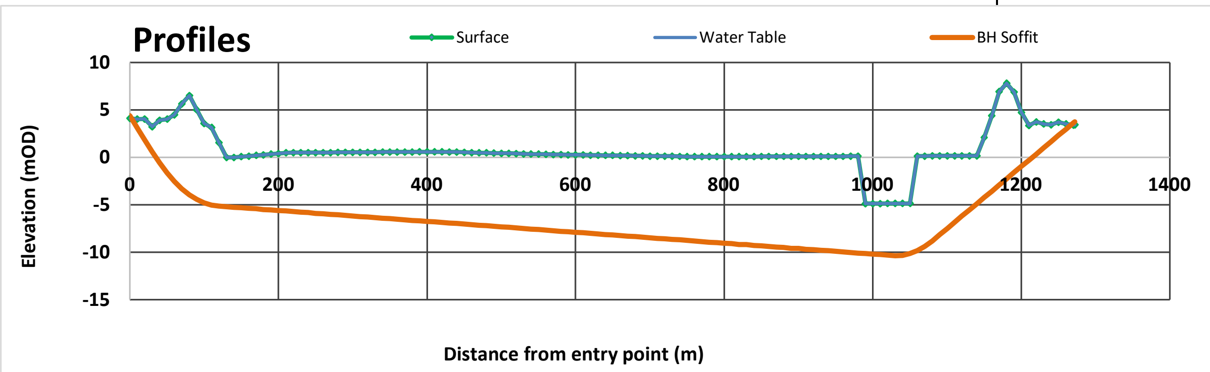
WT controls: 0 -4.89

Dist (m)	Elev'n (mOD)	Loc'n	WTL (mOD)	C-Line (mOD)	Soffit (mOD)	Cover (m)	Sat'd (m)	Bou't (m)	U kN/m2	Hs kN/m3
0.00	4.11		4.11	4.11	4.41	0.00	0.00	0.00	0	0
10.00	4.03		4.03	2.83	3.13	0.90	0.00	0.90	9	12
20.00	4.06		4.06	1.55	1.85	2.21	0.00	2.21	22	29
30.00	3.24		3.24	0.28	0.58	2.66	0.00	2.66	26	45
40.00	3.94		3.94	-0.89	-0.59	4.53	0.00	4.53	44	60
50.00	4.04		4.04	-1.93	-1.63	5.67	0.00	5.67	56	73
60.00	4.50		4.50	-2.83	-2.53	7.03	0.00	7.03	69	85
70.00	5.64		5.64	-3.59	-3.29	8.93	0.00	8.93	88	94
80.00	6.52		6.52	-4.23	-3.93	10.45	0.00	10.45	102	102
90.00	5.03		5.03	-4.73	-4.43	9.46	0.00	9.46	93	109
100.00	3.60		3.60	-5.10	-4.80	8.39	0.00	8.39	82	114
110.00	3.16		3.16	-5.33	-5.03	8.19	0.00	8.19	80	117
120.00	1.58		1.58	-5.43	-5.13	6.71	0.00	6.71	66	118
130.00	0.00		0.00	-5.49	-5.19	5.19	0.00	5.19	51	119
140.00	0.01		0.01	-5.55	-5.25	5.26	0.00	5.26	52	119
150.00	0.08		0.08	-5.61	-5.31	5.39	0.00	5.39	53	120
160.00	0.15		0.15	-5.66	-5.36	5.51	0.00	5.51	54	121
170.00	0.22		0.22	-5.72	-5.42	5.63	0.00	5.63	55	121
180.00	0.29		0.29	-5.78	-5.48	5.76	0.00	5.76	57	122
190.00	0.36		0.36	-5.84	-5.54	5.89	0.00	5.89	58	123
200.00	0.43		0.43	-5.89	-5.59	6.01	0.00	6.01	59	124
210.00	0.49		0.49	-5.95	-5.65	6.14	0.00	6.14	60	124
220.00	0.51		0.51	-6.01	-5.71	6.21	0.00	6.21	61	125
230.00	0.51		0.51	-6.07	-5.77	6.28	0.00	6.28	62	126
240.00	0.52		0.52	-6.12	-5.82	6.33	0.00	6.33	62	127
250.00	0.52		0.52	-6.18	-5.88	6.40	0.00	6.40	63	127
260.00	0.53		0.53	-6.24	-5.94	6.46	0.00	6.46	63	128
270.00	0.53		0.53	-6.30	-6.00	6.53	0.00	6.53	64	129
280.00	0.54		0.54	-6.35	-6.05	6.58	0.00	6.58	65	130
290.00	0.54		0.54	-6.41	-6.11	6.64	0.00	6.64	65	130
300.00	0.54		0.54	-6.47	-6.17	6.71	0.00	6.71	66	131
310.00	0.55		0.55	-6.53	-6.23	6.77	0.00	6.77	66	132
320.00	0.55		0.55	-6.58	-6.28	6.83	0.00	6.83	67	132
330.00	0.56		0.56	-6.64	-6.34	6.89	0.00	6.89	68	133
340.00	0.56		0.56	-6.70	-6.40	6.96	0.00	6.96	68	134
350.00	0.57		0.57	-6.76	-6.46	7.02	0.00	7.02	69	135
360.00	0.57		0.57	-6.81	-6.51	7.08	0.00	7.08	69	135
370.00	0.58		0.58	-6.87	-6.57	7.14	0.00	7.14	70	136
380.00	0.58		0.58	-6.93	-6.63	7.21	0.00	7.21	71	137
390.00	0.59		0.59	-6.99	-6.69	7.27	0.00	7.27	71	138
400.00	0.59		0.59	-7.04	-6.74	7.33	0.00	7.33	72	138
410.00	0.60		0.60	-7.10	-6.80	7.39	0.00	7.39	72	139
420.00	0.60		0.60	-7.16	-6.86	7.45	0.00	7.45	73	140
430.00	0.58		0.58	-7.22	-6.92	7.49	0.00	7.49	74	141
440.00	0.56		0.56	-7.27	-6.97	7.53	0.00	7.53	74	141
450.00	0.54		0.54	-7.33	-7.03	7.57	0.00	7.57	74	142
460.00	0.52		0.52	-7.39	-7.09	7.61	0.00	7.61	75	143
470.00	0.50		0.50	-7.44	-7.14	7.64	0.00	7.64	75	143
480.00	0.48		0.48	-7.50	-7.20	7.68	0.00	7.68	75	144
490.00	0.46		0.46	-7.56	-7.26	7.72	0.00	7.72	76	145
500.00	0.45		0.45	-7.62	-7.32	7.76	0.00	7.76	76	146
510.00	0.43		0.43	-7.67	-7.37	7.79	0.00	7.79	76	146
520.00	0.41		0.41	-7.73	-7.43	7.83	0.00	7.83	77	147

530.00	0.39	0.39	-7.79	-7.49	7.87	0.00	7.87	77	148
540.00	0.37	0.37	-7.85	-7.55	7.91	0.00	7.91	78	149
550.00	0.35	0.35	-7.90	-7.60	7.94	0.00	7.94	78	149
560.00	0.33	0.33	-7.96	-7.66	7.99	0.00	7.99	78	150
570.00	0.32	0.32	-8.02	-7.72	8.03	0.00	8.03	79	151
580.00	0.31	0.31	-8.08	-7.78	8.08	0.00	8.08	79	152
590.00	0.29	0.29	-8.13	-7.83	8.12	0.00	8.12	80	152
600.00	0.28	0.28	-8.19	-7.89	8.16	0.00	8.16	80	153
610.00	0.27	0.27	-8.25	-7.95	8.21	0.00	8.21	81	154
620.00	0.25	0.25	-8.31	-8.01	8.26	0.00	8.26	81	155
630.00	0.24	0.24	-8.36	-8.06	8.30	0.00	8.30	81	155
640.00	0.23	0.23	-8.42	-8.12	8.34	0.00	8.34	82	156
650.00	0.22	0.22	-8.48	-8.18	8.39	0.00	8.39	82	157
660.00	0.20	0.20	-8.54	-8.24	8.44	0.00	8.44	83	157
670.00	0.19	0.19	-8.59	-8.29	8.47	0.00	8.47	83	158
680.00	0.18	0.18	-8.65	-8.35	8.52	0.00	8.52	84	159
690.00	0.17	0.17	-8.71	-8.41	8.57	0.00	8.57	84	160
700.00	0.16	0.16	-8.77	-8.47	8.62	0.00	8.62	85	160
710.00	0.15	0.15	-8.82	-8.52	8.66	0.00	8.66	85	161
720.00	0.14	0.14	-8.88	-8.58	8.71	0.00	8.71	85	162
730.00	0.13	0.13	-8.94	-8.64	8.77	0.00	8.77	86	163
740.00	0.12	0.12	-9.00	-8.70	8.82	0.00	8.82	87	163
750.00	0.10	0.10	-9.05	-8.75	8.85	0.00	8.85	87	164
760.00	0.09	0.09	-9.11	-8.81	8.89	0.00	8.89	87	165
770.00	0.09	0.09	-9.17	-8.87	8.95	0.00	8.95	88	165
780.00	0.09	0.09	-9.23	-8.93	9.02	0.00	9.02	88	166
790.00	0.09	0.09	-9.28	-8.98	9.07	0.00	9.07	89	167
800.00	0.10	0.10	-9.34	-9.04	9.13	0.00	9.13	90	168
810.00	0.10	0.10	-9.40	-9.10	9.19	0.00	9.19	90	168
820.00	0.10	0.10	-9.46	-9.16	9.26	0.00	9.26	91	169
830.00	0.10	0.10	-9.51	-9.21	9.31	0.00	9.31	91	170
840.00	0.10	0.10	-9.57	-9.27	9.37	0.00	9.37	92	171
850.00	0.11	0.11	-9.63	-9.33	9.43	0.00	9.43	93	171
860.00	0.11	0.11	-9.69	-9.39	9.49	0.00	9.49	93	172
870.00	0.11	0.11	-9.74	-9.44	9.55	0.00	9.55	94	173
880.00	0.11	0.11	-9.80	-9.50	9.61	0.00	9.61	94	174
890.00	0.12	0.12	-9.86	-9.56	9.67	0.00	9.67	95	174
900.00	0.12	0.12	-9.91	-9.61	9.72	0.00	9.72	95	175
910.00	0.12	0.12	-9.97	-9.67	9.79	0.00	9.79	96	176
920.00	0.12	0.12	-10.03	-9.73	9.85	0.00	9.85	97	176
930.00	0.13	0.13	-10.09	-9.79	9.91	0.00	9.91	97	177
940.00	0.13	0.13	-10.14	-9.84	9.96	0.00	9.96	98	178
950.00	0.13	0.13	-10.20	-9.90	10.03	0.00	10.03	98	179
960.00	0.13	0.13	-10.26	-9.96	10.09	0.00	10.09	99	179
970.00	0.14	0.14	-10.32	-10.02	10.15	0.00	10.15	100	180
980.00	0.14	0.14	-10.37	-10.07	10.20	0.00	10.20	100	181
990.00	-4.86	-4.86	-10.43	-10.13	5.27	0.00	5.27	52	182
1000.00	-4.86	-4.86	-10.49	-10.19	5.33	0.00	5.33	52	182
1010.00	-4.86	-4.86	-10.55	-10.25	5.39	0.00	5.39	53	183
1020.00	-4.85	-4.85	-10.60	-10.30	5.45	0.00	5.45	53	184
1030.00	-4.85	-4.85	-10.66	-10.36	5.51	0.00	5.51	54	184
1040.00	-4.85	-4.85	-10.61	-10.31	5.46	0.00	5.46	54	184
1050.00	-4.85	-4.85	-10.43	-10.13	5.28	0.00	5.28	52	182
1060.00	0.16	0.16	-10.12	-9.82	9.97	0.00	9.97	98	178
1070.00	0.16	0.16	-9.68	-9.38	9.53	0.00	9.53	94	172
1080.00	0.16	0.16	-9.10	-8.80	8.96	0.00	8.96	88	165
1090.00	0.16	0.16	-8.44	-8.14	8.30	0.00	8.30	81	156
1100.00	0.17	0.17	-7.79	-7.49	7.65	0.00	7.65	75	148
1110.00	0.17	0.17	-7.14	-6.84	7.00	0.00	7.00	69	140
1120.00	0.17	0.17	-6.48	-6.18	6.34	0.00	6.34	62	131
1130.00	0.17	0.17	-5.83	-5.53	5.70	0.00	5.70	56	123
1140.00	0.17	0.17	-5.17	-4.87	5.04	0.00	5.04	49	114
1150.00	2.13	2.13	-4.52	-4.22	6.35	0.00	6.35	62	106
1160.00	4.42	4.42	-3.86	-3.56	7.98	0.00	7.98	78	98
1170.00	6.94	6.94	-3.21	-2.91	9.85	0.00	9.85	97	89
1180.00	7.82	7.82	-2.55	-2.25	10.06	0.00	10.06	99	81
1190.00	6.90	6.90	-1.90	-1.60	8.50	0.00	8.50	83	73

1200.00	4.75	4.75	-1.24	-0.94	5.69	0.00	5.69	***56***	***64***		
1210.00	3.38	3.38	-0.59	-0.29	3.67	0.00	3.67	***36***	***56***		
1220.00	3.74	3.74	0.06	0.36	3.38	0.00	3.38	***33***	***48***		
1230.00	3.53	3.53	0.72	1.02	2.51	0.00	2.51	***25***	***39***		
1240.00	3.47	3.47	1.37	1.67	1.79	0.00	1.79	***18***	***31***		
1250.00	3.71	3.71	2.03	2.33	1.37	0.00	1.37	***13***	***23***		
1260.00	3.53	3.53	2.68	2.98	0.54	0.00	0.54	***5***	***14***		
1270.00	3.43	3.43	3.34	3.64	0.00	0.00	0.00	***0***	***6***		
1272.00	3.44	3.44	3.44	3.74	0.00	0.00	0.00	***0***	***5***		

HDD borehole profile graph based on the above table



Dist (m)	σv (kN/m^2)	σh (kN/m^2)	σo (kN/m^2)	Pf (kN/m^2)	Q	Rpmax (m)	Pemax (kN/m^2)	Pmax (kN/m^2)	Hf (kN/m^2)	H (kN/m^2)
0.0	0.0	0.0	0.0	1.8	0.00012	0.3	2	2	*0*	*0*
10.0	8.3	0.0	8.3	13.7	0.00035	0.4	18	27	*0*	*13*
20.0	20.6	0.0	20.6	31.0	0.00068	1.1	71	93	*1*	*30*
30.0	24.7	0.0	24.7	37.0	0.00080	1.3	94	120	*1*	*46*
40.0	42.2	0.0	42.2	61.8	0.00128	2.3	209	253	*2*	*62*
50.0	52.8	0.0	52.8	77.0	0.00157	2.8	290	346	*2*	*75*
60.0	65.5	0.0	65.5	95.0	0.00192	3.5	392	461	*3*	*87*
70.0	83.2	0.0	83.2	120.1	0.00240	4.5	538	625	*3*	*97*
80.0	97.3	0.0	97.3	140.3	0.00279	5.2	650	753	*3*	*106*
90.0	88.1	0.0	88.1	127.2	0.00254	4.7	577	670	*4*	*113*
100.0	78.2	0.0	78.2	113.1	0.00227	4.2	497	579	*4*	*118*
110.0	76.3	0.0	76.3	110.4	0.00221	4.1	481	562	*5*	*121*
120.0	62.5	0.0	62.5	90.7	0.00183	3.4	368	434	*5*	*123*
130.0	48.3	0.0	48.3	70.6	0.00145	2.6	255	306	*5*	*124*
140.0	49.0	0.0	49.0	71.5	0.00146	2.6	260	312	*6*	*125*
150.0	50.2	0.0	50.2	73.2	0.00150	2.7	270	322	*6*	*126*
160.0	51.3	0.0	51.3	74.8	0.00153	2.8	278	332	*7*	*127*
170.0	52.5	0.0	52.5	76.5	0.00156	2.8	288	343	*7*	*129*
180.0	53.7	0.0	53.7	78.2	0.00159	2.9	297	354	*8*	*130*
190.0	54.9	0.0	54.9	79.9	0.00163	2.9	306	364	*8*	*131*
210.0	57.2	0.0	57.2	83.2	0.00169	3.1	325	385	*9*	*133*
220.0	57.9	0.0	57.9	84.2	0.00171	3.1	330	391	*9*	*134*
230.0	58.5	0.0	58.5	85.0	0.00172	3.1	335	397	*10*	*136*
240.0	59.0	0.0	59.0	85.8	0.00174	3.2	339	402	*10*	*137*
250.0	59.6	0.0	59.6	86.6	0.00176	3.2	344	407	*10*	*138*
260.0	60.2	0.0	60.2	87.5	0.00177	3.2	349	413	*11*	*139*
270.0	60.8	0.0	60.8	88.3	0.00179	3.3	354	418	*11*	*140*
280.0	61.3	0.0	61.3	89.1	0.00180	3.3	358	423	*12*	*141*
290.0	61.9	0.0	61.9	89.9	0.00182	3.3	363	428	*12*	*142*
300.0	62.5	0.0	62.5	90.8	0.00184	3.4	368	434	*13*	*144*
310.0	63.1	0.0	63.1	91.6	0.00185	3.4	373	439	*13*	*145*
320.0	63.6	0.0	63.6	92.3	0.00187	3.4	377	444	*13*	*146*
330.0	64.2	0.0	64.2	93.2	0.00188	3.4	382	450	*14*	*147*
340.0	64.8	0.0	64.8	94.1	0.00190	3.5	387	455	*14*	*148*
350.0	65.4	0.0	65.4	94.9	0.00192	3.5	392	461	*15*	*149*
360.0	66.0	0.0	66.0	95.6	0.00193	3.5	396	466	*15*	*150*
370.0	66.6	0.0	66.6	96.5	0.00195	3.6	401	471	*15*	*152*
380.0	67.2	0.0	67.2	97.4	0.00196	3.6	406	477	*16*	*153*
390.0	67.8	0.0	67.8	98.2	0.00198	3.6	411	482	*16*	*154*
400.0	68.3	0.0	68.3	98.9	0.00199	3.7	415	487	*17*	*155*
410.0	68.9	0.0	68.9	99.8	0.00201	3.7	420	493	*17*	*156*
420.0	69.5	0.0	69.5	100.6	0.00203	3.7	425	498	*18*	*157*
430.0	69.8	0.0	69.8	101.2	0.00204	3.7	428	502	*18*	*159*
440.0	70.1	0.0	70.1	101.6	0.00204	3.8	431	504	*18*	*160*
450.0	70.5	0.0	70.5	102.1	0.00205	3.8	434	508	*19*	*161*
460.0	70.9	0.0	70.9	102.7	0.00207	3.8	437	511	*19*	*162*
470.0	71.2	0.0	71.2	103.1	0.00207	3.8	439	514	*20*	*163*
480.0	71.6	0.0	71.6	103.6	0.00208	3.8	442	518	*20*	*164*
490.0	71.9	0.0	71.9	104.2	0.00209	3.9	445	521	*20*	*165*
500.0	72.3	0.0	72.3	104.7	0.00210	3.9	449	525	*21*	*167*
510.0	72.6	0.0	72.6	105.1	0.00211	3.9	451	527	*21*	*168*
520.0	73.0	0.0	73.0	105.6	0.00212	3.9	454	531	*22*	*169*

The pressure calculations are set out in this table. Note that ***Rpmax*** *varies as it is set to be a proportion of the cover depth.*

Hf is a rough estimate of the drilling mud pressure in the return annular flow.

The total head ***H*** *is the static head* ***Hs*** *(table above) and* ***Hf***.

530.0	73.4	0.0	73.4	106.2	0.00213	3.9	457	534	*22*	*170*
540.0	73.7	0.0	73.7	106.7	0.00214	4.0	460	538	*23*	*171*
550.0	74.0	0.0	74.0	107.1	0.00215	4.0	463	541	*23*	*172*
560.0	74.4	0.0	74.4	107.7	0.00216	4.0	466	544	*23*	*173*
570.0	74.9	0.0	74.9	108.3	0.00217	4.0	469	548	*24*	*175*
580.0	75.3	0.0	75.3	108.9	0.00219	4.0	473	552	*24*	*176*
590.0	75.6	0.0	75.6	109.4	0.00220	4.1	476	556	*25*	*177*
600.0	76.1	0.0	76.1	110.1	0.00221	4.1	480	560	*25*	*178*
610.0	76.5	0.0	76.5	110.7	0.00222	4.1	483	564	*26*	*179*
620.0	77.0	0.0	77.0	111.3	0.00223	4.1	487	568	*26*	*180*
630.0	77.3	0.0	77.3	111.8	0.00224	4.1	490	571	*26*	*181*
640.0	77.7	0.0	77.7	112.4	0.00225	4.2	493	575	*27*	*183*
650.0	78.2	0.0	78.2	113.1	0.00227	4.2	497	579	*27*	*184*
660.0	78.6	0.0	78.6	113.7	0.00228	4.2	500	583	*28*	*185*
670.0	79.0	0.0	79.0	114.2	0.00229	4.2	503	586	*28*	*186*
680.0	79.4	0.0	79.4	114.8	0.00230	4.3	507	591	*28*	*187*
690.0	79.9	0.0	79.9	115.5	0.00231	4.3	511	595	*29*	*188*
700.0	80.3	0.0	80.3	116.1	0.00232	4.3	514	599	*29*	*190*
710.0	80.7	0.0	80.7	116.7	0.00234	4.3	518	603	*30*	*191*
720.0	81.2	0.0	81.2	117.3	0.00235	4.4	521	607	*30*	*192*
730.0	81.7	0.0	81.7	118.1	0.00236	4.4	526	612	*31*	*193*
740.0	82.2	0.0	82.2	118.7	0.00238	4.4	529	616	*31*	*194*
750.0	82.5	0.0	82.5	119.1	0.00238	4.4	532	618	*31*	*195*
760.0	82.9	0.0	82.9	119.7	0.00239	4.4	535	622	*32*	*196*
770.0	83.4	0.0	83.4	120.5	0.00241	4.5	540	627	*32*	*198*
780.0	84.0	0.0	84.0	121.3	0.00243	4.5	544	633	*33*	*199*
790.0	84.5	0.0	84.5	122.0	0.00244	4.5	548	637	*33*	*200*
800.0	85.1	0.0	85.1	122.9	0.00246	4.6	553	643	*33*	*201*
810.0	85.7	0.0	85.7	123.7	0.00247	4.6	558	648	*34*	*202*
820.0	86.3	0.0	86.3	124.5	0.00249	4.6	562	653	*34*	*203*
830.0	86.7	0.0	86.7	125.2	0.00250	4.7	566	658	*35*	*205*
840.0	87.3	0.0	87.3	126.0	0.00252	4.7	571	663	*35*	*206*
850.0	87.9	0.0	87.9	126.9	0.00253	4.7	576	668	*36*	*207*
860.0	88.5	0.0	88.5	127.7	0.00255	4.7	580	673	*36*	*208*
870.0	89.0	0.0	89.0	128.4	0.00256	4.8	584	678	*36*	*209*
880.0	89.6	0.0	89.6	129.2	0.00258	4.8	589	683	*37*	*210*
890.0	90.1	0.0	90.1	130.0	0.00259	4.8	594	688	*37*	*211*
900.0	90.6	0.0	90.6	130.7	0.00261	4.9	597	693	*38*	*213*
910.0	91.2	0.0	91.2	131.6	0.00262	4.9	602	698	*38*	*214*
920.0	91.8	0.0	91.8	132.4	0.00264	4.9	607	703	*38*	*215*
930.0	92.4	0.0	92.4	133.2	0.00265	5.0	611	708	*39*	*216*
940.0	92.9	0.0	92.9	133.9	0.00267	5.0	615	713	*39*	*217*
950.0	93.4	0.0	93.4	134.7	0.00268	5.0	620	718	*40*	*218*
960.0	94.0	0.0	94.0	135.5	0.00270	5.0	624	723	*40*	*220*
970.0	94.6	0.0	94.6	136.4	0.00272	5.1	629	728	*41*	*221*
980.0	95.1	0.0	95.1	137.1	0.00273	5.1	633	733	*41*	*222*
990.0	49.1	0.0	49.1	71.6	0.00147	2.6	261	312	*41*	*223*
1000.0	49.6	0.0	49.6	72.4	0.00148	2.7	265	317	*42*	*224*
1010.0	50.2	0.0	50.2	73.2	0.00150	2.7	269	322	*42*	*225*
1020.0	50.7	0.0	50.7	74.0	0.00151	2.7	274	327	*43*	*226*
1030.0	51.3	0.0	51.3	74.8	0.00153	2.8	278	332	*43*	*228*
1040.0	50.8	0.0	50.8	74.1	0.00151	2.7	274	328	*43*	*227*
1050.0	49.2	0.0	49.2	71.8	0.00147	2.6	261	313	*44*	*225*
1060.0	92.9	0.0	92.9	134.0	0.00267	5.0	616	713	*44*	*222*
1070.0	88.8	0.0	88.8	128.2	0.00256	4.8	583	677	*45*	*217*
1080.0	83.5	0.0	83.5	120.5	0.00241	4.5	540	628	*45*	*210*
1090.0	77.3	0.0	77.3	111.8	0.00224	4.1	490	571	*46*	*202*
1100.0	71.3	0.0	71.3	103.2	0.00208	3.8	440	515	*46*	*194*
1110.0	65.3	0.0	65.3	94.6	0.00191	3.5	390	459	*46*	*186*
1120.0	59.1	0.0	59.1	85.9	0.00174	3.2	340	403	*47*	*178*
1130.0	53.1	0.0	53.1	77.3	0.00158	2.8	292	348	*47*	*170*
1140.0	47.0	0.0	47.0	68.6	0.00141	2.5	245	294	*48*	*162*
1150.0	59.1	0.0	59.1	85.9	0.00174	3.2	340	403	*48*	*154*
1160.0	74.4	0.0	74.4	107.6	0.00216	4.0	465	544	*48*	*146*
1170.0	91.8	0.0	91.8	132.4	0.00264	4.9	607	703	*49*	*138*
1180.0	93.8	0.0	93.8	135.2	0.00269	5.0	622	721	*49*	*130*
1190.0	79.2	0.0	79.2	114.5	0.00229	4.2	505	588	*50*	*123*
1200.0	53.0	0.0	53.0	77.2	0.00157	2.8	291	347	*50*	*115*
1210.0	34.2	0.0	34.2	50.4	0.00106	1.8	153	189	*51*	*107*
1220.0	31.5	0.0	31.5	46.6	0.00098	1.7	135	168	*51*	*99*
1230.0	23.3	0.0	23.3	35.0	0.00076	1.3	86	111	*51*	*91*
1240.0	16.7	0.0	16.7	25.5	0.00058	0.9	52	70	*52*	*83*
1250.0	12.8	0.0	12.8	20.0	0.00047	0.7	35	49	*52*	*75*
1260.0	5.1	0.0	5.1	9.0	0.00026	0.3	8	13	*53*	*67*
1270.0	0.0	0.0	0.0	1.8	0.00012	0.3	2	2	*53*	*59*
1272.0	0.0	0.0	0.0	1.8	0.00012	0.3	2	2	*53*	*58*

Comments

waterman	***Spreadsheet Calcpad*** *(Macros must be enabled. Ctrl+Alt+F9 recalculates.)*	**Project**	
		WIE12731-153	
	WIE12731-153_White Cross Phase 2 Golf Course HDD Option - Hydrofracture Calculations	**Prepared**	**Date**
		LP	18-Jul-23
		Checked	**Date**
		CG	19-Jul-23

Hydrofracture - Longitudinal Profile Check

[redacted]

$$Pmax = Pemax + U$$ ***Eqn(1)***

$$Pemax = (Pf + c.\cot\emptyset).\left\{\left(\frac{Ro}{Rpmax}\right)^2 + Q\right\}^{\frac{-\sin\emptyset}{1+\sin\emptyset}} - c.\cot\emptyset$$ ***Eqn(2)***

$$Q = \frac{(\sigma o.\sin\emptyset + c.\cos\emptyset)}{G}$$ ***Eqn(3)***

$$Pf = \sigma o\,(1 + \sin\emptyset) + c.\cos\emptyset$$ ***Eqn(4)***

$$G = \frac{E}{2}\,(1 + \vartheta)$$ ***Eqn(5)***

Where:

Pmax	maximum allowable mud pressure
U	initial in-situ pore pressure
Pemax	maximum allowable effective mud pressure
σ_o	initial effective stress
ϕ	internal angle of friction
c	cohesion
Ro	internal radius of borehole
Rpmax	maximum allowable radius of plastic zone
G	shear modulus
E	elasticity modulus
N	Poisson's ratio

[redacted]

General variables

Gravity (m/s/s):	**g**	9.81			
Density of water (kg/m3):	**ɣw**	1000			
Density of drilling mud (kg/m3):	**ɣm**	1300			
Soil density (kg/m^3):	**ɣs**	1950			*Soil characteristic values are all assumed and should be confirmed by Intrusive Ground Investigation.*
Cohesion (kN/m^2):	**Coh**	2			
Friction angle (deg):	**Φ**	25	Radians Φr =	0.4363	
Poission's ratio :	**v**	0.3			
Elasticity modulus (kPa):	**Emod**	40000			
Shear modulus (kPa):	Gmod =	15385			

Product pipe OD (m):					
Drill bit diameter (inch):	24.00 inch	**Do**	0.610 m		*Diameters assumed at feasibility stage.*
Drill pipe OD (inch):	12.00 inch	**Di**	0.305 m		

Initial radius of borehole (m):	**Ro**	0.305	*Equal half drill bit diameter*	*Rpmax usually assumed between 1/2 and 2/3 depth, assumed 1/2 as worst case scenario*
Allowable plastic radius factor	**Rpmax**	0.50		

Consider lateral soil pressure: **No** ***Use drop-down to select Y/N***

Passive coefficient **ko** = IF(Y_N = "Yes", 1 - SIN(Φr), 0)
= IF(= "Yes", 1 - SIN(0.43633), 0)
= **0**

Conservative to not consider lateral soil pressures

Annular pressure calculations

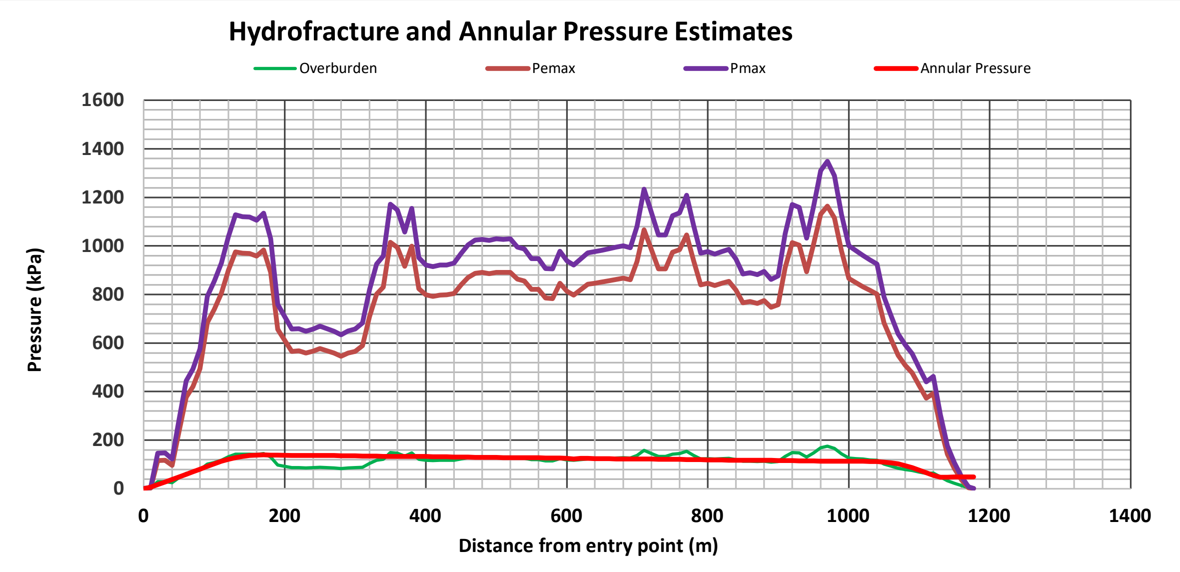
Darcy Weisbach equation for flow in an annulus is: H = f(L/Dh)(V^2/2g), where Dh is the hydraulic diameter, V the flow velocity, L flow pipe length and f is a friction factor. In the case of co-centered circular pipes Dh = Do - Di. The exact drilling operational parameters, such as flow rate are unknown, but some estimated values have been applied - but require verification. The total head is the flow head plus the static head.

Assumed flow velocity (m/s):	V	0.50
Assumed friction coefficient:	f	1.00

The calculations at each chainage location are performed in the frac-out table

Summary Figures

Elevation of entrance hole mOD =	**8.74**	**mOD**			
Elevation of exit hole mOD =	**12.74**	**mOD**	*Diff =*	*-4.00*	m
Maximum cover to HDD borehole =	**18.8**	**m**			
Maximum overburden pressure =	**175.2**	**kN/m^2**		*1.8*	*Bar*
Maximum safe effective stress **Pemax** =	**1164**	**kN/m^2**		*11.6*	*Bar*
Maximum safe stress **Pmax** =	**1348**	**kN/m^3**		*13.5*	*Bar*



Expressions used in hydrofracture calculations

In the tabulation below the following functions are applied

Saturated Layer **Sat'd**: IF (WTL<=HDD, Elevn-HDD, Max(Elevn-WTL, 0))

Bouyant Layer **Bou't**: IF (WTL<=HDD, 0, Min(WTL-HDD, Elevn-HDD))

σv = (γs*Satd+(γs-γw)*Bout)*g/1000

σo = SQRT((γs*Satd+(γs-γw)*Bout)^2 + (ko * (γs*Satd + (γs-γw)*Bout))^2))

Q = (σo*SIN(Φr) + Coh*COS(Φr)) / Gmod

Pf = (σo * (1+SIN(Φr))) + (Coh * COS(Φr))

Pemax = (Pf + Coh*COT(Φr)) * (((Ro/Rpmax)^2 + Q)^(-SIN(Φr)/(1+SIN(Φr)))) - Coh*COT(Φr)

Pelim = (Pf + Coh*COT(Φr)) * (Q^(-SIN(Φr)/(1+SIN(Φr)))) - Coh*COT(Φr)

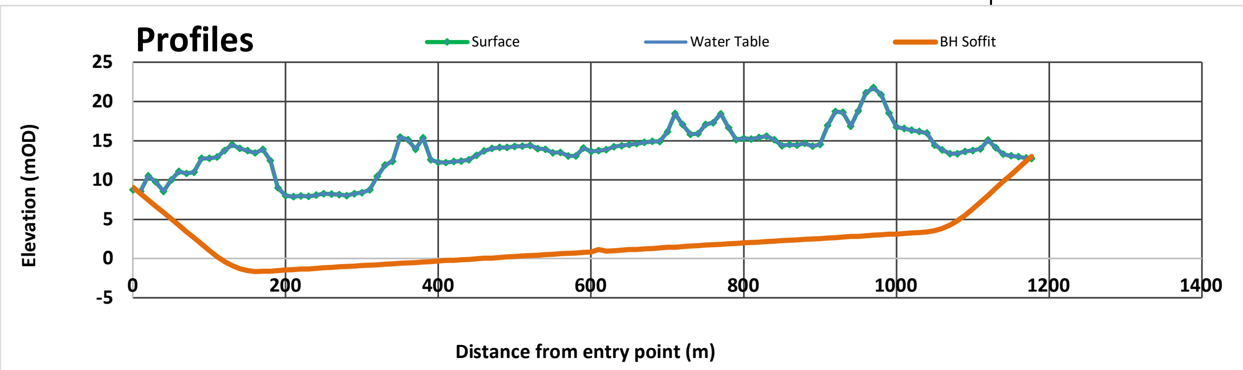
LAT

WT controls: 0 -4.89

Dist (m)	Elev'n (mOD)	Loc'n	WTL (mOD)	C-Line (mOD)	Soffit (mOD)	Cover (m)	Sat'd (m)	Bou't (m)	U kN/m2	Hs kN/m3
0.00	8.74		8.74	8.76	9.06	0.00	0.00	0.00	0	0
10.00	8.57		8.57	7.96	8.26	0.31	0.00	0.31	3	6
20.00	10.51		10.51	7.15	7.46	3.06	0.00	3.06	30	16
30.00	9.75		9.75	6.35	6.66	3.09	0.00	3.09	30	27
40.00	8.54		8.54	5.55	5.85	2.69	0.00	2.69	26	37
50.00	10.02		10.02	4.75	5.05	4.97	0.00	4.97	49	47
60.00	11.08		11.08	3.94	4.25	6.83	0.00	6.83	67	57
70.00	10.85		10.85	3.14	3.45	7.40	0.00	7.40	73	68
80.00	11.00		11.00	2.34	2.64	8.35	0.00	8.35	82	78
90.00	12.77		12.77	1.54	1.84	10.93	0.00	10.93	107	88
100.00	12.76		12.76	0.74	1.04	11.72	0.00	11.72	115	98
110.00	12.94		12.94	-0.04	0.26	12.68	0.00	12.68	124	108
120.00	13.76		13.76	-0.69	-0.39	14.15	0.00	14.15	139	116
130.00	14.51		14.51	-1.21	-0.91	15.42	0.00	15.42	151	123
140.00	14.02		14.02	-1.60	-1.29	15.32	0.00	15.32	150	128
150.00	13.74		13.74	-1.85	-1.54	15.28	0.00	15.28	150	131
160.00	13.45		13.45	-1.97	-1.66	15.12	0.00	15.12	148	133
170.00	13.89		13.89	-1.96	-1.65	15.54	0.00	15.54	152	133
180.00	12.44		12.44	-1.90	-1.59	14.03	0.00	14.03	138	132
190.00	9.00		9.00	-1.84	-1.53	10.53	0.00	10.53	103	131
200.00	8.00		8.00	-1.78	-1.48	9.47	0.00	9.47	93	130
210.00	7.88		7.88	-1.72	-1.42	9.30	0.00	9.30	91	130
220.00	7.98		7.98	-1.67	-1.36	9.34	0.00	9.34	92	129
230.00	7.91		7.91	-1.61	-1.30	9.21	0.00	9.21	90	128
240.00	8.07		8.07	-1.55	-1.25	9.31	0.00	9.31	91	127
250.00	8.26		8.26	-1.49	-1.19	9.45	0.00	9.45	93	127
260.00	8.20		8.20	-1.44	-1.13	9.33	0.00	9.33	92	126
270.00	8.14		8.14	-1.38	-1.07	9.21	0.00	9.21	90	125
280.00	8.02		8.02	-1.32	-1.02	9.04	0.00	9.04	89	124
290.00	8.26		8.26	-1.26	-0.96	9.22	0.00	9.22	90	124
300.00	8.41		8.41	-1.21	-0.90	9.31	0.00	9.31	91	123
310.00	8.76		8.76	-1.15	-0.84	9.60	0.00	9.60	94	122
320.00	10.49		10.49	-1.09	-0.79	11.27	0.00	11.27	111	122
330.00	11.90		11.90	-1.03	-0.73	12.63	0.00	12.63	124	121
340.00	12.39		12.39	-0.97	-0.67	13.05	0.00	13.05	128	120
350.00	15.46		15.46	-0.92	-0.61	16.07	0.00	16.07	158	119
360.00	15.16		15.16	-0.86	-0.55	15.72	0.00	15.72	154	119
370.00	13.92		13.92	-0.80	-0.50	14.42	0.00	14.42	141	118
380.00	15.37		15.37	-0.74	-0.44	15.80	0.00	15.80	155	117
390.00	12.59		12.59	-0.69	-0.38	12.97	0.00	12.97	127	116
400.00	12.26		12.26	-0.63	-0.32	12.58	0.00	12.58	123	116
410.00	12.22		12.22	-0.57	-0.27	12.49	0.00	12.49	122	115
420.00	12.36		12.36	-0.51	-0.21	12.57	0.00	12.57	123	114
430.00	12.43		12.43	-0.46	-0.15	12.58	0.00	12.58	123	113
440.00	12.58		12.58	-0.40	-0.09	12.67	0.00	12.67	124	113
450.00	13.17		13.17	-0.34	-0.04	13.20	0.00	13.20	129	112
460.00	13.70		13.70	-0.28	0.02	13.67	0.00	13.67	134	111
470.00	14.03		14.03	-0.23	0.08	13.95	0.00	13.95	137	110
480.00	14.14		14.14	-0.17	0.14	14.00	0.00	14.00	137	110
490.00	14.14		14.14	-0.11	0.20	13.94	0.00	13.94	137	109
500.00	14.27		14.27	-0.05	0.25	14.02	0.00	14.02	137	108
510.00	14.31		14.31	0.01	0.31	14.00	0.00	14.00	137	108
520.00	14.39		14.39	0.06	0.37	14.02	0.00	14.02	138	107

530.00	14.00	14.00	0.12	0.43	13.57	0.00	13.57	*133*	*106*
540.00	13.94	13.94	0.18	0.48	13.45	0.00	13.45	*132*	*105*
550.00	13.46	13.46	0.24	0.54	12.92	0.00	12.92	*127*	*105*
560.00	13.52	13.52	0.29	0.60	12.92	0.00	12.92	*127*	*104*
570.00	13.05	13.05	0.35	0.66	12.39	0.00	12.39	*122*	*103*
580.00	13.07	13.07	0.41	0.71	12.36	0.00	12.36	*121*	*102*
590.00	14.10	14.10	0.47	0.77	13.33	0.00	13.33	*131*	*102*
600.00	13.63	13.63	0.53	0.83	12.80	0.00	12.80	*126*	*101*
610.00	13.74	13.74	0.85	1.16	12.58	0.00	12.58	*123*	*97*
620.00	13.85	13.85	0.64	0.94	12.91	0.00	12.91	*127*	*99*
630.00	14.25	14.25	0.70	1.00	13.25	0.00	13.25	*130*	*99*
640.00	14.37	14.37	0.76	1.06	13.31	0.00	13.31	*131*	*98*
650.00	14.49	14.49	0.81	1.12	13.38	0.00	13.38	*131*	*97*
660.00	14.65	14.65	0.87	1.18	13.47	0.00	13.47	*132*	*97*
670.00	14.80	14.80	0.93	1.23	13.56	0.00	13.56	*133*	*96*
680.00	14.93	14.93	0.99	1.29	13.64	0.00	13.64	*134*	*95*
690.00	14.88	14.88	1.04	1.35	13.53	0.00	13.53	*133*	*94*
700.00	16.15	16.15	1.10	1.41	14.75	0.00	14.75	*145*	*94*
710.00	18.46	18.46	1.16	1.46	16.99	0.00	16.99	*167*	*93*
720.00	17.08	17.08	1.22	1.52	15.56	0.00	15.56	*153*	*92*
730.00	15.81	15.81	1.28	1.58	14.23	0.00	14.23	*140*	*91*
740.00	15.87	15.87	1.33	1.64	14.24	0.00	14.24	*140*	*91*
750.00	17.07	17.07	1.39	1.69	15.37	0.00	15.37	*151*	*90*
760.00	17.30	17.30	1.45	1.75	15.55	0.00	15.55	*153*	*89*
770.00	18.43	18.43	1.51	1.81	16.62	0.00	16.62	*163*	*88*
780.00	16.65	16.65	1.56	1.87	14.78	0.00	14.78	*145*	*88*
790.00	15.13	15.13	1.62	1.93	13.21	0.00	13.21	*130*	*87*
800.00	15.30	15.30	1.68	1.98	13.32	0.00	13.32	*131*	*86*
810.00	15.21	15.21	1.74	2.04	13.17	0.00	13.17	*129*	*85*
820.00	15.41	15.41	1.79	2.10	13.31	0.00	13.31	*131*	*85*
830.00	15.58	15.58	1.85	2.16	13.43	0.00	13.43	*132*	*84*
840.00	15.10	15.10	1.91	2.21	12.89	0.00	12.89	*126*	*83*
850.00	14.36	14.36	1.97	2.27	12.09	0.00	12.09	*119*	*83*
860.00	14.49	14.49	2.02	2.33	12.16	0.00	12.16	*119*	*82*
870.00	14.44	14.44	2.08	2.39	12.05	0.00	12.05	*118*	*81*
880.00	14.67	14.67	2.14	2.44	12.23	0.00	12.23	*120*	*80*
890.00	14.32	14.32	2.20	2.50	11.82	0.00	11.82	*116*	*80*
900.00	14.55	14.55	2.26	2.56	11.99	0.00	11.99	*118*	*79*
910.00	16.95	16.95	2.31	2.62	14.33	0.00	14.33	*141*	*78*
920.00	18.73	18.73	2.37	2.67	16.06	0.00	16.06	*158*	*77*
930.00	18.61	18.61	2.43	2.73	15.88	0.00	15.88	*156*	*77*
940.00	16.85	16.85	2.49	2.79	14.06	0.00	14.06	*138*	*76*
950.00	18.81	18.81	2.54	2.85	15.96	0.00	15.96	*157*	*75*
960.00	21.09	21.09	2.60	2.91	18.18	0.00	18.18	*178*	*74*
970.00	21.76	21.76	2.66	2.96	18.80	0.00	18.80	*184*	*74*
980.00	20.88	20.88	2.72	3.02	17.86	0.00	17.86	*175*	*73*
990.00	18.54	18.54	2.77	3.08	15.46	0.00	15.46	*152*	*72*
1000.00	16.76	16.76	2.83	3.14	13.62	0.00	13.62	*134*	*71*
1010.00	16.55	16.55	2.89	3.19	13.36	0.00	13.36	*131*	*71*
1020.00	16.34	16.34	2.95	3.25	13.08	0.00	13.08	*128*	*70*
1030.00	16.16	16.16	3.01	3.31	12.85	0.00	12.85	*126*	*69*
1040.00	15.99	15.99	3.07	3.37	12.62	0.00	12.62	*124*	*68*
1050.00	14.43	14.43	3.22	3.53	10.90	0.00	10.90	*107*	*66*
1060.00	13.82	13.82	3.52	3.82	10.00	0.00	10.00	*98*	*63*
1070.00	13.33	13.33	3.94	4.24	9.09	0.00	9.09	*89*	*57*
1080.00	13.35	13.35	4.50	4.80	8.55	0.00	8.55	*84*	*50*
1090.00	13.62	13.62	5.19	5.49	8.13	0.00	8.13	*80*	*41*
1100.00	13.76	13.76	6.01	6.31	7.45	0.00	7.45	*73*	*31*
1110.00	13.96	13.96	6.88	7.18	6.78	0.00	6.78	*66*	*20*
1120.00	15.10	15.10	7.75	8.05	7.04	0.00	7.04	*69*	*9*
1130.00	14.11	14.11	8.62	8.93	5.19	0.00	5.19	*51*	*0*
1140.00	13.30	13.30	9.49	9.80	3.50	0.00	3.50	*34*	*0*
1150.00	13.10	13.10	10.36	10.67	2.43	0.00	2.43	*24*	*0*
1160.00	12.95	12.95	11.23	11.54	1.41	0.00	1.41	*14*	*0*
1170.00	12.80	12.80	12.10	12.41	0.39	0.00	0.39	*4*	*0*
1177.00	12.74	12.74	12.69	13.00	0.00	0.00	0.00	*0*	*0*

HDD borehole profile graph based on the above table



*The pressure calculations are set out in this table. Note that **Rpmax** varies as it is set to be a proportion of the cover depth.*

Hf is a rough estimate of the drilling mud pressure in the return annular flow.

*The total head **H** is the static head **Hs** (table above) and **Hf**.*

Dist (m)	σv (kN/m^2)	σh (kN/m^2)	σo (kN/m^2)	Pf (kN/m^2)	Q	Rpmax (m)	Pemax (kN/m^2)	Pmax (kN/m^2)	Hf (kN/m^2)	H (kN/m^2)
0.0	0.0	0.0	0.0	1.8	0.00012	0.3	2	2	*0*	*0*
10.0	2.9	0.0	2.9	5.9	0.00020	0.2	3	6	*0*	*7*
20.0	28.5	0.0	28.5	42.3	0.00090	1.5	116	146	*1*	*17*
30.0	28.8	0.0	28.8	42.8	0.00091	1.5	118	149	*1*	*28*
40.0	25.1	0.0	25.1	37.5	0.00081	1.3	96	122	*2*	*39*
50.0	46.3	0.0	46.3	67.7	0.00139	2.5	239	288	*2*	*49*
60.0	63.7	0.0	63.7	92.4	0.00187	3.4	377	444	*3*	*60*
70.0	69.0	0.0	69.0	99.9	0.00201	3.7	421	494	*3*	*70*
80.0	77.8	0.0	77.8	112.6	0.00226	4.2	494	576	*3*	*81*
90.0	101.8	0.0	101.8	146.7	0.00292	5.5	685	792	*4*	*92*
100.0	109.2	0.0	109.2	157.1	0.00312	5.9	740	855	*4*	*102*
110.0	118.2	0.0	118.2	169.9	0.00336	6.3	805	930	*5*	*113*
120.0	131.9	0.0	131.9	189.4	0.00374	7.1	900	1039	*5*	*121*
130.0	143.7	0.0	143.7	206.2	0.00406	7.7	977	1128	*5*	*128*
140.0	142.7	0.0	142.7	204.9	0.00404	7.7	970	1121	*6*	*134*
150.0	142.4	0.0	142.4	204.4	0.00403	7.6	969	1118	*6*	*137*
160.0	140.9	0.0	140.9	202.2	0.00399	7.6	959	1107	*7*	*139*
170.0	144.8	0.0	144.8	207.8	0.00410	7.8	984	1136	*7*	*140*
180.0	130.7	0.0	130.7	187.8	0.00371	7.0	892	1030	*8*	*139*
190.0	98.1	0.0	98.1	141.4	0.00281	5.3	656	760	*8*	*139*
210.0	86.7	0.0	86.7	125.1	0.00250	4.7	566	657	*9*	*138*
220.0	87.0	0.0	87.0	125.6	0.00251	4.7	568	660	*9*	*138*
230.0	85.8	0.0	85.8	123.9	0.00248	4.6	559	649	*10*	*138*
240.0	86.8	0.0	86.8	125.3	0.00250	4.7	567	658	*10*	*137*
250.0	88.1	0.0	88.1	127.1	0.00254	4.7	577	670	*10*	*137*
260.0	86.9	0.0	86.9	125.5	0.00251	4.7	568	659	*11*	*137*
270.0	85.8	0.0	85.8	123.9	0.00248	4.6	559	649	*11*	*136*
280.0	84.2	0.0	84.2	121.6	0.00243	4.5	546	635	*12*	*136*
290.0	85.9	0.0	85.9	124.0	0.00248	4.6	559	650	*12*	*136*
300.0	86.7	0.0	86.7	125.2	0.00250	4.7	566	657	*13*	*136*
310.0	89.5	0.0	89.5	129.1	0.00258	4.8	588	683	*13*	*135*
320.0	105.0	0.0	105.0	151.2	0.00300	5.6	709	820	*13*	*135*
330.0	117.7	0.0	117.7	169.2	0.00335	6.3	802	926	*14*	*135*
340.0	121.7	0.0	121.7	174.9	0.00346	6.5	830	958	*14*	*134*
350.0	149.8	0.0	149.8	214.9	0.00423	8.0	1015	1172	*15*	*134*
360.0	146.5	0.0	146.5	210.2	0.00414	7.9	994	1148	*15*	*134*
370.0	134.4	0.0	134.4	193.0	0.00381	7.2	916	1058	*15*	*133*
380.0	147.3	0.0	147.3	211.3	0.00416	7.9	999	1154	*16*	*133*
390.0	120.9	0.0	120.9	173.8	0.00344	6.5	825	952	*16*	*133*
400.0	117.3	0.0	117.3	168.6	0.00334	6.3	799	922	*17*	*132*
410.0	116.4	0.0	116.4	167.4	0.00331	6.2	792	915	*17*	*132*
420.0	117.1	0.0	117.1	168.5	0.00334	6.3	798	921	*18*	*132*
430.0	117.2	0.0	117.2	168.6	0.00334	6.3	799	922	*18*	*131*
440.0	118.1	0.0	118.1	169.8	0.00336	6.3	805	929	*18*	*131*
450.0	123.0	0.0	123.0	176.8	0.00350	6.6	839	969	*19*	*131*
460.0	127.4	0.0	127.4	183.1	0.00362	6.8	870	1004	*19*	*130*
470.0	130.0	0.0	130.0	186.8	0.00369	7.0	887	1024	*20*	*130*
480.0	130.5	0.0	130.5	187.4	0.00370	7.0	890	1028	*20*	*130*
490.0	129.9	0.0	129.9	186.6	0.00369	7.0	887	1023	*20*	*129*
500.0	130.6	0.0	130.6	187.6	0.00371	7.0	891	1029	*21*	*129*
510.0	130.5	0.0	130.5	187.4	0.00370	7.0	890	1028	*21*	*129*
520.0	130.7	0.0	130.7	187.7	0.00371	7.0	892	1029	*22*	*129*

530.0	126.5	0.0	126.5	181.7	0.00359	6.8	863	996	*22*	*128*
540.0	125.4	0.0	125.4	180.1	0.00356	6.7	856	988	*23*	*128*
550.0	120.4	0.0	120.4	173.1	0.00342	6.5	821	948	*23*	*128*
560.0	120.4	0.0	120.4	173.1	0.00343	6.5	821	948	*23*	*127*
570.0	115.5	0.0	115.5	166.1	0.00329	6.2	786	908	*24*	*127*
580.0	115.2	0.0	115.2	165.7	0.00328	6.2	784	905	*24*	*127*
590.0	124.2	0.0	124.2	178.5	0.00353	6.7	848	978	*25*	*126*
600.0	119.3	0.0	119.3	171.5	0.00339	6.4	813	939	*25*	*126*
610.0	117.2	0.0	117.2	168.6	0.00334	6.3	799	922	*26*	*122*
620.0	120.3	0.0	120.3	173.0	0.00342	6.5	820	947	*26*	*125*
630.0	123.4	0.0	123.4	177.4	0.00351	6.6	842	972	*26*	*125*
640.0	124.0	0.0	124.0	178.2	0.00352	6.7	846	977	*27*	*125*
650.0	124.7	0.0	124.7	179.1	0.00354	6.7	851	982	*27*	*124*
660.0	125.5	0.0	125.5	180.4	0.00357	6.7	857	989	*28*	*124*
670.0	126.4	0.0	126.4	181.6	0.00359	6.8	863	996	*28*	*124*
680.0	127.1	0.0	127.1	182.6	0.00361	6.8	868	1001	*28*	*123*
690.0	126.1	0.0	126.1	181.2	0.00358	6.8	861	993	*29*	*123*
700.0	137.4	0.0	137.4	197.3	0.00389	7.4	936	1081	*29*	*123*
710.0	158.4	0.0	158.4	227.1	0.00447	8.5	1067	1233	*30*	*123*
720.0	145.0	0.0	145.0	208.1	0.00410	7.8	985	1137	*30*	*122*
730.0	132.6	0.0	132.6	190.5	0.00376	7.1	905	1045	*31*	*122*
740.0	132.7	0.0	132.7	190.6	0.00376	7.1	905	1045	*31*	*122*
750.0	143.3	0.0	143.3	205.6	0.00405	7.7	974	1125	*31*	*121*
760.0	144.9	0.0	144.9	208.0	0.00410	7.8	984	1137	*32*	*121*
770.0	154.9	0.0	154.9	222.2	0.00437	8.3	1046	1209	*32*	*121*
780.0	137.7	0.0	137.7	197.7	0.00390	7.4	938	1083	*33*	*120*
790.0	123.1	0.0	123.1	176.9	0.00350	6.6	840	969	*33*	*120*
800.0	124.1	0.0	124.1	178.4	0.00353	6.7	847	978	*33*	*120*
810.0	122.7	0.0	122.7	176.4	0.00349	6.6	837	966	*34*	*119*
820.0	124.0	0.0	124.0	178.2	0.00352	6.7	846	977	*34*	*119*
830.0	125.1	0.0	125.1	179.8	0.00356	6.7	854	986	*35*	*119*
840.0	120.1	0.0	120.1	172.7	0.00342	6.4	819	946	*35*	*118*
850.0	112.7	0.0	112.7	162.1	0.00321	6.0	766	884	*36*	*118*
860.0	113.3	0.0	113.3	163.1	0.00323	6.1	771	890	*36*	*118*
870.0	112.3	0.0	112.3	161.6	0.00320	6.0	763	882	*36*	*117*
880.0	114.0	0.0	114.0	163.9	0.00325	6.1	775	895	*37*	*117*
890.0	110.1	0.0	110.1	158.5	0.00314	5.9	747	863	*37*	*117*
900.0	111.7	0.0	111.7	160.8	0.00319	6.0	759	877	*38*	*116*
910.0	133.6	0.0	133.6	191.8	0.00379	7.2	911	1052	*38*	*116*
920.0	149.6	0.0	149.6	214.7	0.00423	8.0	1014	1171	*38*	*116*
930.0	148.0	0.0	148.0	212.3	0.00418	7.9	1003	1159	*39*	*116*
940.0	131.0	0.0	131.0	188.2	0.00372	7.0	894	1032	*39*	*115*
950.0	148.8	0.0	148.8	213.5	0.00420	8.0	1008	1165	*40*	*115*
960.0	169.5	0.0	169.5	242.9	0.00477	9.1	1132	1310	*40*	*115*
970.0	175.2	0.0	175.2	251.0	0.00493	9.4	1164	1348	*41*	*114*
980.0	166.5	0.0	166.5	238.6	0.00469	8.9	1114	1289	*41*	*114*
990.0	144.1	0.0	144.1	206.8	0.00408	7.7	979	1131	*41*	*114*
1000.0	127.0	0.0	127.0	182.4	0.00361	6.8	867	1000	*42*	*113*
1010.0	124.5	0.0	124.5	178.9	0.00354	6.7	850	981	*42*	*113*
1020.0	121.9	0.0	121.9	175.3	0.00347	6.5	832	960	*43*	*113*
1030.0	119.8	0.0	119.8	172.2	0.00341	6.4	817	943	*43*	*112*
1040.0	117.6	0.0	117.6	169.1	0.00335	6.3	801	925	*43*	*112*
1050.0	101.6	0.0	101.6	146.3	0.00291	5.5	683	790	*44*	*110*
1060.0	93.2	0.0	93.2	134.4	0.00268	5.0	618	716	*44*	*107*
1070.0	84.7	0.0	84.7	122.3	0.00244	4.5	550	639	*45*	*102*
1080.0	79.7	0.0	79.7	115.2	0.00231	4.3	509	593	*45*	*95*
1090.0	75.8	0.0	75.8	109.6	0.00220	4.1	477	557	*46*	*87*
1100.0	69.4	0.0	69.4	100.5	0.00202	3.7	424	497	*46*	*77*
1110.0	63.2	0.0	63.2	91.7	0.00185	3.4	373	440	*46*	*66*
1120.0	65.6	0.0	65.6	95.2	0.00192	3.5	393	462	*47*	*56*
1130.0	48.3	0.0	48.3	70.6	0.00145	2.6	255	306	*47*	*47*
1140.0	32.6	0.0	32.6	48.2	0.00101	1.8	143	177	*48*	*48*
1150.0	22.6	0.0	22.6	34.0	0.00074	1.2	83	106	*48*	*48*
1160.0	13.2	0.0	13.2	20.5	0.00048	0.7	37	50	*48*	*48*
1170.0	3.6	0.0	3.6	6.9	0.00022	0.2	4	8	*49*	*49*
1177.0	0.0	0.0	0.0	1.8	0.00012	0.3	2	2	*49*	*49*

Comments

waterman	***Spreadsheet Calcpad*** *(Macros must be enabled. Ctrl+Alt+F9 recalculates.)*	**Project**	
		WIE12731-131	
	WIE12731-153_White Cross Phase 2 Landfall HDD Hydrofracture Calculations	**Prepared**	**Date**
		LP	26-Jul-23
		Checked	**Date**
		CG	27-Jul-23

Hydrofracture - Longitudinal Profile Check

[redacted]

$$Pmax = Pemax + U$$ ***Eqn(1)***

$$Pemax = (Pf + c.\cot\emptyset).\left\{\left(\frac{Ro}{Rpmax}\right)^2 + Q\right\}^{\frac{-\sin\emptyset}{1+\sin\emptyset}} - c.\cot\emptyset$$ ***Eqn(2)***

$$Q = \frac{(\sigma o.\sin\emptyset + c.\cos\emptyset)}{G}$$ ***Eqn(3)***

$$Pf = \sigma o\,(1 + \sin\emptyset) + c.\cos\emptyset$$ ***Eqn(4)***

$$G = \frac{E}{2}\,(1 + \vartheta)$$ ***Eqn(5)***

Where:

Pmax	maximum allowable mud pressure
U	initial in-situ pore pressure
Pemax	maximum allowable effective mud pressure
σ_o	initial effective stress
ϕ	internal angle of friction
c	cohesion
Ro	internal radius of borehole
Rpmax	maximum allowable radius of plastic zone
G	shear modulus
E	elasticity modulus
N	Poisson's ratio

Only enter data into green highlight cells. Other cells may contain calculations and editing them will over-write the formula.

General variables

Gravity (m/s/s):	**g**	9.81			
Density of water (kg/m3):	**ɣw**	1000			
Density of drilling mud (kg/m3):	**ɣm**	1300			
Soil density (kg/m^3):	**ɣs**	1950			*Soil characteristic values are all assumed and should be confirmed by Intrusive Ground Investigation.*
Cohesion (kN/m^2):	**Coh**	2			
Friction angle (deg):	**Φ**	25	Radians Φr =	0.4363	
Poission's ratio :	**v**	0.3			
Elasticity modulus (kPa):	**Emod**	40000			
Shear modulus (kPa):	Gmod =	15385			
Product pipe OD (m):					
Drill bit diameter (inch):		44.00 inch	**Do**	1.118 m	*Diameters assumed at feasibility stage.*
Drill pipe OD (inch):		12.00 inch	**Di**	0.305 m	
Initial radius of borehole (m):	**Ro**	0.559	*Equal half drill bit diameter*		*Rpmax usually assumed between 1/2 and 2/3 depth, assumed 1/2 as worst case scenario*
Allowable plastic radius factor	**Rpmax**	0.50			
Consider lateral soil pressure:	**No**	***Use drop-down to select Y/N***			

Passive coefficient **ko** = IF(Y_N = "Yes", 1 - SIN(Φr), 0)
= IF(= "Yes", 1 - SIN(0.43633), 0)
= **0**

Conservative to not consider lateral soil pressures

Annular pressure calculations

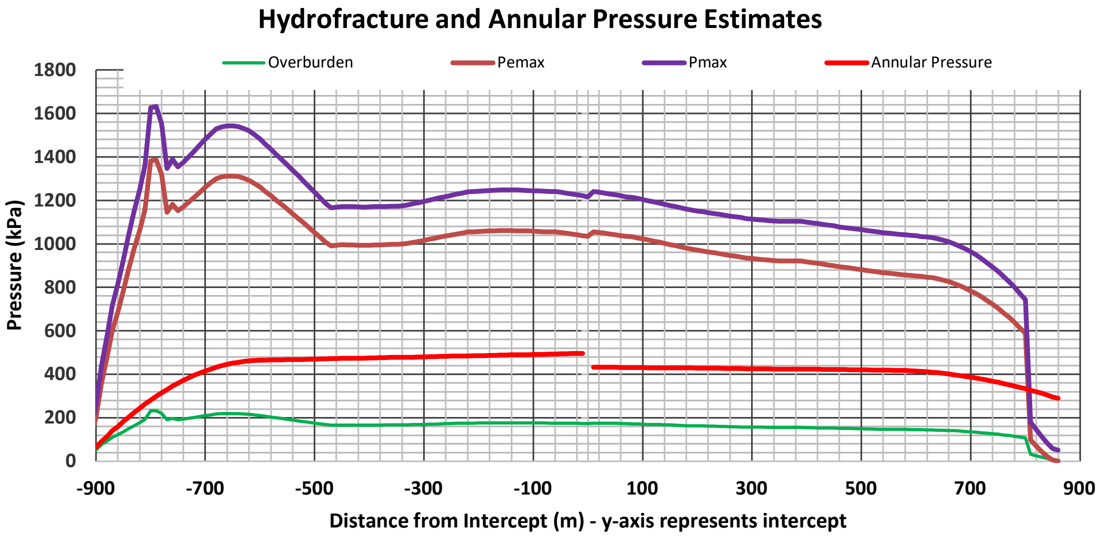
Darcy Weisbach equation for flow in an annulus is: H = f(L/Dh)(V^2/2g), where Dh is the hydraulic diameter, V the flow velocity, L flow pipe length and f is a friction factor. In the case of co-centered circular pipes Dh = Do - Di. The exact drilling operational parameters, such as flow rate are unknown, but some estimated values have been applied - but require verification. The total head is the flow head plus the static head.

Assumed flow velocity (m/s):	V	0.50
Assumed friction coefficient:	f	2.50

The calculations at each chainage location are performed in the frac-out table

Summary Figures

Elevation of entrance hole mOD =	**12.97**	**mOD**			
Elevation of exit hole mOD =	**-9.89**	**mOD**	***Diff =***	***22.86***	m
Maximum cover to HDD borehole =	**25.0**	**m**			
Maximum overburden pressure =	**233.1**	**kN/m^2**		***2.3***	***Bar***
Maximum safe effective stress **Pemax** =	**1387**	**kN/m^2**		***13.9***	***Bar***
Maximum safe stress **Pmax** =	**1632**	**kN/m^3**		***16.3***	***Bar***



Expressions used in hydrofracture calculations

In the tabulation below the following functions are applied

Saturated Layer **Sat'd**: IF (WTL<=HDD, Elevn-HDD, Max(Elevn-WTL, 0))

Bouyant Layer **Bou't**: IF (WTL<=HDD, 0, Min(WTL-HDD, Elevn-HDD))

σv = (γs*Satd+(γs-γw)*Bout)*g/1000

σo = SQRT((γs*Satd+(γs-γw)*Bout)^2 + (ko * (γs*Satd + (γs-γw)*Bout))^2))

Q = (σo*SIN(Φr) + Coh*COS(Φr)) / Gmod

Pf = (σo * (1+SIN(Φr))) + (Coh * COS(Φr))

Pemax = (Pf + Coh*COT(Φr)) * (((Ro/Rpmax)^2 + Q)^(-SIN(Φr)/(1+SIN(Φr)))) - Coh*COT(Φr)

Pelim = (Pf + Coh*COT(Φr)) * (Q^(-SIN(Φr)/(1+SIN(Φr)))) - Coh*COT(Φr)

		LAT
WT controls:	0	-4.89

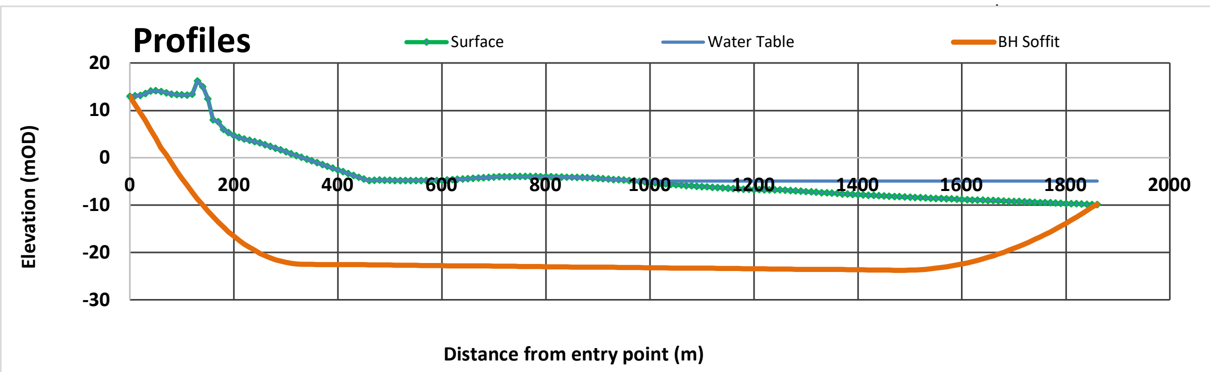
Dist (m)	Elev'n (mOD)	Loc'n	WTL (mOD)	C-Line (mOD)	Soffit (mOD)	Cover (m)	Sat'd (m)	Bou't (m)	U kN/m2	Hs kN/m3
0.00	12.97		12.97		12.97	0.00	0.00	0.00	*0*	*0*
10.00	13.08		13.08		11.21	1.87	0.00	1.87	*18*	*22*
20.00	13.18		13.18		9.45	3.73	0.00	3.73	*37*	*45*
30.00	13.58		13.58		7.96	5.62	0.00	5.62	*55*	*64*
40.00	14.12		14.12		5.94	8.18	0.00	8.18	*80*	*90*
50.00	14.15		14.15		4.18	9.97	0.00	9.97	*98*	*112*
60.00	13.98		13.98		2.15	11.84	0.00	11.84	*116*	*138*
70.00	13.74		13.74		0.66	13.08	0.00	13.08	*128*	*157*
80.00	13.45		13.45		-1.06	14.51	0.00	14.51	*142*	*179*
90.00	13.36		13.36		-2.72	16.08	0.00	16.08	*158*	*200*
100.00	13.28		13.28		-4.31	17.58	0.00	17.58	*172*	*220*
110.00	13.22		13.22		-5.83	19.05	0.00	19.05	*187*	*240*
120.00	13.37		13.37		-7.28	20.66	0.00	20.66	*203*	*258*
130.00	16.25		16.25		-8.67	24.92	0.00	24.92	*244*	*276*
140.00	15.01		15.01		-10.00	25.01	0.00	25.01	*245*	*293*
150.00	12.46		12.46		-11.25	23.71	0.00	23.71	*233*	*309*
160.00	8.02		8.02		-12.44	20.46	0.00	20.46	*201*	*324*
170.00	7.56		7.56		-13.56	21.12	0.00	21.12	*207*	*338*
180.00	5.96		5.96		-14.62	20.58	0.00	20.58	*202*	*352*
190.00	5.29		5.29		-15.61	20.89	0.00	20.89	*205*	*364*
200.00	4.72		4.72		-16.53	21.25	0.00	21.25	*208*	*376*
210.00	4.30		4.30		-17.39	21.69	0.00	21.69	*213*	*387*
220.00	3.97		3.97		-18.18	22.15	0.00	22.15	*217*	*397*
230.00	3.66		3.66		-18.90	22.56	0.00	22.56	*221*	*406*
240.00	3.39		3.39		-19.55	22.95	0.00	22.95	*225*	*415*
250.00	3.17		3.17		-20.14	23.32	0.00	23.32	*229*	*422*
260.00	2.79		2.79		-20.67	23.46	0.00	23.46	*230*	*429*
270.00	2.41		2.41		-21.12	23.53	0.00	23.53	*231*	*435*
280.00	2.03		2.03		-21.51	23.54	0.00	23.54	*231*	*440*
290.00	1.64		1.64		-21.83	23.48	0.00	23.48	*230*	*444*
300.00	1.26		1.26		-22.09	23.35	0.00	23.35	*229*	*447*
310.00	0.88		0.88		-22.28	23.16	0.00	23.16	*227*	*449*
320.00	0.50		0.50		-22.40	22.90	0.00	22.90	*225*	*451*
330.00	0.11		0.11		-22.46	22.57	0.00	22.57	*221*	*452*
340.00	-0.27		-0.27		-22.47	22.20	0.00	22.20	*218*	*452*
350.00	-0.65		-0.65		-22.48	21.83	0.00	21.83	*214*	*452*
360.00	-1.04		-1.04		-22.49	21.46	0.00	21.46	*210*	*452*
370.00	-1.42		-1.42		-22.50	21.08	0.00	21.08	*207*	*452*
380.00	-1.80		-1.80		-22.51	20.71	0.00	20.71	*203*	*452*
390.00	-2.18		-2.18		-22.52	20.34	0.00	20.34	*200*	*453*
400.00	-2.57		-2.57		-22.54	19.97	0.00	19.97	*196*	*453*
410.00	-2.95		-2.95		-22.55	19.60	0.00	19.60	*192*	*453*
420.00	-3.33		-3.33		-22.56	19.23	0.00	19.23	*189*	*453*
430.00	-3.72		-3.72		-22.57	18.85	0.00	18.85	*185*	*453*
440.00	-4.10		-4.10		-22.58	18.48	0.00	18.48	*181*	*453*
450.00	-4.48		-4.48		-22.59	18.11	0.00	18.11	*178*	*453*
460.00	-4.79		-4.79		-22.60	17.81	0.00	17.81	*175*	*454*
470.00	-4.75		-4.75		-22.61	17.87	0.00	17.87	*175*	*454*
480.00	-4.72		-4.72		-22.62	17.91	0.00	17.91	*176*	*454*
490.00	-4.74		-4.74		-22.64	17.90	0.00	17.90	*176*	*454*
500.00	-4.76		-4.76		-22.65	17.89	0.00	17.89	*175*	*454*
510.00	-4.78		-4.78		-22.66	17.88	0.00	17.88	*175*	*454*
520.00	-4.80		-4.80		-22.67	17.87	0.00	17.87	*175*	*454*

530.00	-4.80		-4.80	-22.68	17.88	0.00	17.88	*175*	*455*	
540.00	-4.80		-4.80	-22.69	17.89	0.00	17.89	*176*	*455*	
550.00	-4.80		-4.80	-22.70	17.90	0.00	17.90	*176*	*455*	
560.00	-4.80		-4.80	-22.71	17.91	0.00	17.91	*176*	*455*	
570.00	-4.80		-4.80	-22.72	17.92	0.00	17.92	*176*	*455*	
580.00	-4.80		-4.80	-22.73	17.93	0.00	17.93	*176*	*455*	
590.00	-4.80		-4.80	-22.75	17.95	0.00	17.95	*176*	*455*	
600.00	-4.75		-4.75	-22.76	18.01	0.00	18.01	*177*	*456*	
610.00	-4.68		-4.68	-22.77	18.09	0.00	18.09	*177*	*456*	
620.00	-4.61		-4.61	-22.78	18.17	0.00	18.17	*178*	*456*	
630.00	-4.54		-4.54	-22.79	18.25	0.00	18.25	*179*	*456*	
640.00	-4.48		-4.48	-22.80	18.33	0.00	18.33	*180*	*456*	
650.00	-4.41		-4.41	-22.81	18.41	0.00	18.41	*181*	*456*	
660.00	-4.34		-4.34	-22.82	18.48	0.00	18.48	*181*	*456*	
670.00	-4.27		-4.27	-22.83	18.56	0.00	18.56	*182*	*457*	
680.00	-4.20		-4.20	-22.85	18.64	0.00	18.64	*183*	*457*	
690.00	-4.13		-4.13	-22.86	18.72	0.00	18.72	*184*	*457*	
700.00	-4.07		-4.07	-22.87	18.80	0.00	18.80	*184*	*457*	
710.00	-4.00		-4.00	-22.88	18.88	0.00	18.88	*185*	*457*	
720.00	-3.99		-3.99	-22.89	18.90	0.00	18.90	*185*	*457*	
730.00	-3.98		-3.98	-22.90	18.92	0.00	18.92	*186*	*457*	
740.00	-3.97		-3.97	-22.91	18.94	0.00	18.94	*186*	*458*	
750.00	-3.96		-3.96	-22.92	18.96	0.00	18.96	*186*	*458*	
760.00	-3.95		-3.95	-22.93	18.99	0.00	18.99	*186*	*458*	
770.00	-3.94		-3.94	-22.95	19.01	0.00	19.01	*186*	*458*	
780.00	-3.96		-3.96	-22.96	19.00	0.00	19.00	*186*	*458*	
790.00	-3.97		-3.97	-22.97	18.99	0.00	18.99	*186*	*458*	
800.00	-3.99		-3.99	-22.98	18.99	0.00	18.99	*186*	*458*	
810.00	-4.01		-4.01	-22.99	18.98	0.00	18.98	*186*	*459*	
820.00	-4.04		-4.04	-23.00	18.96	0.00	18.96	*186*	*459*	
830.00	-4.07		-4.07	-23.01	18.94	0.00	18.94	*186*	*459*	
840.00	-4.10		-4.10	-23.02	18.92	0.00	18.92	*186*	*459*	
850.00	-4.12		-4.12	-23.03	18.91	0.00	18.91	*185*	*459*	
860.00	-4.15		-4.15	-23.04	18.90	0.00	18.90	*185*	*459*	
870.00	-4.17		-4.17	-23.06	18.89	0.00	18.89	*185*	*459*	
880.00	-4.22		-4.22	-23.07	18.85	0.00	18.85	*185*	*460*	
890.00	-4.29		-4.29	-23.08	18.79	0.00	18.79	*184*	*460*	
900.00	-4.36		-4.36	-23.09	18.73	0.00	18.73	*184*	*460*	
910.00	-4.43		-4.43	-23.10	18.67	0.00	18.67	*183*	*460*	
920.00	-4.50		-4.50	-23.11	18.61	0.00	18.61	*183*	*460*	
930.00	-4.58		-4.58	-23.12	18.55	0.00	18.55	*182*	*460*	INTERCEPT
940.00	-4.63		-4.63	-23.13	18.51	0.00	18.51	*182*	*397*	
950.00	-4.71		-4.71	-23.14	18.44	0.00	18.44	*181*	*397*	
960.00	-4.79		-4.79	-23.16	18.37	0.00	18.37	*180*	*397*	
970.00	-4.89	sea	-4.89	-23.17	18.28	0.00	18.28	*179*	*397*	
980.00	-4.99	sea	-4.89	-23.18	18.19	0.00	18.19	*179*	*398*	
990.00	-5.09	sea	-4.89	-23.19	18.10	0.00	18.10	*180*	*398*	
1000.00	-5.19	sea	-4.89	-23.20	18.01	0.00	18.01	*180*	*398*	
1010.00	-5.29	sea	-4.89	-23.21	17.92	0.00	17.92	*180*	*398*	
1020.00	-5.39	sea	-4.89	-23.22	17.83	0.00	17.83	*180*	*398*	
1030.00	-5.49	sea	-4.89	-23.23	17.74	0.00	17.74	*180*	*398*	
1040.00	-5.59	sea	-4.89	-23.24	17.65	0.00	17.65	*180*	*398*	
1050.00	-5.69	sea	-4.89	-23.26	17.56	0.00	17.56	*180*	*399*	
1060.00	-5.78	sea	-4.89	-23.27	17.49	0.00	17.49	*180*	*399*	
1070.00	-5.85	sea	-4.89	-23.28	17.43	0.00	17.43	*180*	*399*	
1080.00	-5.93	sea	-4.89	-23.29	17.36	0.00	17.36	*180*	*399*	
1090.00	-6.00	sea	-4.89	-23.30	17.30	0.00	17.30	*181*	*399*	
1100.00	-6.08	sea	-4.89	-23.31	17.23	0.00	17.23	*181*	*399*	
1110.00	-6.16	sea	-4.89	-23.32	17.17	0.00	17.17	*181*	*399*	
1120.00	-6.23	sea	-4.89	-23.33	17.10	0.00	17.10	*181*	*400*	
1130.00	-6.30	sea	-4.89	-23.34	17.04	0.00	17.04	*181*	*400*	
1140.00	-6.37	sea	-4.89	-23.36	16.99	0.00	16.99	*181*	*400*	
1150.00	-6.45	sea	-4.89	-23.37	16.92	0.00	16.92	*181*	*400*	
1160.00	-6.50	sea	-4.89	-23.38	16.88	0.00	16.88	*181*	*400*	
1170.00	-6.55	sea	-4.89	-23.39	16.84	0.00	16.84	*181*	*400*	
1180.00	-6.60	sea	-4.89	-23.40	16.80	0.00	16.80	*182*	*400*	
1190.00	-6.65	sea	-4.89	-23.41	16.76	0.00	16.76	*182*	*401*	

1200.00	-6.70	sea	-4.89	-23.42	16.73	0.00	16.73	*182*	*401*
1210.00	-6.74	sea	-4.89	-23.43	16.69	0.00	16.69	*182*	*401*
1220.00	-6.75	sea	-4.89	-23.44	16.70	0.00	16.70	*182*	*401*
1230.00	-6.75	sea	-4.89	-23.45	16.70	0.00	16.70	*182*	*401*
1240.00	-6.77	sea	-4.89	-23.47	16.70	0.00	16.70	*182*	*401*
1250.00	-6.79	sea	-4.89	-23.48	16.68	0.00	16.68	*182*	*401*
1260.00	-6.85	sea	-4.89	-23.49	16.64	0.00	16.64	*182*	*402*
1270.00	-6.92	sea	-4.89	-23.50	16.58	0.00	16.58	*183*	*402*
1280.00	-6.99	sea	-4.89	-23.51	16.52	0.00	16.52	*183*	*402*
1290.00	-7.06	sea	-4.89	-23.52	16.46	0.00	16.46	*183*	*402*
1300.00	-7.13	sea	-4.89	-23.53	16.40	0.00	16.40	*183*	*402*
1310.00	-7.20	sea	-4.89	-23.54	16.34	0.00	16.34	*183*	*402*
1320.00	-7.27	sea	-4.89	-23.55	16.28	0.00	16.28	*183*	*402*
1330.00	-7.34	sea	-4.89	-23.57	16.23	0.00	16.23	*183*	*403*
1340.00	-7.41	sea	-4.89	-23.58	16.17	0.00	16.17	*183*	*403*
1350.00	-7.47	sea	-4.89	-23.59	16.11	0.00	16.11	*183*	*403*
1360.00	-7.54	sea	-4.89	-23.60	16.06	0.00	16.06	*184*	*403*
1370.00	-7.61	sea	-4.89	-23.61	16.00	0.00	16.00	*184*	*403*
1380.00	-7.67	sea	-4.89	-23.62	15.95	0.00	15.95	*184*	*403*
1390.00	-7.74	sea	-4.89	-23.63	15.90	0.00	15.90	*184*	*403*
1400.00	-7.80	sea	-4.89	-23.64	15.84	0.00	15.84	*184*	*404*
1410.00	-7.85	sea	-4.89	-23.65	15.80	0.00	15.80	*184*	*404*
1420.00	-7.90	sea	-4.89	-23.67	15.76	0.00	15.76	*184*	*404*
1430.00	-7.95	sea	-4.89	-23.68	15.72	0.00	15.72	*184*	*404*
1440.00	-8.00	sea	-4.89	-23.69	15.68	0.00	15.68	*184*	*404*
1450.00	-8.06	sea	-4.89	-23.70	15.64	0.00	15.64	*185*	*404*
1460.00	-8.11	sea	-4.89	-23.71	15.60	0.00	15.60	*185*	*404*
1470.00	-8.16	sea	-4.89	-23.72	15.56	0.00	15.56	*185*	*405*
1480.00	-8.21	sea	-4.89	-23.73	15.52	0.00	15.52	*185*	*405*
1490.00	-8.26	sea	-4.89	-23.73	15.47	0.00	15.47	*185*	*405*
1500.00	-8.31	sea	-4.89	-23.71	15.40	0.00	15.40	*185*	*404*
1510.00	-8.36	sea	-4.89	-23.67	15.31	0.00	15.31	*184*	*404*
1520.00	-8.41	sea	-4.89	-23.61	15.20	0.00	15.20	*184*	*403*
1530.00	-8.46	sea	-4.89	-23.53	15.07	0.00	15.07	*183*	*402*
1540.00	-8.51	sea	-4.89	-23.44	14.92	0.00	14.92	*182*	*401*
1550.00	-8.56	sea	-4.89	-23.32	14.75	0.00	14.75	*181*	*399*
1560.00	-8.61	sea	-4.89	-23.18	14.56	0.00	14.56	*179*	*398*
1570.00	-8.67	sea	-4.89	-23.02	14.35	0.00	14.35	*178*	*396*
1580.00	-8.71	sea	-4.89	-22.84	14.12	0.00	14.12	*176*	*393*
1590.00	-8.76	sea	-4.89	-22.64	13.88	0.00	13.88	*174*	*391*
1600.00	-8.80	sea	-4.89	-22.42	13.62	0.00	13.62	*172*	*388*
1610.00	-8.84	sea	-4.89	-22.18	13.34	0.00	13.34	*170*	*385*
1620.00	-8.88	sea	-4.89	-21.92	13.04	0.00	13.04	*167*	*382*
1630.00	-8.92	sea	-4.89	-21.64	12.72	0.00	12.72	*164*	*378*
1640.00	-8.96	sea	-4.89	-21.34	12.38	0.00	12.38	*161*	*374*
1650.00	-9.00	sea	-4.89	-21.02	12.03	0.00	12.03	*158*	*370*
1660.00	-9.03	sea	-4.89	-20.68	11.65	0.00	11.65	*155*	*366*
1670.00	-9.07	sea	-4.89	-20.32	11.25	0.00	11.25	*151*	*361*
1680.00	-9.12	sea	-4.89	-19.94	10.83	0.00	10.83	*148*	*356*
1690.00	-9.16	sea	-4.89	-19.55	10.39	0.00	10.39	*144*	*351*
1700.00	-9.20	sea	-4.89	-19.13	9.92	0.00	9.92	*140*	*346*
1710.00	-9.25	sea	-4.89	-18.69	9.44	0.00	9.44	*135*	*340*
1720.00	-9.29	sea	-4.89	-18.23	8.94	0.00	8.94	*131*	*334*
1730.00	-9.34	sea	-4.89	-17.75	8.41	0.00	8.41	*126*	*328*
1740.00	-9.38	sea	-4.89	-17.25	7.87	0.00	7.87	*121*	*322*
1750.00	-9.42	sea	-4.89	-16.73	7.30	0.00	7.30	*116*	*315*
1760.00	-9.47	sea	-4.89	-16.19	6.72	0.00	6.72	*111*	*308*
1770.00	-9.51	sea	-4.89	-15.63	6.12	0.00	6.12	*105*	*301*
1780.00	-9.56	sea	-4.89	-15.05	5.49	0.00	5.49	*100*	*294*
1790.00	-9.60	sea	-4.89	-14.45	4.85	0.00	4.85	*94*	*286*
1800.00	-9.64	sea	-4.89	-13.83	4.19	0.00	4.19	*88*	*278*
1810.00	-9.69	sea	-4.89	-13.19	3.51	0.00	3.51	*81*	*270*
1820.00	-9.73	sea	-4.89	-12.53	2.80	0.00	2.80	*75*	*262*
1830.00	-9.77	sea	-4.89	-11.85	2.08	0.00	2.08	*68*	*253*
1840.00	-9.82	sea	-4.89	-11.16	1.34	0.00	1.34	*61*	*244*
1850.00	-9.86	sea	-4.89	-10.45	0.59	0.00	0.59	*55*	*235*
1860.00	-9.89	sea	-4.89	-9.89	0.00	0.00	0.00	*49*	*228*

HDD borehole profile graph based on the above table

JUB	8.00	8.00	8.00	0.00	



Dist (m)	σv (kN/m²)	σh (kN/m²)	σo (kN/m²)	Pf (kN/m²)	Q	Rpmax (m)	Pemax (kN/m²)	Pmax (kN/m²)	Hf (kN/m²)	H (kN/m²)
0.0	0.0	0.0	0.0	1.8	0.00012	0.6	2	2	*0*	*0*
10.0	17.4	0.0	17.4	26.6	0.00060	0.9	38	56	*0*	*23*
20.0	34.8	0.0	34.8	51.3	0.00107	1.9	109	146	*1*	*46*
30.0	52.4	0.0	52.4	76.3	0.00156	2.8	204	259	*1*	*65*
40.0	76.3	0.0	76.3	110.3	0.00221	4.1	357	438	*2*	*91*
50.0	92.9	0.0	92.9	134.0	0.00267	5.0	475	573	*2*	*114*
60.0	110.3	0.0	110.3	158.7	0.00315	5.9	601	717	*2*	*140*
70.0	121.9	0.0	121.9	175.2	0.00347	6.5	685	814	*3*	*160*
80.0	135.3	0.0	135.3	194.2	0.00383	7.3	781	923	*3*	*182*
90.0	149.8	0.0	149.8	215.0	0.00423	8.0	882	1040	*4*	*204*
100.0	163.9	0.0	163.9	234.9	0.00462	8.8	976	1149	*4*	*224*
110.0	177.6	0.0	177.6	254.4	0.00500	9.5	1064	1251	*4*	*244*
120.0	192.5	0.0	192.5	275.7	0.00541	10.3	1157	1359	*5*	*263*
130.0	232.2	0.0	232.2	332.2	0.00650	12.5	1382	1627	*5*	*281*
140.0	233.1	0.0	233.1	333.4	0.00652	12.5	1387	1632	*5*	*298*
150.0	221.0	0.0	221.0	316.2	0.00619	11.9	1321	1554	*6*	*315*
160.0	190.7	0.0	190.7	273.1	0.00536	10.2	1146	1346	*6*	*330*
170.0	196.8	0.0	196.8	281.8	0.00552	10.6	1182	1390	*7*	*345*
180.0	191.8	0.0	191.8	274.7	0.00539	10.3	1152	1354	*7*	*359*
190.0	194.7	0.0	194.7	278.8	0.00547	10.4	1170	1375	*7*	*372*
210.0	202.1	0.0	202.1	289.3	0.00567	10.8	1213	1426	*8*	*395*
220.0	206.4	0.0	206.4	295.5	0.00579	11.1	1239	1456	*9*	*406*
230.0	210.2	0.0	210.2	300.9	0.00589	11.3	1261	1482	*9*	*415*
240.0	213.9	0.0	213.9	306.0	0.00599	11.5	1281	1506	*9*	*424*
250.0	217.3	0.0	217.3	311.0	0.00609	11.7	1300	1529	*10*	*432*
260.0	218.6	0.0	218.6	312.8	0.00612	11.7	1308	1538	*10*	*439*
270.0	219.3	0.0	219.3	313.8	0.00614	11.8	1312	1542	*11*	*445*
280.0	219.4	0.0	219.4	313.9	0.00614	11.8	1312	1543	*11*	*451*
290.0	218.8	0.0	218.8	313.1	0.00613	11.7	1309	1539	*11*	*455*
300.0	217.6	0.0	217.6	311.4	0.00610	11.7	1302	1531	*12*	*459*
310.0	215.8	0.0	215.8	308.8	0.00605	11.6	1292	1519	*12*	*462*
320.0	213.4	0.0	213.4	305.4	0.00598	11.4	1278	1503	*13*	*464*
330.0	210.3	0.0	210.3	301.0	0.00590	11.3	1261	1482	*13*	*465*
340.0	206.9	0.0	206.9	296.1	0.00580	11.1	1241	1459	*13*	*465*
350.0	203.4	0.0	203.4	291.2	0.00571	10.9	1221	1435	*14*	*466*
360.0	199.9	0.0	199.9	286.3	0.00561	10.7	1201	1411	*14*	*466*
370.0	196.5	0.0	196.5	281.3	0.00552	10.5	1180	1387	*15*	*467*
380.0	193.0	0.0	193.0	276.4	0.00542	10.4	1160	1363	*15*	*467*
390.0	189.6	0.0	189.6	271.5	0.00532	10.2	1139	1338	*15*	*468*
400.0	186.1	0.0	186.1	266.6	0.00523	10.0	1118	1313	*16*	*468*
410.0	182.6	0.0	182.6	261.6	0.00513	9.8	1096	1288	*16*	*469*
420.0	179.2	0.0	179.2	256.7	0.00504	9.6	1075	1263	*16*	*469*
430.0	175.7	0.0	175.7	251.8	0.00494	9.4	1053	1238	*17*	*470*
440.0	172.2	0.0	172.2	246.8	0.00485	9.2	1031	1212	*17*	*471*
450.0	168.8	0.0	168.8	241.9	0.00475	9.1	1008	1186	*18*	*471*
460.0	166.0	0.0	166.0	237.9	0.00468	8.9	990	1165	*18*	*472*
470.0	166.5	0.0	166.5	238.7	0.00469	8.9	994	1169	*18*	*472*
480.0	166.9	0.0	166.9	239.2	0.00470	9.0	996	1172	*19*	*473*
490.0	166.8	0.0	166.8	239.1	0.00470	8.9	995	1171	*19*	*473*
500.0	166.7	0.0	166.7	238.9	0.00470	8.9	995	1170	*20*	*474*
510.0	166.6	0.0	166.6	238.8	0.00469	8.9	994	1170	*20*	*474*
520.0	166.5	0.0	166.5	238.7	0.00469	8.9	994	1169	*20*	*475*
530.0	166.6	0.0	166.6	238.9	0.00469	8.9	994	1170	*21*	*475*
540.0	166.7	0.0	166.7	239.0	0.00470	8.9	995	1171	*21*	*476*

*The pressure calculations are set out in this table. Note that **Rpmax** varies as it is set to be a proportion of the cover depth.*

Hf is a rough estimate of the drilling mud pressure in the return annular flow.

*The total head **H** is the static head **Hs** (table above) and **Hf**.*

550.0	166.8	0.0	166.8	239.1	0.00470	9.0	996	1171	22	476
560.0	166.9	0.0	166.9	239.3	0.00470	9.0	996	1172	22	477
570.0	167.0	0.0	167.0	239.4	0.00471	9.0	997	1173	22	477
580.0	167.1	0.0	167.1	239.6	0.00471	9.0	998	1174	23	478
590.0	167.2	0.0	167.2	239.7	0.00471	9.0	998	1174	23	479
600.0	167.8	0.0	167.8	240.6	0.00473	9.0	1002	1179	24	479
610.0	168.6	0.0	168.6	241.6	0.00475	9.0	1007	1184	24	480
620.0	169.3	0.0	169.3	242.7	0.00477	9.1	1012	1190	24	480
630.0	170.0	0.0	170.0	243.7	0.00479	9.1	1017	1196	25	481
640.0	170.8	0.0	170.8	244.8	0.00481	9.2	1021	1201	25	481
650.0	171.5	0.0	171.5	245.8	0.00483	9.2	1026	1207	25	482
660.0	172.3	0.0	172.3	246.9	0.00485	9.2	1031	1212	26	482
670.0	173.0	0.0	173.0	247.9	0.00487	9.3	1036	1218	26	483
680.0	173.7	0.0	173.7	249.0	0.00489	9.3	1040	1223	27	483
690.0	174.5	0.0	174.5	250.0	0.00491	9.4	1045	1229	27	484
700.0	175.2	0.0	175.2	251.1	0.00493	9.4	1050	1234	27	484
710.0	175.9	0.0	175.9	252.1	0.00495	9.4	1054	1239	28	485
720.0	176.1	0.0	176.1	252.4	0.00496	9.4	1055	1241	28	485
730.0	176.3	0.0	176.3	252.6	0.00496	9.5	1057	1242	29	486
740.0	176.5	0.0	176.5	252.9	0.00497	9.5	1058	1244	29	487
750.0	176.7	0.0	176.7	253.2	0.00497	9.5	1059	1245	29	487
760.0	176.9	0.0	176.9	253.5	0.00498	9.5	1061	1247	30	488
770.0	177.1	0.0	177.1	253.8	0.00498	9.5	1062	1248	30	488
780.0	177.1	0.0	177.1	253.7	0.00498	9.5	1061	1248	31	489
790.0	177.0	0.0	177.0	253.6	0.00498	9.5	1061	1247	31	489
800.0	177.0	0.0	177.0	253.6	0.00498	9.5	1061	1247	31	490
810.0	176.9	0.0	176.9	253.4	0.00498	9.5	1060	1246	32	490
820.0	176.7	0.0	176.7	253.2	0.00497	9.5	1059	1245	32	491
830.0	176.5	0.0	176.5	252.9	0.00497	9.5	1058	1244	33	491
840.0	176.3	0.0	176.3	252.7	0.00496	9.5	1057	1242	33	492
850.0	176.2	0.0	176.2	252.5	0.00496	9.5	1056	1242	33	492
860.0	176.1	0.0	176.1	252.4	0.00496	9.4	1055	1241	34	493
870.0	176.0	0.0	176.0	252.2	0.00495	9.4	1055	1240	34	493
880.0	175.7	0.0	175.7	251.8	0.00494	9.4	1053	1238	34	494
890.0	175.1	0.0	175.1	250.9	0.00493	9.4	1049	1233	35	495
900.0	174.6	0.0	174.6	250.1	0.00491	9.4	1045	1229	35	495
910.0	174.0	0.0	174.0	249.3	0.00490	9.3	1042	1225	36	496
920.0	173.4	0.0	173.4	248.5	0.00488	9.3	1038	1221	36	496
930.0	172.8	0.0	172.8	247.7	0.00487	9.3	1035	1217	36	
920.0	176.0	0.0	176.0	252.2	0.00495	9.4	1055	1240	36	433
910.0	175.7	0.0	175.7	251.8	0.00494	9.4	1053	1238	36	433
900.0	175.1	0.0	175.1	250.9	0.00493	9.4	1049	1233	35	433
890.0	174.6	0.0	174.6	250.1	0.00491	9.4	1045	1229	35	432
880.0	174.0	0.0	174.0	249.3	0.00490	9.3	1042	1225	34	432
870.0	173.4	0.0	173.4	248.5	0.00488	9.3	1038	1221	34	432
860.0	172.8	0.0	172.8	247.7	0.00487	9.3	1035	1217	34	432
850.0	172.5	0.0	172.5	247.2	0.00486	9.3	1032	1214	33	431
840.0	171.8	0.0	171.8	246.3	0.00484	9.2	1028	1209	33	431
830.0	171.2	0.0	171.2	245.3	0.00482	9.2	1024	1204	33	431
820.0	170.4	0.0	170.4	244.2	0.00480	9.1	1019	1198	32	431
810.0	169.5	0.0	169.5	243.0	0.00477	9.1	1013	1192	32	430
800.0	168.7	0.0	168.7	241.8	0.00475	9.0	1008	1187	31	430
790.0	167.9	0.0	167.9	240.6	0.00473	9.0	1002	1182	31	430
780.0	167.0	0.0	167.0	239.4	0.00471	9.0	997	1177	31	430
770.0	166.2	0.0	166.2	238.2	0.00468	8.9	992	1171	30	429
760.0	165.4	0.0	165.4	237.1	0.00466	8.9	986	1166	30	429
750.0	164.5	0.0	164.5	235.9	0.00464	8.8	981	1161	29	429
740.0	163.7	0.0	163.7	234.7	0.00461	8.8	975	1155	29	429
730.0	163.0	0.0	163.0	233.7	0.00459	8.7	971	1151	29	428
720.0	162.4	0.0	162.4	232.8	0.00458	8.7	967	1147	28	428
710.0	161.8	0.0	161.8	232.0	0.00456	8.7	963	1143	28	428
700.0	161.2	0.0	161.2	231.1	0.00455	8.6	959	1139	27	428
690.0	160.6	0.0	160.6	230.3	0.00453	8.6	955	1135	27	427
680.0	160.0	0.0	160.0	229.4	0.00451	8.6	951	1131	27	427
670.0	159.4	0.0	159.4	228.6	0.00450	8.6	947	1128	26	427
660.0	158.8	0.0	158.8	227.7	0.00448	8.5	943	1124	26	427
650.0	158.3	0.0	158.3	227.0	0.00447	8.5	940	1121	25	426
640.0	157.6	0.0	157.6	226.1	0.00445	8.5	935	1116	25	426
630.0	157.3	0.0	157.3	225.6	0.00444	8.4	933	1114	25	426
620.0	156.9	0.0	156.9	225.1	0.00443	8.4	930	1112	24	426
610.0	156.6	0.0	156.6	224.6	0.00442	8.4	928	1110	24	425
600.0	156.2	0.0	156.2	224.1	0.00441	8.4	926	1107	24	425
590.0	155.9	0.0	155.9	223.6	0.00440	8.4	923	1105	23	425
580.0	155.5	0.0	155.5	223.1	0.00439	8.3	921	1103	23	425
570.0	155.6	0.0	155.6	223.2	0.00439	8.3	921	1103	22	424
560.0	155.7	0.0	155.7	223.3	0.00439	8.4	922	1104	22	424
550.0	155.6	0.0	155.6	223.2	0.00439	8.3	921	1104	22	424

540.0	155.5	0.0	155.5	223.0	0.00439	8.3	921	1103	*21*	*424*
530.0	155.0	0.0	155.0	222.4	0.00438	8.3	918	1100	*21*	*423*
520.0	154.5	0.0	154.5	221.6	0.00436	8.3	914	1097	*20*	*423*
510.0	153.9	0.0	153.9	220.8	0.00435	8.3	910	1093	*20*	*423*
500.0	153.4	0.0	153.4	220.0	0.00433	8.2	907	1089	*20*	*423*
490.0	152.8	0.0	152.8	219.2	0.00432	8.2	903	1086	*19*	*422*
480.0	152.3	0.0	152.3	218.4	0.00430	8.2	899	1082	*19*	*422*
470.0	151.7	0.0	151.7	217.7	0.00429	8.1	895	1078	*18*	*422*
460.0	151.2	0.0	151.2	216.9	0.00427	8.1	892	1075	*18*	*422*
450.0	150.7	0.0	150.7	216.2	0.00426	8.1	888	1071	*18*	*421*
440.0	150.2	0.0	150.2	215.4	0.00424	8.1	885	1068	*17*	*421*
430.0	149.7	0.0	149.7	214.7	0.00423	8.0	881	1065	*17*	*421*
420.0	149.1	0.0	149.1	214.0	0.00421	8.0	878	1061	*16*	*421*
410.0	148.6	0.0	148.6	213.3	0.00420	8.0	874	1058	*16*	*420*
400.0	148.1	0.0	148.1	212.6	0.00419	7.9	871	1055	*16*	*420*
390.0	147.6	0.0	147.6	211.8	0.00417	7.9	867	1051	*15*	*420*
380.0	147.3	0.0	147.3	211.3	0.00416	7.9	865	1049	*15*	*420*
370.0	146.9	0.0	146.9	210.8	0.00415	7.9	862	1046	*15*	*419*
360.0	146.5	0.0	146.5	210.3	0.00414	7.9	860	1044	*14*	*419*
350.0	146.2	0.0	146.2	209.7	0.00413	7.8	857	1042	*14*	*418*
340.0	145.8	0.0	145.8	209.2	0.00412	7.8	855	1039	*13*	*416*
330.0	145.4	0.0	145.4	208.7	0.00411	7.8	852	1037	*13*	*415*
320.0	145.0	0.0	145.0	208.1	0.00410	7.8	849	1034	*13*	*413*
310.0	144.7	0.0	144.7	207.6	0.00409	7.8	847	1032	*12*	*412*
300.0	144.2	0.0	144.2	207.0	0.00408	7.7	844	1028	*12*	*409*
290.0	143.5	0.0	143.5	206.0	0.00406	7.7	839	1024	*11*	*407*
280.0	142.7	0.0	142.7	204.8	0.00404	7.7	833	1018	*11*	*404*
270.0	141.7	0.0	141.7	203.4	0.00401	7.6	826	1010	*11*	*401*
260.0	140.5	0.0	140.5	201.6	0.00398	7.5	818	1001	*10*	*398*
250.0	139.1	0.0	139.1	199.6	0.00394	7.5	808	990	*10*	*395*
240.0	137.5	0.0	137.5	197.4	0.00389	7.4	797	977	*9*	*391*
230.0	135.7	0.0	135.7	194.9	0.00385	7.3	784	964	*9*	*387*
220.0	133.8	0.0	133.8	192.1	0.00379	7.2	770	948	*9*	*383*
210.0	131.6	0.0	131.6	189.1	0.00373	7.1	755	931	*8*	*378*
200.0	129.3	0.0	129.3	185.8	0.00367	6.9	739	913	*8*	*374*
190.0	126.9	0.0	126.9	182.3	0.00360	6.8	722	893	*7*	*369*
180.0	124.3	0.0	124.3	178.7	0.00353	6.7	703	873	*7*	*363*
170.0	121.5	0.0	121.5	174.7	0.00346	6.5	683	850	*7*	*358*
160.0	118.5	0.0	118.5	170.4	0.00337	6.4	661	825	*6*	*352*
150.0	115.4	0.0	115.4	166.0	0.00329	6.2	638	800	*6*	*346*
140.0	112.1	0.0	112.1	161.2	0.00320	6.0	614	772	*5*	*340*
130.0	108.6	0.0	108.6	156.3	0.00310	5.8	589	744	*5*	*333*
120.0	32.7	0.0	32.7	48.3	0.00102	1.8	99	181	*5*	*327*
110.0	26.1	0.0	26.1	39.0	0.00084	1.4	70	145	*4*	*320*
100.0	19.4	0.0	19.4	29.4	0.00065	1.0	44	113	*4*	*312*
90.0	12.5	0.0	12.5	19.6	0.00046	0.7	22	84	*4*	*305*
80.0	5.5	0.0	5.5	9.7	0.00027	0.3	5	60	*3*	*297*
70.0	0.0	0.0	0.0	1.8	0.00012	0.6	2	51	*3*	*289*
60.0	153.0	0.0	153.0	219.5	0.00432	4.0	675	675	*2*	*281*
50.0	0.0	0.0	0.0	1.8	0.00012	0.6	2	2	*2*	*272*
40.0	0.0	0.0	0.0	1.8	0.00012	0.6	2	2	*2*	*263*
30.0	0.0	0.0	0.0	1.8	0.00012	0.6	2	2	*1*	*254*
20.0	0.0	0.0	0.0	1.8	0.00012	0.6	2	2	*1*	*245*
10.0	0.0	0.0	0.0	1.8	0.00012	0.6	2	2	*0*	*236*
0.0	0.0	0.0	0.0	1.8	0.00012	0.6	2	2	*0*	*228*

Comments

White Cross Offshore Windfarm

Appendix 5.B: Outline Construction Environmental Management Plan

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Approved by Client:	OG	*Electronic Signature*

Version Number	Reason for Issue / Major Changes	Date of Change
00	For Issue	09/08/2023

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Glossary of Acronyms

Acronym	Definition
CEMP	Construction Environmental Management Plan
COSHH	Control of Substances Hazardous to Health
EA	Environment Agency
EIA	Environmental Impact Assessment
EMS	Environmental Management System
ES	Environmental Statement
EU	European Union
HSE	Health Safety Environment
km	Kilometre
MHWS	Mean High Water Springs
MMO	Marine Management Organisation
MW	Megawatts
NE	Natural England
PEMP	Project Environmental Management Plan
PPG	Pollution Prevention Guidance
SAC	Special Area of Conservation
SSSI	Site of Special Scientific Interest
SUDS	Sustainable Urban Drainage Systems
TBT	Toolbox Talk
TCPA	Town and Country Planning Act
UK	United Kingdom
WSI	Written Scheme of Investigation

Glossary of Terminology

Defined Term	Description
Applicant	White Cross Offshore Windfarm Limited
Environmental Impact Assessment (EIA)	Assessment of the potential impact of the proposed Project on the physical, biological and human environment during construction, operation and decommissioning.
Export Cable Corridor	The area in which the export cables will be laid, either from the Offshore Substation or the inter-array cable junction box (if no offshore substation), to the NG Onshore Substation comprising both the Offshore Export Cable Corridor and Onshore Export Cable Corridor.
Landfall	Where the offshore export cables come ashore
Mean high water springs	The average tidal height throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest.
Mean low water springs	The average tidal height throughout a year of two successive low waters during those periods of 24 hours when the range of the tide is at its greatest.
Mitigation	Mitigation measures have been proposed where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts and discussed with the relevant authorities and stakeholders in order to avoid, prevent or reduce impacts to acceptable levels. For the purposes of the EIA, two types of mitigation are defined: • Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIA • Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or eliminate any predicted significant impacts. Additional mitigation is therefore subsequently adopted by WCOWL as the EIA process progresses.
National Grid Onshore Substation	Part of an electrical transmission and distribution system. Substations transform voltage from high to low, or the reverse by means of the electrical transformers.
National Grid Connection Point	The point at which the White Cross Offshore Windfarm connects into the distribution network at East Yelland substation and the distributed electricity network. From East Yelland substation electricity is transmitted to Alverdiscott where it enters the national transmission network.
Onshore Export Cables	The cables which bring electricity from MLWS at the Landfall to the White Cross Onshore Substation and onward to the NG grid connection point at East Yelland.
Onshore Export Cable Corridor	The proposed onshore area in which the export cables will be laid, from MLWS at the Landfall to the White Cross Onshore Substation and onward to the NG grid connection point at East Yelland.
Onshore Infrastructure	The combined name for all infrastructure associated with the Project from MLWS at the Landfall to the NG grid connection point at East Yelland. The onshore infrastructure will form part of a separate planning application to the Local Planning Authority (LPA) under the Town and Country Planning Act 1990
the Onshore Project	The Onshore Project for the onshore TCPA application includes all elements onshore of MLWS. This includes the infrastructure associated with the offshore export cable (from MLWS), landfall, Onshore Export Cable and associated infrastructure and new Onshore Substation (if required).

Defined Term	Description
White Cross Offshore Windfarm Limited	White Cross Offshore Windfarm Ltd (WCOWL) is a joint venture between Cobra Instalaciones Servicios, S.A., and Flotation Energy Ltd
White Cross Offshore Windfarm	Up to 100MW capacity offshore windfarm including associated onshore and offshore infrastructure
White Cross Onshore Substation	A new substation built specifically for the White Cross project. It is required to ensure electrical power produced by the offshore windfarm is compliant with NG electrical requirements at the grid connection point at East Yelland.
Windfarm Site	The area within which the wind turbines, Offshore Substation Platform and inter-array cables will be present
Works completion date	Date at which construction works are deemed to be complete and the windfarm is handed to the operations team. In reality, this may take place over a period of time.

Appendix 5.B: Outline Construction Environmental Management Plan

1. Introduction

1. There are potential onshore environmental sensitivities associated with the Onshore Project, which need to be identified and considered before construction of its associated infrastructure takes place. These potential effects are outlined in the Onshore Project's Environmental Statement (ES), including embedded mitigation in the form of good practice that will require an adherence to during the construction phase as a minimum standard. A description of the proposed development is presented in **Chapter 5: Project Description**. The Onshore Project infrastructure is shown in **Figure 4.1**.

2. Offshore Wind Limited (henceforth the 'Applicant') recognises from feedback during the Environmental Impact Assessment (EIA) consultation and stakeholder engagement process, that the provision of an Outline Construction Environmental Management Plan (Outline CEMP) for the Onshore Project is required. The Outline CEMP adds value by demonstrating the linkages between the ES, site activities, and likely conditions associated with the Town and Country Planning Act 1990 (TCPA, 1990).

2. Purpose of the Outline CEMP

3. The purpose of the Outline CEMP is to set out the framework of the CEMP. It sets out the controls and processes that will be developed and adopted in the CEMP to mitigate environmental impacts throughout the construction phase of the Onshore Project and measures set out to comply with consent conditions.

4. The CEMP will be prepared by the Principal Contractor appointed by the Applicant. Principal Contractors will be responsible for the construction of the main infrastructure associated with the Onshore Project including the Onshore Export Cable and Onshore Substation.

5. The Principal Contractor is required to operate an Environmental Management System (EMS) based on the requirements of ISO 14001:2015, which describes the processes and procedures by which the environmental issues are managed in line with the relevant legislation and standards, pollution prevention and continual improvement.

6. Typical contents for an Onshore Project CEMP are set out below. Outline content for each section is described in:

- **Section 4: Project Description and Environmental Sensitivities**
- **Section 5: Management of Key Environmental Issues**
- **Section 6: Environmental Management Structure and Responsibilities**
- **Section 7: Environmental Incident Response and Contingency**
- **Section 8: Monitoring**
- **Section 9: Training and Awareness**
- **Section 10: Communication and Reporting**
- **Section 11: Sub-Contractor Management**
- **Section 12: Sustainable Construction**

3. Legislative and Regulatory Compliance

3.1 Town and Country Planning Act 1990

7. Planning permission under TCPA 1990 is required for the Onshore Project infrastructure (landward of MLWS). The Town and Country Planning Act 1990 will be the key permission to be adhered to for the Onshore Project and the planning conditions will need to be taken into consideration during the development of the CEMP.

8. The Principal Contractor must ensure that all relevant planning conditions for the Onshore Project are complied with.

3.2 Legal compliance

9. The ES identified the legal requirements which the Onshore Project has to comply with. The environmental legislation is covered in **Chapter 3: Policy and Legislative Context** of the Onshore Project ES and topic specific legislation presented in the technical chapters of the ES (**Chapter 8 to 24**).

10. The Principal Contractor will be required to ensure that all relevant environmental legislation and good practice are complied with on site.

11. The Principal Contractor will be responsible for applying for and obtaining any permits/licenses related to the construction activities. Specific consents and licenses will be applied for to Government bodies such as Natural England, the Lead Local Flood Authority and the Environment Agency (EA).

12. Specific limits for emissions to air, discharges to the marine environment and working practices (such as seasonal exclusions) are contained within these consents/licenses and shall not be breached at any time.

3.3 Guidance

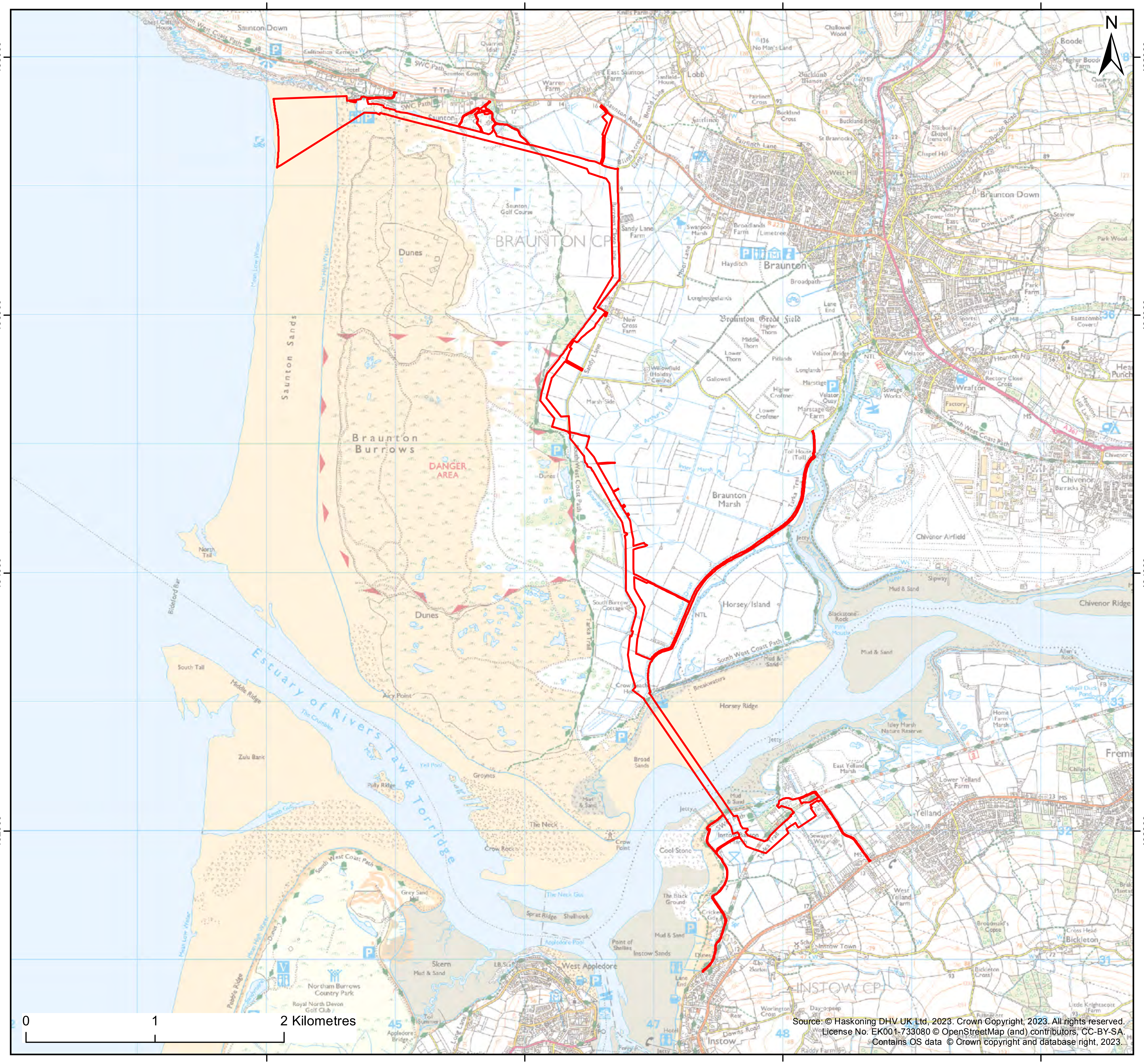
13. Good Practice Guidance/Industry Standards such as Pollution Prevention Guidance Notes and other guidance documents are available from the EA and Marine Management Organisation (MMO) websites. As requested within the MMO's Scoping Opinion (Case reference: EIA/2022/00002), PPG5 – Works and maintenance in or near water[1] and PPG6 – Working at construction and demolition sites will be adhered to[2].

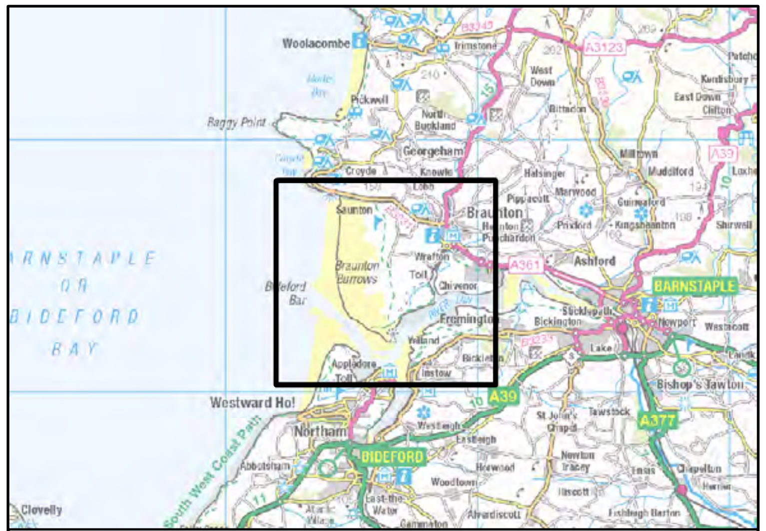
4. Project Description and Environmental Sensitivities

14. **Chapter 5: Project Description** of the Onshore Project ES provides a description of the Onshore Project and sets out the Project Design Envelope. The Onshore Development Area is shown in **Figure 4.1**.

1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/485199/pmho1107bnkg-e-e.pdf

2 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/485215/pmho0412bwfe-e-e.pdf





Legend:

Onshore Development Area

Client:	Project:
Offshore Wind Ltd.	White Cross Offshore Windfarm

Title:

Onshore Development Area

Figure:	Drawing No:
4.1	PC2978-RHD-ZZ-XX-DR-Z-0706

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	03/08/2023	AB	LA	A3	1:30,000

Co-ordinate system: British National Grid

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15. Following the final detailed design phase, this section of the CEMP will set out information with regard to the detailed design and the associated environmental sensitivities. In particular, sensitive ecological, archaeological or human receptors, such as protected habitats, protected wrecks, constraints from other infrastructure, site layout plans, and the scope of works to be undertaken, will be considered.

16. The Principal Contractor for the construction of the Onshore Project will be required to prepare an Aspect and Impacts Register as part of their Environmental Management System (EMS).

5. Management of Key Environmental Issues

17. This section should refer to relevant associated environmental documents which form part of the Principal Contractor EMS and project/site specific documentation that is required to be developed as part of the CEMP.

18. The controls and procedures to be adopted to mitigate the environmental impacts associated with the development would cover the following issues:

- Noise and vibration
- Terrestrial ecology
- Terrestrial archaeology and cultural heritage
- Wastewater discharges
- Oils, fuel, and chemicals
- Waste management and circular economy
- Traffic management
- Surface water management
- Water abstraction
- Emissions to air
- UXO risk
- Project programme and working hours.

19. It is recognised that some of the issues identified above relate only to the terrestrial environment, whilst others will apply to both the onshore and offshore construction activities. A separate offshore specific Outline CEMP has been produced and submitted as part of the Offshore Project ES.

5.1 Noise and vibration

20. There is the potential for noise and vibration to be generated during the construction process, especially from heavy plant and machinery. Measures will be required to be implemented on site to minimise any effects and a programme of monitoring may be required.

21. Within **Chapter 18: Noise and Vibration** (Section 22.4.1), of the Onshore Project ES, receptors that may be sensitive to noise and vibration effects are identified, along with proposed mitigation measures. It is the responsibility of the Principal Contractor to have in place adequate controls measure to avoid and minimise noise and vibration impacts during the construction phase. Proposed mitigation within **Chapter 18: Noise and Vibration** includes:

- Commitment to Best Practicable Means (BPM) implemented during the construction phase, detailed in the Construction Noise and Vibration Management Plan
- Temporary screening at the Landfall and along the haul road
- Traffic management measures specified in Construction Traffic Management Plan (CTMP). A CTMP is included in **Appendix 19.B**.

5.2 Terrestrial ecology

22. **Chapter 16: Onshore Ecology and Ornithology** within the Onshore Project ES identifies areas of conservation/protection and sets out appropriate mitigation (**Section 16.3.6**).

23. It is the responsibility of the Principal Contractor to have in place adequate controls measure to avoid and minimise impacts on the flora and fauna and any protected species. The CEMP will provide details of the extent and location of the standoff. As such, the features of this SSSI and SAC would not be directly affected by the proposed crossing works and no change to Braunton Barrows SAC/ SSSI is predicted.

24. Precautionary measures to ensure legal compliance will be incorporated within the CEMP as detailed in **Section 16.3.6.** These include pre-construction surveys, habitat manipulation and vegetation clearance. The Principal Contractor will employ an Ecological Clerk of Works (ECoW) prior to the commencement of works to ensure that the specified protection and mitigation measures are appropriately implemented.

25. Lighting of habitats suitable for foraging or commuting bats will be avoided, and where the use of lighting is necessary within the Onshore Development Area, then the lighting will be minimised during the period when bats are active. The CEMP will provide further detail on lighting requirements.

5.2.1 Invasive and Non-Native Species

26. An Invasive and Non-Native Species (INNS) Management Plan will be detailed in the CEMP which will include the following measures:

- A plan of all INNS locations and extents
- A protocol for removing INNS and for managing the waste generated

- Good site practice measures for managing the spread of invasive species during works at or near to watercourses
- A requirement for an ECoW and details of their responsibilities with respect to non-native invasive species.

5.2.2 Hedgerow Removal

27. Prior to the commencement of any works to a hedgerow, an ECoW will be present on site to ensure that the specified protection and mitigation measures are appropriately implemented. Replacement planting of removed hedgerows and trees will be implemented during the first suitable period following completion of the construction works. Gaps in hedges will be present initially until the new planting matures.

28. The species list for re-instatement will be of UK and local provenance species, such as hawthorn, blackthorn, field maple *Acer campestre*, dog-rose *Rosa canina*, hazel *Corylus avellana*, dogwood *Cornus sanguinea*, crab apple *Malus sylvestris* and holly *Ilex aquifolium*. Replanting of hedgerow trees will use either pedunculate oak *Quercus robur* or a like for like replacement if other native species are to be removed, as appropriate. It is likely that the reinstatement will increase the range of species present in some sections of hedgerow which are currently species poor.

29. Ecological enhancement will involve reinstating pre-existing gaps in hedgerows within the Onshore Development Area.

5.3 Terrestrial archaeology and cultural heritage

30. **Chapter 17: Onshore Archaeology and Cultural Heritage** within the Onshore Project ES identifies sites of potential archaeological importance, and these will be identified in the Written Scheme of Investigation (WSI) with appropriate mitigation, such as establishment of exclusion and buffer zones clearly marked out. The CEMP should include the measures to be adopted to communicate awareness of sensitive archaeological sites to the Project team and procedures to be adopted in the event of an unanticipated find.

31. An Outline Onshore Written Scheme of Investigation (WSI) (**Appendix 17.E**) is submitted alongside the Outline CEMP.

32. The Principal Contractor is required to prepare site specific WSIs and final pre-construction and construction mitigation WSIs and be agreed with and approved by the relevant planning authority in consultation with Devon County Council Historic Environment Team (DCC HET) (and Historic England (HE), as required) in the post-consent stages of the project.

5.4 Wastewater discharges

33. The Principal Contractor will be responsible for obtaining any permits from the regulator associated with the use of septic tanks or other effluent/washout water treatment facilities. In addition, they will be responsible for monitoring and recording specified volumetric, quality or reference conditions, to demonstrate compliance.

34. Waste sludge from septic tanks and effluents from cesspits and sewage holding tanks must be removed by a suitably licenced and registered waste carrier in accordance with Duty of Care requirements.

35. Monitoring records in relation to the disposal of grey water, foul water, bilge water or ballast water during the construction phase must be retained.

5.5 Oils, fuels, and chemicals

36. It is the responsibility of each Principal Contractor to have in place adequate controls for the delivery, storage and use of fuels, oils and chemicals on site, and other materials as required.

37. The Principal Contractor must consider the delivery, storage, and handling of hazardous materials, in particular oils and fuels, taking into account the legal requirements and good practice guidelines.

38. Oils and chemicals must be clearly labelled, and the Principal Contractor should retain an up-to-date hazardous substance register. Activities involving the handling of large quantities of hazardous materials, such as deliveries and refuelling, should have detailed method statements in place and be undertaken by designated and trained personnel.

39. Oil and fuel storage tanks must be robust and provide adequate secondary containment and be located in designated areas taking into account security, the location of sensitive receptors and pathways such as drains and watercourses, and safe access and egress for plant and manual handling.

40. Spill response materials should be provided nearby and be readily accessible, with project personnel trained in spill response.

5.5.1 Control of Substances Hazardous to Health (COSHH)

41. The Principal Contractor is responsible for ensuring that all materials ordered or brought to site listed as hazardous under the Control of Substances Hazardous to Health (COSHH) Regulations are accompanied with a hazardous information sheet. The Principal Contractor will comply with the COSHH Regulations.

5.6 Waste management and circular economy

42. Waste generated during the excavation, demolition and construction of the Onshore Project will be managed by the Principal Contractor in accordance with the waste hierarchy. The waste hierarchy requires the producer/holder of a waste to demonstrate that the priorities outlined in **Table 5.1** have been considered in the priority order, and to determine the most suitable waste management option for all wastes prior to removal from site. The Applicant will aim to prevent, reuse, recycle and/or recover waste where practical and economically feasible prior to considering disposal.

Table 5.1 The Waste Hierarchy

Waste Hierarchy	Relevant activity
Prevention	Using less material in design and manufacture, keeping products for longer, re-use, using less hazardous materials.
Preparing for re-use	Checking, cleaning, repairing, refurbishing, whole items, or spare parts.
Recycling	Turning waste into a new substance or product, includes composting if it meets quality protocols.
Other recovering	Includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat, and power) and materials from waste, some backfilling.
Disposal	Landfill and incineration without energy recovery.

Table reproduced from Defra website: https://www.gov.uk/waste-legislation-and-regulations

43. The design of the Onshore Project will consider sustainability principals to make sure that over ordering on materials such a substation components, cement bound sand, ducting, tape, tiles and cables is kept to a minimum. As part of the preliminary design of the Onshore Project for the planning application estimates on the likely material quantities to be used during the construction phase have been provided by the engineering team. These quantities will be further refined as the project moves through the detailed design and will be monitored through the use of a Quantity Surveyor during the construction phase of the Onshore Project.

44. During construction the Principal Contractor will be responsible for the collection, storage and disposal of any waste produced as part of the Onshore Project and will be required to prepare a Site Waste Management Plan (SWMP) in line with legislation, good practice. The SWMP will be developed post-consent to ensure the proper handling and protocols are in place to deal with any generated wastes. The Plan will record the following information, as a minimum:

- The types and quantities of waste generated

- The management approach for each waste type (Reuse, Recycle, Recover, Dispose) including any treatment
- The storage arrangements for each waste type
- The site waste monitoring and reporting arrangements
- Waste carrier details and waste management/disposal facilities.

45. Adoption of a CL:AIRE Industry Code of Practice to manage the re-use and disposal of excavated soils within the Onshore Development Area would also be incorporated as an additional mitigation measure in the CEMP, this would aid in maximising sustainability and provide an audit trail to demonstrate the appropriate use of materials. A Materials Management Plan will be drafted in advance of any construction works, this would include chemical screening criteria in order to ensure that imported and/or reused materials are chemically suitable for use. If materials identified as containing asbestos are identified, then a specialist contractor would be employed to aid in its removal from Onshore Project Area, in line with current legislation.

46. Circular economy principles will be considered, where practical and economically feasible, specifically the priority area of circular construction and adopting circular economy interventions such as:

- adopting circular design principles and construction processes, particularly the opportunity to create a physical and virtual resource recovery and material exchange hub to make better use of material wasted in construction
- supporting the growth of regional specialist circular products and services in the construction industry.

47. Further information is contained within the Waste Audit Statement (refer to **Annex 1**).

5.7 Traffic management

48. **Chapter 19: Traffic and Transport** within the Onshore Project ES identified that during the construction phase for onshore aspects of the development, there will be traffic movements within the site boundary in addition to associated traffic movements on the local road network, including heavy goods vehicles, which may give rise to significant environment effects. Measures to address associated impacts are set out in **Appendix 23.B: Outline Construction Traffic Management Plan** (CTMP) and will be developed into a full CTMP which will be part of the CEMP.

49. The list below sets out the implementation of each of the measures that will be implemented by the Applicant, Principal Contractor and the Traffic Management Coordinator (TMCo). The exact details and associated timescales will be

established in consultation with Devon County Council as part of the preparation of the final CTMP:

- Appointment of a TMCo
- Obtain technical approval for construction of accesses and crossings
- Implement direction signing
- Establish monitoring systems:
    - Delivery booking system
    - Highway condition
    - Unique vehicle identifier
    - Telephone reporting system.
- Agree scope of and undertake pre-commencement highway condition surveys.
- Agree and implement measures for each access to control the deposition of detritus on the public highway
- Inspect the highway for detritus and request regular cleansing as required.
- Monitoring of CTMP measures:
    - HGV trips
    - Accidents and near misses
    - Employee mode share
    - Complaints.
- Produce monthly monitoring reports
- Update condition surveys and agree any remedial works.

5.8 Surface water management

50. **Chapter 14: Water Resources and Flood Risk** within the Onshore Project ES identifies considers impacts to water resources and flood risk and sets out appropriate mitigation (**Section 16.3.6**). **Appendix 14.C: Flood Risk Assessment** provides an assessment of flood risk and the measures to reduce flood risk within the Onshore Development Area.

51. For onshore construction sites, the CEMP should include a detailed surface water management design/drainage plan for the Onshore Project. The plan should detail the surface water management measures to be implemented during the works. The detailed design should be supported by the rationale for selecting the chosen mitigation measures, together with associated calculations and methodologies for sizing. Where appropriate, the principles of Sustainable Urban Drainage Schemes (SUDS) should be applied.

52. During construction, the haul road will be bound by parallel drainage channels (one on each side) to intercept drainage within the working width. Depending upon the precise location, water from the channels will be infiltrated or

discharged into the local drainage network via temporary interceptor drains and / or silt traps. Mitigation measures must be maintained and monitored on a regular basis. A record of inspections of mitigation measures and any required maintenance carried out by the Contractor must be maintained.

53. The Principal Contract will include for provision of an Agricultural Liaison Officer (ALO) and/or local specialised drainage contractor to manage impacts on agricultural drainage during construction including maintaining and/or reinstating land drainage systems. The CEMP will detail the approach to pre- and post-construction drainage plans on agricultural fields.

5.9 Water abstraction

54. For onshore construction sites, abstraction of water may be required for potable supply or for use during site activities, such as concrete batching or washing. The Principal Contractor is responsible for obtaining from the regulator (such as the Environment Agency), in advance of use, any permits for the use of abstracted water during the construction related activities and for monitoring and recording associated abstraction rates or other licence requirements to demonstrate compliance.

5.10 Emissions to air

55. For onshore construction sites, the CEMP will consider the potential for dust nuisance to arise. The Principal Contractor is responsible for implementing appropriate mitigation measures to suppress dust and minimise emissions to air during the construction works. Measures to address potential emissions to the air are set out in **Chapter 13: Air Quality** (**Section 13.3.6**) and include:

- Best practice measures as recommended by the Institute of Air Quality Management (IAQM)
- Non-Road Mobile Machinery (NRMM) measures

5.10.1 IAQM best practice measures

56. These measures will be secured within the final CEMP.

- Communications:
  - Develop and implement a stakeholder communications plan that includes community engagement before work commences on site
  - Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager
  - Display the head or regional office contact information.
- Dust Management:

- Develop and implement a Dust Management Plan (DMP) (this will form part of the CEMP), which may include measures to control other emissions, approved by the local authority. The level of detail will depend on the risk and should include as a minimum the highly recommended measures in this document. The desirable measures should be included as appropriate for the site
- Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken
- Make the complaints log available to the local authority when asked
- Record any exceptional incidents that cause dust and/or air emissions, either on- or off-site, and the action taken to resolve the situation in the logbook
- Hold regular liaison meetings with other high risk construction sites within 500m of the site boundary, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/deliveries which might be using the same strategic road network routes
- Undertake daily on-site and off-site inspection, where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and windowsills within 100m of site boundary, with cleaning to be provided if necessary
- Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the local authority when asked
- Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions
- Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible
- Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site
- Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period
- Avoid site runoff of water or mud
- Keep site fencing, barriers and scaffolding clean using wet methods
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below.

- Manage stockpiles to prevent wind whipping
- Ensure all vehicles switch off engines when stationary - no idling vehicles
- Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable

- Impose and signpost a maximum-speed-limit of 15mph on surfaced and 10mph on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate)
- Produce a Construction Traffic Management Plan to manage the sustainable delivery of goods and materials. Further details provided in **Appendix 19.B: Outline Construction Traffic Management Plan**
- Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing). Further details provided in **Chapter 19: Traffic and Transport**
- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g., suitable local exhaust ventilation systems
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate
- Use enclosed chutes and conveyors and covered skips
- Minimise drop heights from handling equipment and use fine water sprays on such equipment wherever appropriate
- Ensure equipment is readily available on site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods
- Avoid bonfires and burning of waste materials.
- Construction:
  - Ensure sand and other aggregates are stored in appropriate manner to minimise dust generation for example the use of bunded areas
  - Avoid scabbling (roughening of concrete surfaces) if possible
  - Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery
  - For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.
- Earthworks:
  - Manage earthworks and exposed areas/soil stockpiles to stabilise surfaces
  - Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.
- Trackout:

- Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site
- Avoid dry sweeping of large areas
- Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport
- Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable
- Record all inspections of haul routes and any subsequent action in a site logbook
- Install hard surfaced haul routes where practicable, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned
- Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits
- Locate access gates at least 10m from receptors where possible.

5.10.2 NRMM measures

57. The following mitigation measures specific to NRMM will be secured within the final CEMP submitted post-consent.

58. NRMM and plant should be well maintained. If any emissions of dark smoke occur, then the relevant machinery should stop immediately, and any problem rectified.

59. In addition, the following controls should apply to NRMM:

- All NRMM should use fuel equivalent to ultralow sulphur diesel (fuel meeting the specification within EN590:2004) where practicable
- All NRMM should comply with the appropriate NRMM regulations
- All NRMM would be fitted with Diesel Particulate Filters (DPF) conforming to defined and demonstrated filtration efficiency (load/duty cycle permitting)
- The ongoing conformity of plant retrofitted with DPF, to a defined performance standard, should be ensured through a programme of onsite checks
- Fuel conservation measures should be implemented, including instructions to (i) throttle down or switch off idle construction equipment; (ii) switch off the engines of trucks while they are waiting to access the site and while they are being loaded or unloaded and (iii) ensure equipment is properly maintained to ensure efficient fuel consumption.

60. Consideration should also be given to the siting of NRMM within the working area. Where practicable, locating generators and plant at the greatest distance from receptors will reduce the potential for air quality effects.

5.11 UXO Risk

61. **Chapter 24: Major Accidents and Disasters** considers the risk of Unexploded Ordinance (UXO). UXOs are remnants of past military activities that may still pose a significant threat to the safety and well-being of construction personnel and the surrounding environment. Surveys and assessments of the construction site, identifying potential UXO presence or historical activities will be undertaken by the Principal Contractor. In the event of any suspected or confirmed UXO findings, Principal Contractor will be required to implement appropriate measures, such as notifying relevant authorities, establishing exclusion zones, and engaging specialised personnel for safe removal and disposal. This approach aims to safeguard the construction workforce, local communities, and the environment, ensuring a secure and responsible construction process.

6. Environmental Management Structure and Responsibilities

62. The Principal Contractor is required to outline the environmental management roles and responsibilities for the Onshore Project in this section. This includes identification of key site staff, their environmental management responsibilities and how these links with other members of the Project team, such as the Project Manager, the project Health and Safety/Environmental Manager(s) and/or Advisors and environmental specialists such as an ECoW, TMCo ALO and Archaeological Coordinator.

63. The contact details for the individuals listed should also be included in this section or attached as an appendix to the CEMP.

64. The Construction Design and Management (CDM) Regulations of 2015 are a comprehensive set of legal guidelines implemented in the United Kingdom to ensure the safe and efficient management of construction projects. These regulations aim to prioritise health and safety considerations throughout the entire project lifecycle, from the design stage to completion and beyond. The CDM Regulations outline the roles and responsibilities of all parties involved, including clients, designers, contractors, and workers, in fostering a proactive safety culture. By encouraging collaboration, risk assessment, and proper planning, the CDM Regulations seek to reduce accidents, injuries, and health hazards within the construction industry, ultimately contributing to the delivery of successful and secure projects.

65. The different roles and summary of duties set out in the CDM regs 2015 include:

- Commercial clients – Organisations or individuals for whom the construction project is carried. Done as part of a business. Main duties include:

  - Making suitable arrangements for managing a project
  - Ensuring sufficient resources and time are allocated
  - Ensuring other duty holders are appointed as appropriate
  - Ensuring the principal designer and principal contractor carry out their duties
  - Ensuring welfare facilities are provided.

- Domestic clients – People who have construction work carried out on their own home.
- Designers – Organisations or individuals who as part of a business, prepare or modify designs for a building, product or system relating to construction work.
- Principal designers – Designers appointed by the client in projects involving more than one contractor. They can be an organisation or an individual with sufficient knowledge, experience and ability to carry out the role.
- Principal contractors - Contractors appointed by the client to coordinate the construction phase of a project where it involves more than one contractor. Main duties include:

  - Plan, manage, monitor and coordinate health and safety in the construction phase of a project
  - Ensure suitable site inductions and reasonable steps to prevent unauthorised access are in place
  - Ensure workers are consulted and engaged in securing their health and safety
  - Ensure welfare facilities are provided.

- Contractors - Those who carry out the actual construction work, contractors can be an individual or a company.
- Workers - Those working for or under the control of contractors on a construction site.

7. Environmental Incident Response and Contingency

66. The Principal Contractor is required to include in this section the environmental incident response and contingency procedure. It is essential that any environmental incidents are reported and managed appropriately and appropriate mitigation measures are implemented to avoid future occurrences.

7.1 Emergency response plan

67. Principal Contractors will be required to have an environmental emergency response plan. This will be in additional to individual management plans already in place for day-to-day operations. The plan should identify the key personnel who can respond promptly in the event of an environmental incident, including a response flow chart and with details how to report and respond to an environmental incident (e.g., local spill kits, waste reception facilities, manage

dropped objects in the marine environment and offsite emergency response resources). The plan needs to include the protocol of how to deal with flood events and ensure that the project is signing up to EA flood warning system for the area.

68. Potential impacts from frac-out and drill fluid release will be considered within the CEMP. The Principal Contractor will, wherever possible use drilling fluids that are on the PLONOR list (Poses Little Or No Risk), the list is controlled and maintained by The Centre for Environment, Fisheries and Aquaculture Science (CEFAS). Products on the list are safe for discharge into the offshore or onshore environment, engagement with the relevant statutory bodies is still required but vastly reduced. The Principal Contractor will be required to have an environmental emergency response plan that includes the response to potential frac out incidents.

7.2 Reporting

69. The Principal Contractor is responsible for reporting and recording the environmental incidents and near misses in line with the Principal Contractor Environmental Management System.

70. Principal Contractor is required to produce performance monthly reports to demonstrate how the environmental objectives and targets are being met.

7.3 Nonconformance

71. If an environmental incident or deviation from the EMS procedures should occur, it shall be thoroughly investigated by the Principal Contractor to establish the root cause and prevent any recurrence. The Principal Contractor is required to outline the procedure for managing nonconformances and the process of implementing corrective actions.

8. Monitoring

72. The Principal Contractor is responsible for establishing a programme of performance and compliance monitoring will be established for the Onshore Project.

73. The Principal Contractor is required to include a monitoring process for complying with environmental permits and consents (i.e. water quality monitoring protocol agreed with the EA).

8.1 Site inspections and environmental monitoring

74. The Principal Contractor, or appointed delegate, will undertake site inspections on weekly basis. These site inspections should be undertaken by a component

person which should, as a minimum, and where relevant, cover the key issues outlined within this document. Weekly inspections should be complimented by audits to ensure legal compliance.

75. The Principal Contractor is responsible for ensuring the close out of any actions identified during the inspections. Records of the inspections carried out should be retained onsite by the Principal Contractor and a copy provided to the Applicant; any remedial actions required must also be recorded.

8.2 Environmental audits

76. Environmental audits should comprise both internal and external audits.

77. The Principal Contractor is responsible for developing and implementing an audit programme to audit construction sites on a periodic basis. The Principal Contractor's environmental audits shall be carried out by experienced auditors, either from within the Principal Contractor's environmental team, or via delegated specialists.

78. All actions raised from the audits shall be logged in line with the company audit procedure. Any nonconformances identified during the audit should be tracked, and closed out in a timely manner.

9. Training and Awareness

79. A range of mechanisms are used for training and raising awareness of project environmental issues; these include environmental inductions, TBTs, environmental notice boards, and environmental bulletins and alerts.

80. The Principal Contractor must ensure that all staff including any sub-contractors are trained in the Onshore Project's environmental emergency response procedures, so that they are able and prepared to respond to an incident promptly and effectively on-site. Where appropriate, the Applicant may request environmental emergency response plans to be tested on-site by the Principal Contractor.

9.1 Project/site inductions

81. All site personnel will be required to have a site induction that includes an environmental component. The Principal Contractor is responsible for preparing and delivering the site induction and maintain documented attendee records for the on-site personnel.

82. It is expected that the environmental management contents of site inductions will include reference to compliance with:

- environmental management contacts

- site specific environmental sensitivities
- waste management arrangements
- water and wastewater management
- hazardous material management
- fuel, oil and chemical management
- environmental emergency response
- reporting of incidents and complaints
- UXO risk management
- Construction traffic management.

9.2 Toolbox Talks (TBTs)

83. TBTs are considered to be an effective method for the dissemination of information relating to work activities. Environmental TBTs will be required to be delivered by the Principal Contractor to on-site personnel as required. They also in part be delivered by the relevant member of the project team as well as the health, safety and environment (HSE) team. Toolbox talks are an opportunity for the Principal Contractor to disclose any other environmental sensitivities that the sub-Contractors must be aware of.

84. It is the responsibility of the Principal Contractor to ensure that all personnel attending the TBT have signed a TBT attendance sheet; TBT attendance sheets are likely to be inspected as part of environmental audits.

9.3 Environmental notice board

85. The Principal Contractor is required to display, in an appropriate and prominent location, copies of relevant environmental management information, including but not limited to the following:

- Environmental policies
- Key contacts details, including Principal Contractor's environmental management representative
- Environmental bulletins
- Site location plan showing ecologically/archaeologically sensitive areas, key management areas and location of contingency materials/features
- Emergency response contact details
- Emergency response flowchart.

10. Communication and Reporting

10.1 Meetings

86. Regular HSA meetings are required to be held on all construction sites, and are likely to comprise representatives from the Applicant's project team, the Principal

Contractor, and key sub-contractors. Minutes of meetings will be recorded, and standard agenda items will include items such as: status of outstanding items, reports of environmental incidents or complaints, stakeholder engagement, TBTs issued/delivered, and key findings of environmental inspections and audits. All reporting will be undertaken as stated in Health, Safety, Environmental and Quality minimum requirements document.

87. The Principal Contractor is expected to convene regular project team meetings to convey environmental information to the Project team, including sub-contractors and to raise awareness of environmental issues.

10.2 Community complaints

88. The Applicant values its relationship with the communities that surround the Onshore Project. All work shall be carefully planned to minimise disturbance to the local communities.

89. The Principal Contractor must have a procedure in place to report public complaints and ensure that any complaints are reported to the Project team and investigated promptly.

10.3 Community liaison and land use

90. A public/community relations plan will be developed for the Onshore Project by the Principal Contractor. The purpose of the plan, which must be developed in liaison with the Project team, should set out the approach to community liaison for the duration of the Onshore Project. For the Onshore Project an Ecological Clerk of Works will be appointed, as required.

91. The Principal Contractor needs to outline the process that will limit and manage the timing of construction activities at Landfall up to Mean High Water Springs (MHWS) with the potential to affect public use of Saunton Sands Beach. These measures will include:

- Communication and engagement activities to ensure that visitors to Saunton Sands are aware of the timing and extent of construction activities in the nearshore/intertidal zone
- Maintaining access to Saunton Sands during construction – no closure of the beach
- Providing safety marshals for the protection of the public
- Apply health and safety requirements proportionately: for example, balance the need for fencing/hoarding/barriers in nearshore/intertidal zone to protect swimmers and surfers from accessing construction and/or maintenance works with the need to maintain access to Saunton Sands.

92. The Onshore Project has the opportunity to enhance community safety at Saunton Sands by providing resources and by increasing capacity for human intervention if people are attempting or considering self-harm. It is acknowledged that a self-harm event, leading to injury or fatality, is low probability but that it would also be very serious.

93. The additional enhancement would comprise of signs that provide information about safety and sources of help for those considering self-harm; and training for safety marshals to train increased awareness about self-harm and actions to take. The CEMP will include water safety risk assessment and water safety plans and relevant training for safety marshals and other operation and maintenance workers.

94. The Principal Contractor must observe public rights of way and maintenance of flood defences where project activities may impact on these issues. A Public Rights of Way Strategy is provided in **Appendix 15.A**.

10.4 Stakeholders engagement

95. Reference should also be made to any reporting requirements in relation to stakeholders set out under the TCPA (1990). Interactions with stakeholders such as Natural England, Environment Agency (EA), Local Planning Authority, etc. should also be covered in this section.

11. Sub-Contractor Management

96. The CEMP will set out how the Principal Contractor manages their sub-Contractors. This may range from the selection and assessment processes through to the assessment of performance on site.

12. Sustainable Construction

97. The Sustainable Construction guidance issued by the Institute of Environmental Management and Assessment (2008) states the following: "Application of sustainable development to the construction industry, whereby the construction and management of a development is based on principles of resource efficiency and the protection/enhancement of natural and built heritage. Sustainable construction comprises such matters as site planning and design, material selection, resource and energy use, recycling, and waste minimisation". (Institute of Environmental Management and Assessment, 2008).

98. The Principal Contractor is required to outline in this section how the sustainable construction principles are embedded during the design phase and construction phases of the Onshore Project.

13. References

Institute of Environmental Management and Assessment (2008) Environmental Management Plans Practitioner, Volume 12. Available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwic37H1xqf9AhVRsKQKHQSWB7sQFnoECBgQAQ&url=https%3A%2F%2Fwww.iema.net%2Fdownload-document%2F7014&usg=AOvVaw37vBz691GKel7dL9wojy1G. [Accessed February 2023]

Environment Agency (2014) Pollution Prevention Guidance. Available at: https://www.gov.uk/government/collections/planning-practice-guidance. [Accessed February 2023].

Health and Safety Executive (2015). Construction (Design and Management) Regulations 2015. https://www.hse.gov.uk/construction/cdm/2015/summary.htm. [Accessed July 2023].

Annex 1: Waste Audit Statement

1. Introduction

99. This Waste Audit Statement has been produced by the Applicant in order to address the North Devon Council (NDC) requirement for details in relation to waste management regarding the proposals for the Onshore Project.

100. The purpose of this document is to provide a draft of the Wate Audit Statement and to demonstrate that appropriate waste management measures will be developed and implemented during all phases of the Onshore Project.

2. Policy

101. The Devon County Council (DCC) have produced the Devon Waste Plan 2011-2031[3] and a Supplementary Planning Document (SPD) on Waste Management and Infrastructure[4] which sets out the requirement for a Waste Audit Statement for 'major development' applications[5]. The SPD provides guidance to local planning authorities and developers to assist in implementation of three of the Waste Plan's policies dealing with waste prevention, waste management infrastructure and the protection of waste management capacity:

- Policy W4: Waste Prevention and Policy
- Policy W10: Protection of Waste Management Capacity
- W21: Making Provision for Waste Management.

102. This Waste Audit Statement will be updated and resubmitted to NDC for approval once the detailed design of the Onshore Project is complete. A condition that a revised Waste Audit Statement be produced, and that all works will be undertaken in accordance with the approved Waste Audit Statement will likely be attached to the consent for the Onshore Project following the example as set out in Appendix C of the SPD.

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[3] https://www.devon.gov.uk/planning/planning-policies/minerals-and-waste-policy/devon-waste-plan/
[4] https://www.devon.gov.uk/planning/planning-policies/minerals-and-waste-policy/supplementary-planning-document/
[5] The Onshore Project is considered 'major development' as it has a site area of 1 hectare or more as defined in Appendix A of the SPD.

3. Structure of Waste Audit Statement

103. This statement includes all information outlined in the waste audit template provided in Appendix B of the SPD. In line with Appendix B of the SPD, the Waste Audit Statement provides:

- Description of the site
- Steps to be taken to minimise waste the amount of waste generated during excavation, demolition and construction
- Type and volume of the waste to be generated during excavation, demolition and construction
- Steps to be taken to achieve the re-use and recycling percentages
- Type and volume of the waste to be generated during operation
- How waste collection and sustainable waste management principles are incorporated into the development.

4. Waste Audit Statement

4.1 Project and Site Description

104. The Onshore Project comprises the construction of the following onshore infrastructure assets (landward of Mean Low Water Springs):

- Onshore export cables (approximately 8km)
- White Cross Onshore substation
- Temporary main construction compound and temporary construction compounds
- Transition Joint Bay, jointing bays and link boxes
- Access roads and haul roads
- Grid connection works within the existing East Yelland substation.

105. The Onshore Project includes approximately 8km of export cable which crosses a variety land uses as follows:

- Saunton Sands Beach and Car Park
- Saunton Golf Course
- Arable farmland
- Field boundaries and drainage ditches
- Sandy Lane
- River Taw / Taw Estuary
- Pastural Fields
- Tarka Trail
- Infrastructure such as roads.

4.2 Step to minimise generation of waste during excavation, demolition and construction

106. Waste generated during the excavation, demolition and construction of the Onshore Project will be managed by the Principal Contractor in accordance with the waste hierarchy. The waste hierarchy requires the producer/holder of a waste to demonstrate that the priorities outlined in **Table 5.1** have been considered in the priority order, and to determine the most suitable waste management option for all wastes prior to removal from site. The Applicant will aim to prevent, reuse, recycle and/or recover waste where practical and economically feasible prior to considering disposal.

Table 4.1 The Waste Hierarchy

Waste Hierarchy	Relevant activity
Prevention	Using less material in design and manufacture, keeping products for longer, re-use, using less hazardous materials.
Preparing for re-use	Checking, cleaning, repairing, refurbishing, whole items, or spare parts.
Recycling	Turning waste into a new substance or product, includes composting if it meets quality protocols.
Other recovering	Includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat, and power) and materials from waste, some backfilling.
Disposal	Landfill and incineration without energy recovery.

Table reproduced from Defra website: https://www.gov.uk/waste-legislation-and-regulations

107. The design of the Onshore Project will consider sustainability principals to make sure that over ordering on materials such a substation components, cement bound sand, ducting, tape, tiles and cables is kept to a minimum. As part of the preliminary design of the Onshore Project for the planning application estimates on the likely material quantities to be used during the construction phase have been provided by the engineering team. These quantities will be further refined as the project moves through the detailed design and will be monitored through the use of a Quantity Surveyor during the construction phase of the Onshore Project.

108. The Onshore Project has been designed with an operational lifetime of at least 25 years in order to align with the operational lifetime of the infrastructure from the Offshore Project, such as the wind turbine generators. Therefore, the materials to be used will be of a long-life span designed to be used for the minimum 25 years.

109. The SPD does not require that a Waste Audit Statement be produced for the decommissioning stage of projects, therefore any measures to be implemented during decommissioning are outside the scope of this Waste Audit Statement. However as set out within the Chapter 5: Project Description of the ES produced for the Onshore Project the decommissioning could be subject to a separate consenting process, which would likely require the production of a Waste Audit Statement in accordance with the relevant policy, legislation and guidance at the time.

4.3 Type and volume of the waste to be generated during excavation, demolition and construction

110. Demolition is not required as part of the Onshore Project due to its nature and therefore has not been considered further.

111. Excavation is identified as a 'waste' generating activity. It is considered that excavation during the Onshore Project will mainly comprise of the excavation of site soils to facilitate the installation of infrastructure, for example the excavation of the trenches for the instillation of the export cable.

112. Soils produced during the excavation will be re-used to backfill the subsequent excavation, or elsewhere on site, for example in the construction of the Onshore Substation to create the building platform to provide the required finished floor level to mitigate the flood risk. Excavated material will be removed from site either for re-use or recycling where no on-site re-use is possible.

113. Construction has the potential to create a variety of waste streams such as excess building materials, packaging or general waste generated from on-site activities. This includes the aggregates used for the construction of the temporary compounds, haul roads and other working area which will need to be removed before reinstatement.

114. At this stage the values some of these construction waste streams are not known, and without the detailed design would be difficult to estimate. However all the management of all construction waste streams will be undertaken in accordance with a Site Waste Management Plan (SWMP) which will be produced by the Principal Contractor (see **Section 4.6** below).

115. Indicative values of the known waste streams these have been summarised in **Table 4.2**. An updated Waste Audit Statement will be provided once the design as been progressed sufficiently to provide further estimates.

Table 4.2 Construction Waste

Material	Quantity						
	Total estimated amount (tonnes)	% to be re-used on-site	% to be re-used off-site	% to be recycled on-site	% to be recycled off-site	% to be recovered	% to be landfilled
Inert (waste that does not undergo any significant physical, chemical, or biological transformations (for example concrete, bricks, rubble)							
Aggregate • (Construction Consolidation Site Landfall HDD Compound • Haul Road • HDD compounds • HDD installation • Landfall transition bays • Joint Bays • Substation – Compound and Access Road)	68,371	15			85		
Excavated materials • (Cable Trench • Substation access road	40,500	34			66		

Material	Quantity						
• Subtation building platform • Landfall Transitions Bay • Joint Bays)							
Non-Hazardous (waste which does not cause harm to human health or the environment)	Estimated amounts of non-hazardous waste are unknown at this stage. An updated Waste Audit Statement will be provided once the project design is sufficiently progressed.						
Hazardous (Waste which contains substances or has properties that might make it harmful to human health or the environment)	Estimated amounts of hazardous waste are unknown at this stage. An updated Waste Audit Statement will be provided once the project design is sufficiently progressed. The CEMP will include specific measures that are protective of controlled waters in relation to the storage of fuels, oils, lubricants, wastewater, and other chemicals during the works.						

4.4 Steps to be taken to achieve the re-use and recycling percentages

116. The excavated material generated during the construction phase will be properly segregated and stored, as set out in the OCMEP, in order that it can be re-used to backfill the excavations or elsewhere on site. Where is can't be re-used will be taken off-site for recycling using a local appropriately licensed site.

117. The aggregates used during the construction will be re-used where possible on the site, for example to provide the subbase materials for the permanent access road and substation permanent compound. The aggregates that can not be re-used will be recycled using a local appropriately licensed site.

118. Methods and commitments for preparing other construction waste streams for re-use and recycling on site are not known at this stage. Re-use and recycling will be undertaken on site where possible. The nearest suitable facility for hazardous waste or waste not re-used or recycled on site will be provide in an updated version of the Waste Audit Statement to be submitted and approved in advance of construction.

4.5 Type and volume of the waste to be generated during operation

119. On the basis of what is proposed during its operational phase it is unlikely that there will be waste generated. This has therefore not been considered further nor has the requirements for access for waste disposal vehicles or storage requirements.

120. Any waste that is generated, for example from the maintenance or servicing of the export cables and/or substation equipment, will be managed in accordance with the waste hierarchy (see **Table 5.1**).Given that any such waste will likely be of a high value, such as substation equipment or components, where prevention is not possible the majority of the waste will likely be re-used or recycled.

4.6 Waste Collection and Sustainable Waste Management Principles

121. During construction the Principal Contractor will be responsible for the collection, storage and disposal of any waste produced as part of the Onshore Project and will be required to prepare a Site Waste Management Plan (SWMP) in line with legislation, good practice. The SWMP will be developed post-consent to ensure the proper handling and protocols are in place to deal with any generated wastes. The Plan will record the following information, as a minimum:

- The types and quantities of waste generated

- The management approach for each waste type (Reuse, Recycle, Recover, Dispose) including any treatment
- The storage arrangements for each waste type
- The site waste monitoring and reporting arrangements
- Waste carrier details and waste management/disposal facilities.

122. Adoption of a CL:AIRE Industry Code of Practice to manage the re-use and disposal of excavated soils within the Onshore Development Area would also be incorporated as an additional mitigation measure in the CEMP, this would aid in maximising sustainability and provide an audit trail to demonstrate the appropriate use of materials. A Materials Management Plan will be drafted in advance of any construction works, this would include chemical screening criteria in order to ensure that imported and/or reused materials are chemically suitable for use. If materials identified as containing asbestos are identified, then a specialist contractor would be employed to aid in its removal from Onshore Project Area, in line with current legislation.

123. Circular economy principles will be considered, where practical and economically feasible, specifically the priority area of circular construction and adopting circular economy interventions such as:

- adopting circular design principles and construction processes, particularly the opportunity to create a physical and virtual resource recovery and material exchange hub to make better use of material wasted in construction
- supporting the growth of regional specialist circular products and services in the construction industry.

WHITE CROSS

White Cross Offshore Windfarm

Appendix 5.C: Outline Drainage Strategy

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REPORT

White Cross Offshore Windfarm

Drainage Strategy Report

Client: Offshore Wind Limited

Reference: S2

Status: S2/P03

Date: 7 August 2023

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Author(s):	Iyiola Ojo
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Royal HaskoningDHV

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Appendices

1 Introduction

1.1 Background

1.1.1 Royal HaskoningDHV was commissioned by Offshore Wind Limited (here in referred to as 'the Applicant') to prepare a Outline Drainage Strategy to support the proposed construction of onshore infrastructure associated with the White Cross Offshore Windfarm.

1.1.2 The White Cross Offshore Windfarm is a proposed floating offshore windfarm located in the Celtic Sea with a capacity of up to 100MW. The 'Onshore Project', entailing all infrastructure of the project landward of Mean Low Water Springs (MLWS), requires a Town and Country Planning Act 1990 (TCPA) application. A separate Section 36 (under the Electricity Act 1989) and Marine Licence (ML) application for Offshore Project components (seaward of Mean High Water Springs (MHWS)), which has been submitted as a to the Marine Management Organisation (MMO) following the MMO confirming that they would not consent the Onshore Infrastructure of the Windfarm Project.

1.1.3 The Onshore Project includes the infrastructure associated with the Landfall at Saunton Sands (to MLWS) where the onshore elements connect to the Offshore Project infrastructure, Onshore Export Cable (including joint bays and link boxes), Taw Estuary Crossing, a new White Cross Onshore Substation, and an Interconnecting Cable to the Grid Connection Point at the existing East Yelland Substation.

1.1.4 The set of consents/permission required in order for the Project as a whole to proceed are outlined below:

- Planning permission under the Town and Country Planning Act 1990 (TCPA) 1990) is required for the following Onshore Project infrastructure (landward of MLWS):
- Offshore export cables (from MLWS to above MHWS at the Landfall and Transition Joint Bay (TJB))
- Onshore export cables (2 x 66 kilovolts (kV) or 1 x 132kV from Landfall to White Cross Onshore Substation and 132kV from the White Cross Onshore Substation to Grid Connection Point) – excluding section below MLWS at the Taw Estuary crossing
- White Cross Onshore Substation
- Temporary main construction compound and temporary construction compounds
- Transition Joint Bay, jointing bays, link boxes, access roads and haul roads
- Grid Connection Point.

1.1.5 Consent under the Section 36 of the Electricity Act 1989 and a Marine Licence under the Marine and Coastal Access Act 2009 (MCAA 2009) from the MMO are required for the following generation assets (within the Windfarm Site):

- Wind Turbine Generators
- Semi-submersible floating platforms
- Subsea catenary mooring lines
- Anchoring solutions (drag embedment anchors, suction anchor or pin piles)
- Inter-array cables and associated protection
- Other associated offshore infrastructure, such as navigational markers.

- A second Marine Licence is required to enable the option for an Offshore Transmission Owner (OFTO) to be appointed under The Electricity (Competitive Tenders for Offshore Transmission Licences) Regulations 2015 for the following transmission assets (to MHWS):
- Offshore Substation Platform
- Offshore export cable
- Other associated offshore infrastructure, such as navigational markers.

1.1.6 The Section 36 and Marine Licences applications were submitted to the MMO on 14th March 2023.

1.1.7 Further detail on the consenting regime and relevant legislation is presented in **Chapter 3: Policy and Legislative Context**.

1.2 Purpose of this Document

1.2.1 The purpose of this report is to present the proposed Outline Drainage Strategy for the proposed development at the application site and support the Flood Risk Assessment (FRA) in providing justification to regulators and other stakeholders that the proposed development is feasible.

1.2.2 This Drainage Strategy has been prepared in line with national policy requirements, and ultimately aims to support the future outline planning application for the application site. This report should be read in conjunction with the FRA (Ref. PC2978-RHD-ZZ-XX-DR-Z-0266), prepared by Royal HaskoningDHV.

1.2.3 The information outlined in this report has been developed in accordance with the National Planning Policy Framework (NPPF) along with advice and guidance from the Environment Agency, The Sustainable Drainage System (SuDS) Manual, and Lead Local Flood Authority (LLFA) local policies. In deducing the conclusions contained herein, Royal HaskoningDHV engaged in the following exercises:

- Review of the LIDAR Survey Information
- Undertook existing surface Water Run-off Calculation
- Defined allowable surface Water Discharge
- Undertook a Quick Storage Estimates calculations to define the volume of surface water storage required
- Outline drainage design following a high-level proposed site level strategy
- Full microdrainage network assessment of the proposals.

1.2.4 This Report references the priorities and preferences of National policies and in particular Devon County Council s' LLFA Guidance Documents[1]. It outlines the drainage strategy by exploring SuDS options which allow regulators and other stakeholders to assess whether the development is feasible.

[1] *https://www.devon.gov.uk/floodriskmanagement/planning-and-development/sustainable-drainage/*

2 Site Description

2.1 Site Location

2.1.1 A Site Location Plan of the Onshore Substation is shown in **Annex A.**

2.1.2 The Windfarm Site is located over 52km off the North Cornwall and North Devon coast (west-north-west of Hartland Point). The Offshore Export Cable will connect the Offshore Substation Platform (if required) to shore. The Export Cable will come ashore at a Landfall at Saunton Sands on the North Devon Coast, and then be routed underground to the East Yelland Substation where it connects into the distribution network. Prior to connecting to the East Yelland Substation the cable will connect to a new White Cross Onshore Substation. A full description of the Onshore Project is given in **Chapter 5: Project Description** of the Onshore Project ES.

2.1.3 The site of the proposed Onshore Substation was previously used as an oil and gas storage facility. It is situated at the north-east part of Yelland, north of Barnstaple. The River Taw is located far north of the site. The existing site is approximately 0.99 of brownfield site, however the purposes of this outline drainage strategy and in line with the requirement of the Devon County Council SUDs Design Guidance, will be considered as greenfield. The total area of the proposed development is 1.48ha.

Table 2.2.1: Existing Site Surroundings

Direction	Neighbouring Features Description
West	East Yelland Substation
East	Existing Industrial Depot and B3233
North	Immediately north is an industrial depot, far north is River Taw
South	Existing Solar Farm, far south is B3233-West Yelland

2.1.4 Table 2.2 presents The site is referenced in paragraph 2.1.2, and a site location plan is shown in Annex A.

Table 2.2 Site Location Information

Item	Brief Description
Site Address and Location	Land to west of Estuary Business Park. Closest postcode is EX31 3HB.
Council Area	North Devon Council / Devon County Council
Approximate Grid Reference	SS 48217 32177
Total impermeable footprint (including Onshore Substation access road, excluding landscape and embankment)	Approximately 0.5ha
Existing greenfield area impact	0.48ha

2.2 Topography

2.2.1 The site topography is generally very flat. The existing ground appears to slope in two directions from 5.3mAOD in the north-east direction to approximately 4.83mAOD in the south-west direction.

2.3 Geology

2.3.1 Information presented on the BGS online viewer[2] indicates that the superficial deposits underlying the Site consist of Alluvium, sand and gravel. The bedrock geology underlying the Site consist of Ashton Mudstone Member and Crackington Formation - Mudstone and siltstone.

2.3.2 Intrusive ground investigation evaluating sub soil strata has not been undertaken at this stage, and there is no readily available information from historic boreholes in the vicinity of the site. The information extracted from the BGS website suggests the underlying strata is of cohesive soil composition.

2.4 Existing Watercourses

2.4.1 There appears to be existing land drainage ditches at the northern boundary of the site. River Taw is located to the far north of the site.

Figure 2.1 Existing bedrock underlying the site (British Geological Society Maps)

[2] https://www.bgs.ac.uk/discovering-geology/maps-and-resources/maps/

3 Proposed Drainage Strategy

3.1.1 The proposal involves the installation proposed onshore substation building, control building and associated access road and parking. The proposals consist of a total of 0.64ha of newly introduced impermeable area.

3.1.2 Management of surface water is an essential element for reducing flood risk and SuDS techniques are often designed to achieve this in a way that mimics the natural environment. This SuDS Strategy is subject to consents and approval from the Devon County Council. Devon County Council will be formally consulted by North Devon Council as part of the TCPA planning application process.

3.1.3 Following a telephone conversation with the office of the Lead Local Flooding Authority, the acceptability of the outline drainage strategy will be determined based on adherence to the dictates of the policies as stated in the Devon County Council (DCC) s' LLFA Guidance Documents. As stated on in paragraph 1.24 on this report, the drainage strategy is based on these DCC preferences and requirements.

3.1.4 This SuDS Assessment has been developed in line with the SuDS hierarchical approach outlined in the Flood Risk and Coastal Change Section of the Planning Practice Guidance, which recommends that surface water run-off should be discharged as high up the following hierarchy of drainage options as reasonably practicable:

- Infiltration into ground
- To a surface water body
- To a surface water sewer, highway drain or other drainage system
- To a combined sewer.

3.1.5 As discussed in **Section 2.4**, the BGS mapping indicates the underlying ground conditions to have a cohesive composition. Given the information currently available, it is assumed that surface water discharge methods using infiltration techniques are deemed unsuitable for this site.

3.1.6 As noted in **paragraph 2.1.2**, the site was previously used as an oil and gas storage facilities, however the Devon County Council Sustainable Drainage Guidance requires that development for developments on brownfield sites, peak flow control must still match the greenfield run-off rate, especially where there is increase in impermeable surface introduced as a result of a proposed development.

3.1.7 The existing greenfield run-off estimate for the site using the HR Wallingford procedure is presented in **Annex C**. The drainage design strategy is sought that the post development discharge rate is no more that the equivalent greenfield run-off rates up to the 1 in 100-year storm event including climate change allowance.

3.1.8 This Drainage Strategy is informed by the Flood Risk Assessment (Ref. PC2978-RHD-ZZ-XX-DR-Z-0266), which suggested an Upper End allowance for the future Extreme Water Levels of 6.43mAOD. The FFL of the substation will therefore be at least 300mm above this level (equating to 6.73mAOD). The proposed ground level is 1.4m above the existing ground at the development site.

3.2 Proposed Surface Water Strategy

3.2.1 Overall impermeable area contributing surface water run-off is approximately 0.64ha. It is proposed that surface water drainage from all impermeable surfaces are routed via a proprietary treatment system, such as hydro-downstream defenders or similarly equivalent, into an attenuation pond located to the south of the proposed development.

3.2.2 Peak surface water run-off is then restricted to the maximum greenfield run-off rate of 3.87l/s for the 1 in 100-year rainfall event. This is to be restricted, via a proposed hydrobrake flow control device at the downstream end of the pond.

3.2.3 It is proposed to channel the restricted surface-water flow via a 150mm pipe laid at a minimum gradient of 1 in 150, but ensuring no conflict between this proposed pipe and the proposed/existing underground cables in the vicinity of the works.

3.2.4 The proposed drainage strategy is indicated in drawing PC3506-RHD-ZZ-XX-DR-D-0500 (**Annex B**).

3.2.5 The proposed attenuation pond contributes approximately 433m^3 of storage. Maximum depth of the pond is approximately 1.2m with a minimum side slope of 1 in 3. The geometry of the pond ensures a free board of approximately 0.15m is secured in the 1 in 100 year plus climate change event.

3.2.6 Surface water run-off is contained without flooding during the 1 in 100-year storm event in line with the requirements of the Devon County Council. **Annex C** presents the Full Microdrainage Network calculations modelling the storage and conveyance capacity of the proposed drainage system. A summary of the SuDS provision is provided in **Table 3-1**.

Table 3.1: Summary of SuDS Provision

SUDs Storage Structure	Surface Water Disposal Mechanism	Volume of Storage (m^3)	Discharge Flowrate (l/s)
Detention Basin (Attenuation Pond)	Attenuation	433	3.8l/s

4 Water Quality

4.1.1 Proposed run-off quality control for the site will include proprietary treatment. A schedule of the size of the oil interceptors is included in **Annex D**. The proposed oil interceptors ensures that that:

$$\begin{matrix} \textit{TOTAL SUDS MITIGATION INDEX} \\ (\textit{FOR EACH CONTAMINANT}) \end{matrix} \geq \begin{matrix} \textit{POLLUTION HARDARD INDEX} \\ (\textit{FOR EACH CONTAMINANT}) \end{matrix}$$

4.1.2 **Annex D** includes details of the results of the SIA tools and demonstrates that the proposals are sufficient and meet the required standards for water quality.

5 Conclusions

5.1.1 The existing site is previously developed. The Devon County Council Sustainable Drainage requires proposed peak outflow from existing brownfield sites to be the equivalent greenfield run-off rates. The existing ground appear to slope in two directions from 5.3mAOD in the north-east direction to approximately 4.83mAOD in the south-west direction.

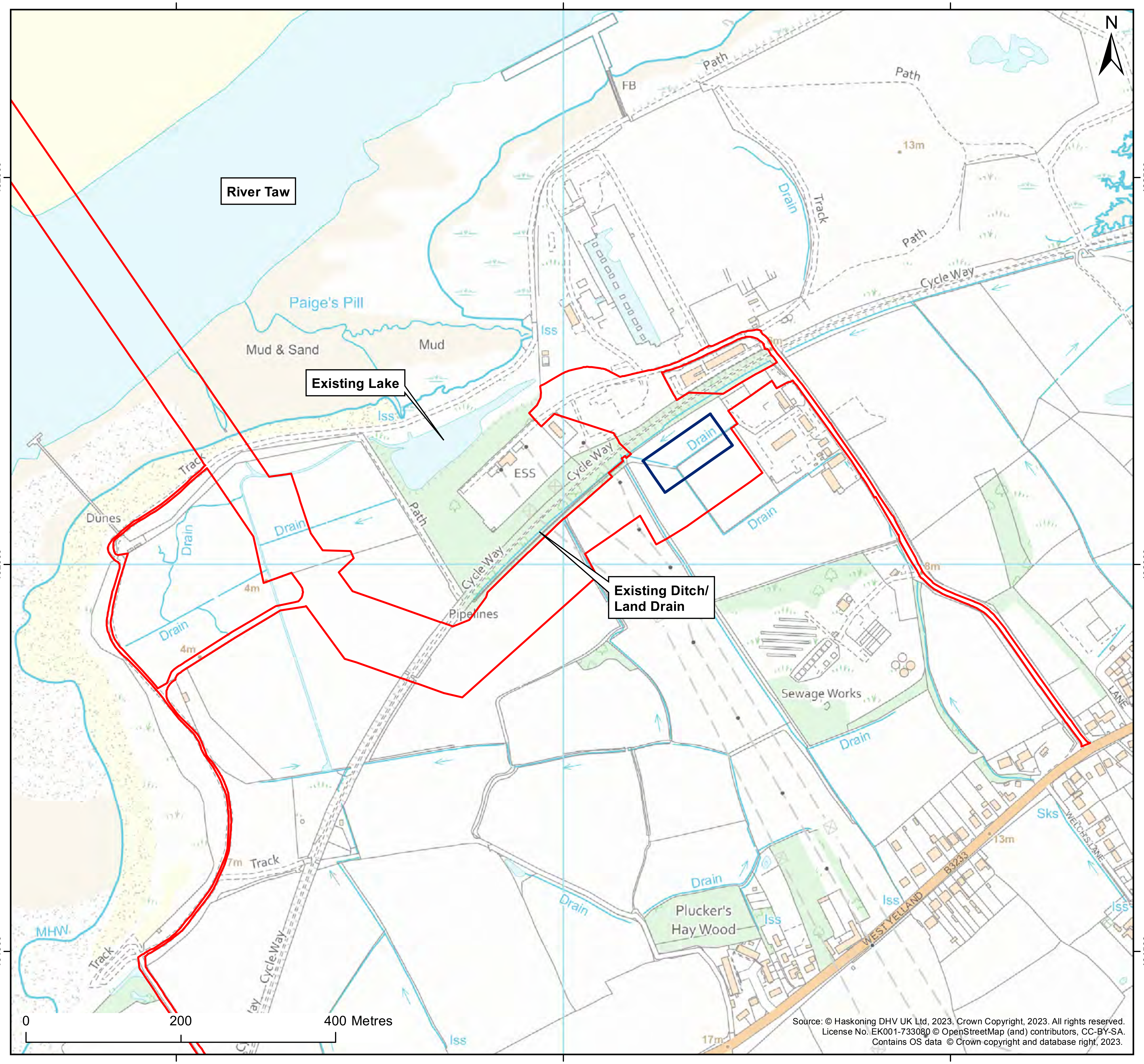
5.1.2 Information presented on the BGS online viewer indicates the bedrock geology underlying the Site consist of Ashton Mudstone Member and Crackington Formation - Mudstone and siltstone. The BGS mapping indicates the underlying ground conditions to have a cohesive composition. It is assumed that surface water discharge methods using infiltration techniques are deemed unsuitable for this site. Infiltration tests to BRE 365 should be conducted to verify this assumption.

5.1.3 Extensive topographical survey will be undertaken during detailed design to verify the presence, direction of water flow and the existing invert levels of the land drains in the vicinity of the site.

5.1.4 The surface water drainage from approximately 0.64ha of impermeable surfaces will be routed via a proprietary treatment system, into an attenuation pond providing a storage volume of approximately 433m^3.

5.1.5 Peak surface water run-off is restricted via a hydro-brake flow control device to the maximum greenfield run-off rate of 3.87l/s for the 1 in 100-year rainfall event including climate change allowances. This is to be restricted surface water outflow is directed into existing land drains located northwest of the development.

5.1.6 There will be no increase in flood risk from the site to the surrounding area due to the restricted run-off rates and inclusion of SuDS. This SuDS Assessment/Drainage Strategy demonstrates to regulators and other stakeholders that the proposed development is feasible.



Legend:
- Onshore Development Area
- White Cross Onshore Substation

Client: Offshore Wind Ltd.	Project: White Cross Offshore Windfarm

Title: Annex A: Site Location Plan

Figure:	1.1	Drawing No:	PC2978-RHD-ZZ-XX-DR-Z-0711

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	03/08/2023	AB	LA	A3	1:5,000

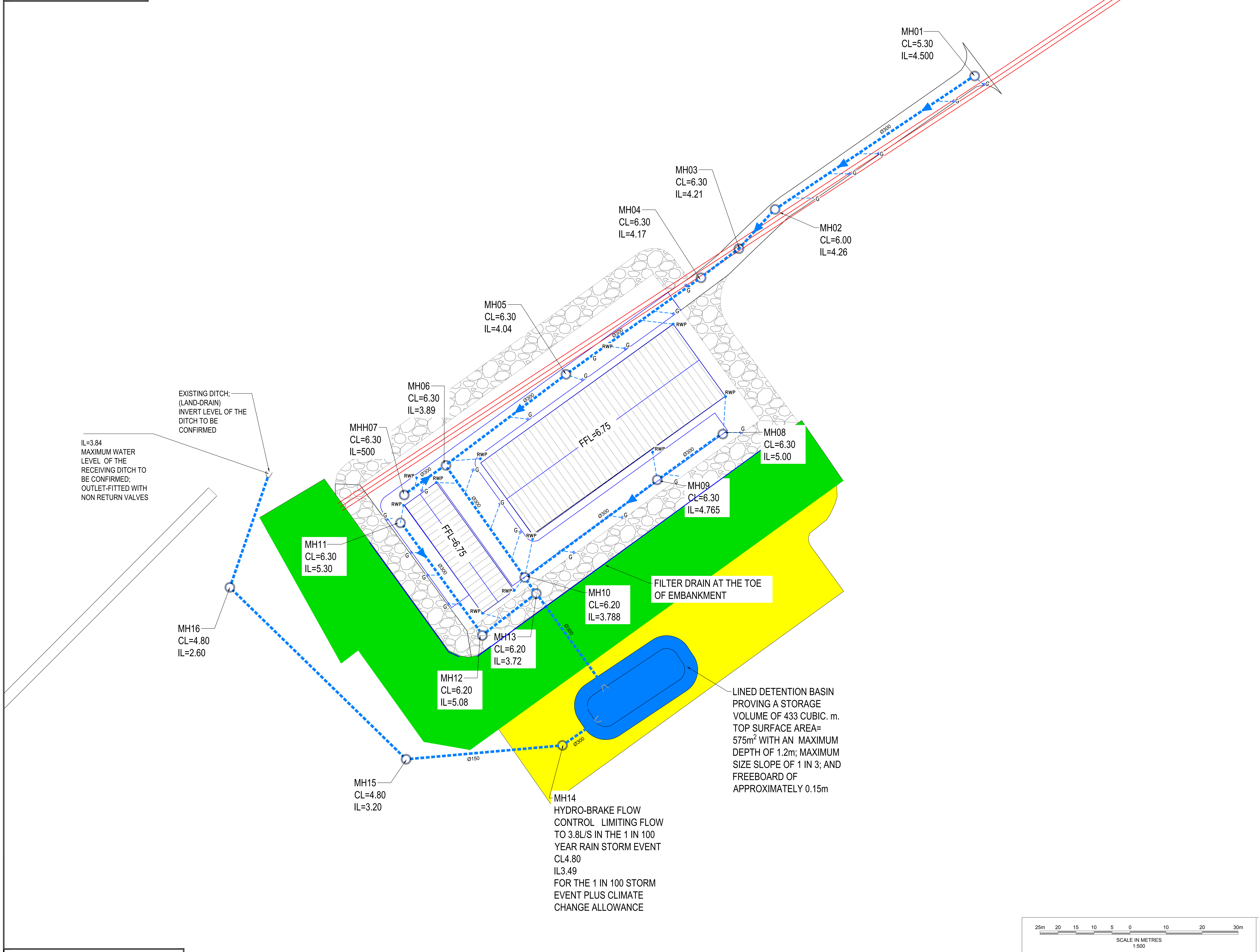
Co-ordinate system: British National Grid

WHITE CROSS

Royal HaskoningDHV
Enhancing Society Together

DRAWING No. PC2978-RHD-ZZ-XX-DR-D-0502

DO NOT SCALE



NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN METRES ABOVE CHART DATUM UNLESS NOTED OTHERWISE.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS DRAWINGS AND PROJECT SPECIFICATION.
4. WORKS TO BE UNDERTAKEN IN ACCORDANCE WITH THE SPECIFICATION FOR HIGHWAYS WORKS (SHW) UNLESS NOTED OTHERWISE.
5. ALL DIMENSIONS AND LEVELS ARE TO BE VERIFIED AND CONFIRMED ON SITE PRIOR TO WORK COMMENCING.
6. ANY DISCREPENCIES TO OR OMISSIONS ARE TO BE REPORTED TO THE PROJECT MANAGER FOR FURTHER INSTRUCTIONS BEFORE COMMENCEMENT OF WORKS.

LEGEND

- PROPOSED SURFACE WATER SEWER AND MANHOLE
- G PROPOSED GULLY
- EXISTING OVERHEAD ELECTRICAL CABLE
- EXISTING UNDERGROUND ELECTRICAL CABLE
- PROPOSED LANDSCAPED AREA
- TEMPORARY CONSTRUCTION COMPOUND
- PROPOSED DETENTION BASIN
- PROPOSED GRADED EMBANKMENT
- PROPOSED FILTER DRAIN AT THE TOE OF EMBANKMENT
- RWP PROPOSED RAINWATER OUTLET FROM ROOF

REV	DATE	DESCRIPTION	BY	CHK	APP
P05	08-09-23	GULLY POSITIONS AND MANHOLE REFRENCES	IO	OA	DJ
P04	20-07-23	REVISED TO INCLUDE UPDATED SITE PLAN	IO	OA	DJ
P01	16-05-23	FIRST ISSUE	IO	OA	DJ

REVISIONS

DRAWING STATUS PRELIMINARY

CLIENT

OFFSHORE WIND LIMITED

PROJECT

WHITE CROSS WINDFARM

TITLE

OUTLINE SURFACE WATER DRAINAGE STRATEGY

Royal HaskoningDHV
Enhancing Society Together
Portland Street,
Manchester One, 9th Floor
Manchester, M1 3LF
Tel +44(0)161 2361018
Email info.manchester@uk.rhdhv.com
Website www.royalhaskoning.com

DRAWN	CHECKED	APPROVED
DW	IO	PPV
DATE	SCALE AT A1	PROJECT NUMBER
OCT-22	1:500	PC2978

DRAWING No.	REVISION
PC3506-RHD-ZZ-XX-DR-D-0500	P05

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 1080 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	97.754	0.254	0.0	0.0	0.0	125.2	O K
30 min Summer	97.850	0.350	0.0	1.1	1.1	172.7	O K
60 min Summer	97.954	0.454	0.0	3.4	3.4	224.2	O K
120 min Summer	98.069	0.569	0.0	3.8	3.8	281.3	O K
180 min Summer	98.138	0.638	0.0	3.9	3.9	315.0	O K
240 min Summer	98.183	0.683	0.0	3.9	3.9	337.5	O K
360 min Summer	98.240	0.740	0.0	3.9	3.9	365.5	O K
480 min Summer	98.277	0.777	0.0	3.9	3.9	384.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	104.373	0.0	0.0	27
30 min Summer	72.185	0.0	20.5	42
60 min Summer	47.821	0.0	78.6	70
120 min Summer	30.679	0.0	143.1	128
180 min Summer	23.321	0.0	184.2	188
240 min Summer	19.055	0.0	213.9	246
360 min Summer	14.198	0.0	256.5	364
480 min Summer	11.527	0.0	289.7	482

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
600 min Summer	98.302	0.802	0.0	3.9	3.9	396.4	O K
720 min Summer	98.319	0.819	0.0	3.9	3.9	404.6	O K
960 min Summer	98.344	0.844	0.0	3.9	3.9	416.7	O K
1440 min Summer	98.372	0.872	0.0	3.9	3.9	430.9	O K
2160 min Summer	98.386	0.886	0.0	3.9	3.9	437.6	O K
2880 min Summer	98.379	0.879	0.0	3.9	3.9	434.1	O K
4320 min Summer	98.334	0.834	0.0	3.9	3.9	412.1	O K
5760 min Summer	98.273	0.773	0.0	3.9	3.9	381.8	O K
7200 min Summer	98.211	0.711	0.0	3.9	3.9	351.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
600 min Summer	9.797	0.0	316.7	602
720 min Summer	8.572	0.0	339.5	700
960 min Summer	6.935	0.0	376.8	812
1440 min Summer	5.133	0.0	429.3	1068
2160 min Summer	3.788	0.0	503.7	1476
2880 min Summer	3.049	0.0	551.0	1880
4320 min Summer	2.239	0.0	620.6	2684
5760 min Summer	1.796	0.0	678.3	3464
7200 min Summer	1.516	0.0	723.6	4184

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	98.154	0.654	0.0	3.9	3.9	323.2	O K
10080 min Summer	98.105	0.605	0.0	3.9	3.9	298.9	O K
15 min Winter	97.784	0.284	0.0	0.0	0.0	140.3	O K
30 min Winter	97.889	0.389	0.0	2.5	2.5	192.4	O K
60 min Winter	98.008	0.508	0.0	3.7	3.7	251.1	O K
120 min Winter	98.140	0.640	0.0	3.9	3.9	316.3	O K
180 min Winter	98.219	0.719	0.0	3.9	3.9	355.0	O K
240 min Winter	98.271	0.771	0.0	3.9	3.9	381.0	O K
360 min Winter	98.338	0.838	0.0	3.9	3.9	414.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.320	0.0	762.0	4928
10080 min Summer	1.174	0.0	794.8	5640
15 min Winter	104.373	0.0	0.0	27
30 min Winter	72.185	0.0	40.6	41
60 min Winter	47.821	0.0	106.0	68
120 min Winter	30.679	0.0	178.3	126
180 min Winter	23.321	0.0	224.2	184
240 min Winter	19.055	0.0	257.4	242
360 min Winter	14.198	0.0	305.0	358

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
480 min Winter	98.383	0.883	0.0	3.9	3.9	436.4	O K
600 min Winter	98.415	0.915	0.0	3.9	3.9	451.9	O K
720 min Winter	98.437	0.937	0.0	3.9	3.9	463.0	O K
960 min Winter	98.464	0.964	0.0	3.9	3.9	476.3	O K
1440 min Winter	98.481	0.981	0.0	3.9	3.9	484.6	O K
2160 min Winter	98.479	0.979	0.0	3.9	3.9	483.5	O K
2880 min Winter	98.450	0.950	0.0	3.9	3.9	469.2	O K
4320 min Winter	98.357	0.857	0.0	3.9	3.9	423.5	O K
5760 min Winter	98.253	0.753	0.0	3.9	3.9	372.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
480 min Winter	11.527	0.0	342.0	472
600 min Winter	9.797	0.0	372.0	586
720 min Winter	8.572	0.0	397.3	698
960 min Winter	6.935	0.0	438.0	916
1440 min Winter	5.133	0.0	488.8	1168
2160 min Winter	3.788	0.0	582.0	1624
2880 min Winter	3.049	0.0	634.8	2072
4320 min Winter	2.239	0.0	712.5	2904
5760 min Winter	1.796	0.0	777.7	3688

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
7200 min Winter	98.160	0.660	0.0	3.9	3.9	325.9	O K
8640 min Winter	98.083	0.583	0.0	3.9	3.9	288.2	O K
10080 min Winter	98.025	0.525	0.0	3.7	3.7	259.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.516	0.0	828.4	4400
8640 min Winter	1.320	0.0	871.6	5096
10080 min Winter	1.174	0.0	908.7	5752

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 97.500 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	520.0	0.0	1.000	520.0	0.0	1.001	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0089-5000-2200-5000	Sump Available	Yes
Design Head (m)	2.200	Diameter (mm)	89
Design Flow (l/s)	5.0	Invert Level (m)	97.800
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	150
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.200	5.0	Kick-Flo®	0.801	3.1
Flush-Flo™	0.391	3.9	Mean Flow over Head Range	-	3.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.8	0.600	3.8	1.600	4.3	2.600	5.4	5.000	7.3	7.500	8.9
0.200	3.6	0.800	3.1	1.800	4.5	3.000	5.8	5.500	7.7	8.000	9.2
0.300	3.9	1.000	3.5	2.000	4.8	3.500	6.2	6.000	8.0	8.500	9.4
0.400	3.9	1.200	3.8	2.200	5.0	4.000	6.6	6.500	8.3	9.000	9.7
0.500	3.9	1.400	4.0	2.400	5.2	4.500	7.0	7.000	8.6	9.500	10.0

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100
M5-60 (mm)	16.500
Ratio R	0.281
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.073	4-8	0.468	8-12	0.073

Total Area Contributing (ha) = 0.614

Total Pipe Volume (m³) = 47.077

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	71.553	0.239	300.0	0.023	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	14.359	0.048	300.0	0.023	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	13.917	0.046	300.0	0.023	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	63.816	0.213	300.0	0.024	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	45.487	0.152	300.0	0.024	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.004	36.675	0.122	300.0	0.071	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.000	19.814	0.066	300.0	0.071	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	34.169	0.115	298.2	0.071	0.00	0.0	0.600	o	300	Pipe/Conduit	
4.000	25.423	0.085	300.0	0.071	5.00	0.0	0.600	o	150	Pipe/Conduit	
4.001	40.066	0.135	297.6	0.071	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.006	16.825	0.055	303.8	0.071	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.000	43.815	0.219	200.0	0.071	5.00	0.0	0.600	o	300	Pipe/Conduit	
5.001	19.668	0.066	300.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	6.32	4.500	0.023	0.0	0.0	0.0	0.90	63.8	3.1
1.001	50.00	6.59	4.261	0.046	0.0	0.0	0.0	0.90	63.8	6.2
1.002	50.00	6.84	4.214	0.069	0.0	0.0	0.0	0.90	63.8	9.3
2.000	50.00	6.18	5.400	0.024	0.0	0.0	0.0	0.90	63.8	3.2
1.003	50.00	7.68	4.167	0.117	0.0	0.0	0.0	0.90	63.8	15.8
1.004	50.00	8.36	4.015	0.188	0.0	0.0	0.0	0.90	63.8	25.5
3.000	50.00	5.57	5.000	0.071	0.0	0.0	0.0	0.58	10.2	9.6
1.005	50.00	8.99	3.893	0.330	0.0	0.0	0.0	0.91	64.0	44.7
4.000	50.00	5.74	5.000	0.071	0.0	0.0	0.0	0.58	10.2	9.6
4.001	50.00	6.47	4.765	0.142	0.0	0.0	0.0	0.91	64.1	19.2
1.006	50.00	9.30	3.778	0.543	0.0	0.0	0.0	0.90	63.4«	73.5
5.000	50.00	5.66	5.300	0.071	0.0	0.0	0.0	1.11	78.3	9.6
5.001	50.00	6.02	5.081	0.071	0.0	0.0	0.0	0.90	63.8	9.6

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.007	21.995	0.073	300.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.008	25.489	0.085	300.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.009	69.832	0.466	150.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.010	53.379	0.356	150.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.007	50.00	9.71	3.723	0.614	0.0	0.0	0.0	0.90	63.8«	83.1
1.008	50.00	10.12	3.575	0.614	0.0	0.0	0.0	1.04	115.0	83.1
1.009	50.00	10.90	3.490	0.614	0.0	0.0	0.0	1.48	163.1	83.1
1.010	50.00	11.51	3.024	0.614	0.0	0.0	0.0	1.48	163.1	83.1

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	300	01	5.300	4.500	0.500	Open Manhole	1200
1.001	o	300	02	6.000	4.261	1.439	Open Manhole	1200
1.002	o	300	03	6.300	4.214	1.786	Open Manhole	1200
2.000	o	300	16	6.400	5.400	0.700	Open Manhole	1200
1.003	o	300	04	6.300	4.167	1.833	Open Manhole	1200
1.004	o	300	05	6.300	4.015	1.985	Open Manhole	1200
3.000	o	150	H07	6.300	5.000	1.150	Open Manhole	1200
1.005	o	300	06	6.300	3.893	2.107	Open Manhole	1200
4.000	o	150	07	6.300	5.000	1.150	Open Manhole	1200
4.001	o	300	08	6.300	4.765	1.235	Open Manhole	1200
1.006	o	300	09	6.200	3.778	2.122	Open Manhole	1200
5.000	o	300	10	6.300	5.300	0.700	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	71.553	300.0	02	6.000	4.261	1.439	Open Manhole	1200
1.001	14.359	300.0	03	6.300	4.214	1.786	Open Manhole	1200
1.002	13.917	300.0	04	6.300	4.167	1.833	Open Manhole	1200
2.000	63.816	300.0	04	6.300	5.187	0.813	Open Manhole	1200
1.003	45.487	300.0	05	6.300	4.015	1.985	Open Manhole	1200
1.004	36.675	300.0	06	6.300	3.893	2.107	Open Manhole	1200
3.000	19.814	300.0	06	6.300	4.934	1.216	Open Manhole	1200
1.005	34.169	298.2	09	6.200	3.778	2.122	Open Manhole	1200
4.000	25.423	300.0	08	6.300	4.915	1.235	Open Manhole	1200
4.001	40.066	297.6	09	6.200	4.631	1.269	Open Manhole	1200
1.006	16.825	303.8	12	6.200	3.723	2.177	Open Manhole	1200
5.000	43.815	200.0	11	6.200	5.081	0.819	Open Manhole	1200

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
5.001	o	300	11	6.200	5.081	0.819	Open Manhole	1200
1.007	o	300	12	6.200	3.723	2.177	Open Manhole	1200
1.008	o	375	13	4.850	3.575	0.900	Open Manhole	1350
1.009	o	375	14	4.800	3.490	0.935	Open Manhole	1350
1.010	o	375	15	4.800	3.024	1.401	Open Manhole	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
5.001	19.668	300.0	12	6.200	5.015	0.885	Open Manhole	1200
1.007	21.995	300.0	13	4.850	3.650	0.900	Open Manhole	1350
1.008	25.489	300.0	14	4.800	3.490	0.935	Open Manhole	1350
1.009	69.832	150.0	15	4.800	3.024	1.401	Open Manhole	1350
1.010	53.379	150.0		4.800	2.668	1.757	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.010		4.800	2.668	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750
Areal Reduction Factor	1.000
Hot Start (mins)	0
Hot Start Level (mm)	0
Manhole Headloss Coeff (Global)	0.500
Foul Sewage per hectare (l/s)	0.000
Additional Flow - % of Total Flow	0.000
MADD Factor * 10m³/ha Storage	2.000
Inlet Coeffiecient	0.800
Flow per Person per Day (l/per/day)	0.000
Run Time (mins)	60
Output Interval (mins)	1

Simulation Criteria for Storm

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	16.500	Storm Duration (mins)	30
Ratio R	0.281		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 13, DS/PN: 1.008, Volume (m³): 3.3

Unit Reference	MD-SHE-0090-3800-1200-3800
Design Head (m)	1.200
Design Flow (l/s)	3.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	90
Invert Level (m)	3.575
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	3.8
Flush-Flo™	0.355	3.8
Kick-Flo®	0.735	3.0
Mean Flow over Head Range	-	3.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.8	1.600	4.3	5.000	7.4
0.200	3.6	1.800	4.6	5.500	7.7
0.300	3.8	2.000	4.8	6.000	8.1
0.400	3.8	2.200	5.0	6.500	8.4
0.500	3.7	2.400	5.2	7.000	8.7
0.600	3.5	2.600	5.4	7.500	9.0
0.800	3.2	3.000	5.8	8.000	9.2
1.000	3.5	3.500	6.3	8.500	9.5
1.200	3.8	4.000	6.7	9.000	9.8
1.400	4.1	4.500	7.0	9.500	10.0

Storage Structures for Storm

Tank or Pond Manhole: 13, DS/PN: 1.008

Invert Level (m) 3.575

Depth (m)	Area (m^2)	Depth (m)	Area (m^2)	Depth (m)	Area (m^2)
0.000	350.0	1.200	673.0	1.201	673.0

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000
Hot Start (mins)	0
Hot Start Level (mm)	0
Manhole Headloss Coeff (Global)	0.500
Foul Sewage per hectare (l/s)	0.000
Additional Flow - % of Total Flow	0.000
MADD Factor * 10m³/ha Storage	2.000
Inlet Coeffiecient	0.800
Flow per Person per Day (l/per/day)	0.000

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.275
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	16.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow
1.000	01	30 Summer	1	+0%	100/30 Summer	100/30 Winter	
1.001	02	30 Summer	1	+0%	100/30 Summer		
1.002	03	30 Summer	1	+0%	100/30 Summer		
2.000	16	30 Summer	1	+0%			
1.003	04	30 Summer	1	+0%	100/30 Summer		
1.004	05	30 Summer	1	+0%	30/30 Summer		
3.000	H07	30 Summer	1	+0%	30/30 Summer		
1.005	06	30 Summer	1	+0%	30/30 Summer		
4.000	07	30 Summer	1	+0%	30/30 Summer		
4.001	08	30 Summer	1	+0%			

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
1.000	01		4.536	-0.264	0.000	0.03			2.0
1.001	02		4.318	-0.244	0.000	0.07			3.7
1.002	03		4.282	-0.232	0.000	0.10			5.4
2.000	16		5.437	-0.263	0.000	0.04			2.2
1.003	04		4.246	-0.221	0.000	0.15			9.1
1.004	05		4.115	-0.201	0.000	0.23			13.8
3.000	H07		5.091	-0.059	0.000	0.68			6.5
1.005	06		4.033	-0.160	0.000	0.40			23.8
4.000	07		5.090	-0.060	0.000	0.67			6.5
4.001	08		4.857	-0.208	0.000	0.20			12.2

PN	US/MH Name	Status	Level Exceeded
1.000	01	OK	1
1.001	02	OK	
1.002	03	OK	
2.000	16	OK	
1.003	04	OK	
1.004	05	OK	
3.000	H07	OK	
1.005	06	OK	
4.000	07	OK	
4.001	08	OK	

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.006	09	30 Summer	1	+0%	30/30 Summer			
5.000	10	30 Summer	1	+0%				
5.001	11	30 Summer	1	+0%				
1.007	12	30 Summer	1	+0%	30/30 Summer			
1.008	13	600 Winter	1	+0%	30/180 Winter			
1.009	14	600 Winter	1	+0%				
1.010	15	600 Winter	1	+0%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.006	09	3.979	-0.099	0.000	0.73			39.6	OK
5.000	10	5.360	-0.240	0.000	0.09			6.4	OK
5.001	11	5.148	-0.232	0.000	0.12			6.4	OK
1.007	12	3.929	-0.094	0.000	0.81			45.5	OK
1.008	13	3.767	-0.183	0.000	0.04			3.6	OK
1.009	14	3.528	-0.336	0.000	0.02			3.6	OK
1.010	15	3.063	-0.336	0.000	0.02			3.6	OK

PN	US/MH Name	Level Exceeded
1.006	09	
5.000	10	
5.001	11	
1.007	12	
1.008	13	
1.009	14	
1.010	15	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000
Hot Start (mins)	0
Hot Start Level (mm)	0
Manhole Headloss Coeff (Global)	0.500
Foul Sewage per hectare (l/s)	0.000
Additional Flow - % of Total Flow	0.000
MADD Factor * 10m³/ha Storage	2.000
Inlet Coeffiecient	0.800
Flow per Person per Day (l/per/day)	0.000

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.275
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	16.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow
1.000	01	30 Summer	30	+0%	100/30 Summer	100/30 Winter	
1.001	02	30 Summer	30	+0%	100/30 Summer		
1.002	03	30 Summer	30	+0%	100/30 Summer		
2.000	16	30 Summer	30	+0%			
1.003	04	30 Summer	30	+0%	100/30 Summer		
1.004	05	30 Summer	30	+0%	30/30 Summer		
3.000	H07	30 Summer	30	+0%	30/30 Summer		
1.005	06	30 Summer	30	+0%	30/30 Summer		
4.000	07	30 Summer	30	+0%	30/30 Summer		
4.001	08	30 Summer	30	+0%			

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
1.000	01		4.558	-0.242	0.000	0.08			4.9
1.001	02		4.452	-0.110	0.000	0.24			12.6
1.002	03		4.448	-0.065	0.000	0.33			17.7
2.000	16		5.460	-0.240	0.000	0.09			5.4
1.003	04		4.448	-0.019	0.000	0.40			24.0
1.004	05		4.436	0.121	0.000	0.60			35.4
3.000	H07		5.257	0.107	0.000	1.63			15.6
1.005	06		4.407	0.214	0.000	0.83			48.8
4.000	07		5.278	0.128	0.000	1.60			15.5
4.001	08		4.921	-0.145	0.000	0.52			31.0

PN	US/MH Name	Status	Level Exceeded
1.000	01	OK	1
1.001	02	OK	
1.002	03	OK	
2.000	16	OK	
1.003	04	OK	
1.004	05	SURCHARGED	
3.000	H07	SURCHARGED	
1.005	06	SURCHARGED	
4.000	07	SURCHARGED	
4.001	08	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.006	09	30 Summer	30	+0%	30/30 Summer			
5.000	10	30 Summer	30	+0%				
5.001	11	30 Summer	30	+0%				
1.007	12	30 Summer	30	+0%	30/30 Summer			
1.008	13	720 Winter	30	+0%	30/180 Winter			
1.009	14	240 Winter	30	+0%				
1.010	15	1440 Winter	30	+0%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.006	09	4.329	0.251	0.000	1.60			86.3	SURCHARGED
5.000	10	5.395	-0.205	0.000	0.21			15.7	OK
5.001	11	5.189	-0.192	0.000	0.28			15.7	OK
1.007	12	4.182	0.159	0.000	1.82			102.6	SURCHARGED
1.008	13	4.033	0.084	0.000	0.04			3.8	SURCHARGED
1.009	14	3.529	-0.336	0.000	0.02			3.8	OK
1.010	15	3.064	-0.335	0.000	0.02			3.8	OK

PN	US/MH Name	Level Exceeded
1.006	09	
5.000	10	
5.001	11	
1.007	12	
1.008	13	
1.009	14	
1.010	15	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000
Hot Start (mins)	0
Hot Start Level (mm)	0
Manhole Headloss Coeff (Global)	0.500
Foul Sewage per hectare (l/s)	0.000
Additional Flow - % of Total Flow	0.000
MADD Factor * 10m³/ha Storage	2.000
Inlet Coeffiecient	0.800
Flow per Person per Day (l/per/day)	0.000

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.275
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	16.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow
1.000	01	30 Winter	100	+40%	100/30 Summer	100/30 Winter	
1.001	02	30 Winter	100	+40%	100/30 Summer		
1.002	03	30 Winter	100	+40%	100/30 Summer		
2.000	16	30 Summer	100	+40%			
1.003	04	30 Winter	100	+40%	100/30 Summer		
1.004	05	30 Winter	100	+40%	30/30 Summer		
3.000	H07	30 Summer	100	+40%	30/30 Summer		
1.005	06	30 Winter	100	+40%	30/30 Summer		
4.000	07	30 Summer	100	+40%	30/30 Summer		
4.001	08	30 Summer	100	+40%			

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
1.000	01		5.300	0.500	0.001	0.13			8.2
1.001	02		5.290	0.728	0.000	0.56			29.7
1.002	03		5.280	0.766	0.000	0.63			33.4
2.000	16		5.480	-0.220	0.000	0.16			9.9
1.003	04		5.266	0.799	0.000	0.65			38.8
1.004	05		5.226	0.910	0.000	0.80			47.2
3.000	H07		5.623	0.473	0.000	2.84			27.2
1.005	06		5.162	0.969	0.000	1.39			81.7
4.000	07		5.705	0.555	0.000	2.72			26.3
4.001	08		5.002	-0.063	0.000	0.88			52.6

PN	US/MH Name	Status	Level Exceeded
1.000	01	FLOOD	1
1.001	02	SURCHARGED	
1.002	03	SURCHARGED	
2.000	16	OK	
1.003	04	SURCHARGED	
1.004	05	SURCHARGED	
3.000	H07	SURCHARGED	
1.005	06	SURCHARGED	
4.000	07	SURCHARGED	
4.001	08	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.006	09	30 Winter	100	+40%	30/30 Summer			
5.000	10	30 Summer	100	+40%				
5.001	11	30 Summer	100	+40%				
1.007	12	30 Summer	100	+40%	30/30 Summer			
1.008	13	960 Winter	100	+40%	30/180 Winter			
1.009	14	2880 Summer	100	+40%				
1.010	15	5760 Summer	100	+40%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.006	09	4.938	0.860	0.000	2.61			141.1	SURCHARGED
5.000	10	5.431	-0.169	0.000	0.39			28.6	OK
5.001	11	5.234	-0.147	0.000	0.51			28.5	OK
1.007	12	4.564	0.541	0.000	2.92			164.1	SURCHARGED
1.008	13	4.463	0.514	0.000	0.04			3.8	SURCHARGED
1.009	14	3.529	-0.336	0.000	0.02			3.8	OK
1.010	15	3.064	-0.335	0.000	0.02			3.8	OK

PN	US/MH Name	Level Exceeded
1.006	09	
5.000	10	
5.001	11	
1.007	12	
1.008	13	
1.009	14	
1.010	15	

SIMPLE INDEX APPROACH: TOOL

1. The steps set out in the tool should be applied for each inflow or 'runoff area' (ie each impermeable surface area separately discharging to a SuDS component).

2. The supporting 'Design Conditions' stated by the tool must be fully considered and implemented in all cases.

3. The process that is automated in this tool is described in the SuDS Manual, Chapter 26 (Section 26.7)

3. Relevant design examples are included in the SuDS Manual Appendix C.

4. Each of the steps below are part of the process set out in the flowchart on Sheet 3.

5. Sheet 4 summarises the selections made below and indicates the acceptability of the proposed SuDS components.

6. Interception should be delivered for all upstream impermeable areas as part of the strategy for water quantity and quality control for the site. This is required in order to deliver both of the water quality criteria set out in Chapter 4 of the SuDS Manual

	DROP DOWN LIST	**RELEVANT INPUTS NEED TO BE SELECTED FROM THESE LISTS, FOR EACH STEP**
	USER ENTRY	**USER ENTRY CELLS ARE ONLY REQUIRED WHERE INDICATED BY THE TOOL**

STEP 1: **Determine the Pollution Hazard Index for the runoff area discharging to the proposed SuDS scheme**

This step requires the user to select the appropriate land use type for the area from which the runoff is occurring

If the land use varies across the 'runoff area', either:

- use the land use type with the highest Pollution Hazard Index

- apply the approach for each of the land use types to determine whether the proposed SuDS design is sufficient for all. If it is not, consider collecting more hazardous runoff separately and providing additional treatment.

If the generic land use types suggested are not applicable, select 'Other' and enter a description of the land use of the runoff area and agreed user defined indices in the row below the drop down lists.

	Runoff Area Land Use Description	*Hazard Level*	*Pollution Hazard Indices* Total Suspended Solids	Metals	Hydrocarbons	*DESIGN CONDITIONS* 1	2
Select land use type from the drop down list (or 'Other' if none applicable):	Standard commercial yard or delivery area	Medium	0.7	0.6	0.7	This classification is not appropriate for haulage yards, lorry parks, waste management areas, or chemical storage/handling zones	
If the generic land use types in the drop down list above are not applicable, select 'Other' and enter a description of the land use of the runoff area and agreed user defined indices in this row:							
	Landuse Pollution Hazard Index	**Medium**	**0.7**	**0.6**	**0.7**		

STEP 2A: **Determine the Pollution Mitigation Index for the proposed SuDS components**

This step requires the user to select the proposed SuDS components that will be used to treat runoff - before it is discharged to a receiving surface waterbody or downstream infiltration component
If the runoff is discharged directly to an infiltration component, without upstream treatment, select 'None' for each of the 3 SuDS components and move to Step 2B

This step should be applied to evaluate the water quality protection provided by proposed SuDS components for discharges to receiving surface waters or downstream infiltration components (note: in England and Wales this will include components that allow any amount of infiltration, however small, even where infiltration is not specifically accounted for in the design).

If you have fewer than 3 components, select 'None' for the components that are not required

If the proposed component is bespoke and/or a proprietary treatment product and not generically described by the suggested components, then 'Proprietary treatment system' or 'User defined indices' should be selected and a description of the component and agreed user defined indices should be entered in the rows below the drop down lists

SuDS Component Description	*Pollution Mitigation Indices* Total Suspended Solids	Metals	Hydrocarbons	*DESIGN CONDITIONS* 1	2	3

Select SuDS Component 1 (i.e. the upstream SuDS component) from the drop down list:	Pond or wetland		0.7	0.7	0.5
Select SuDS Component 2 (i.e. the second SuDS component in a series) from the drop down list:	Proprietary treatment system	Enter User Defined Indices in row below			
Select SuDS Component 3 (i.e. the third SuDS component in a series) from the drop down list:	None		0	0	0
If the proposed SuDS components are bespoke/proprietary and/or the generic indices above are not considered appropriate, select 'Proprietary treatment system' or 'User defined indices' and enter component descriptions and agreed user defined indices in these rows:			0.8	0.8	0.5
		SuDS Component 2			0.5
	Aggregated Surface Water Pollution Mitigation Index		**0.7**	**0.7**	**0.75**

SuDS components can only be assumed to deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters of the SuDS Manual. See also checklists in Appendix B

Ponds/wetlands should be preceded by an upstream component(s) that trap(s) silt, or designed specifically to retain sediment in a separate zone, easily accessible for maintenance, such that the sediment will not be re-suspended in subsequent events

Detailed assessment of performance of designed component in reducing inflow concentrations of each pollutant type required as evidence of adopted indices.
Enter indices approved by the environmental regulator in appropriate 'User Defined Indices' row below

SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. WAT-RM-08 (SEPA, 2014) also provides a flow chart with a summary of checks on suitability of a proprietary system

See Chapter 15 Proprietary treatment systems for approaches to demonstrate product performance. Note: a British Water/Environment Agency assessment Code of Practice is currently under development that will allow manufacturers to complete an agreed test protocol for systems intended to treat contaminated surface water runoff. Full details can be found at: http://www.britishwater.co.uk/Publications/codes-of-practise.aspx.

Note: If the total aggregated mitigation index is > 1 (which is not a realistic outcome), then the outcome is fixed at ">0.95". In this scenario, the proposed components are likely to have a very high mitigation potential for reducing pollutant levels in the runoff and should be sufficient for any proposed land use (note: where risk assessment is required, this outcome would need more detailed verification).

Is the runoff now discharged to an infiltration component?

Yes ? Go to Step 2B
No ? Go to Step 2C

STEP 2B: Determine the Pollution Mitigation Index for the proposed Groundwater Protection

This step requires the user to select the type of groundwater protection that is either part of the SuDS component or that lies between the component and the groundwater

This step should be applied where a SuDS component is specifically designed to infiltrate runoff (note: in England and Wales this will include components that allow any amount of infiltration, however small, even where infiltration is not specifically accounted for in the design).

'Groundwater protection' describes the proposed depth of soil or other material through which runoff will flow between the runoff surface and the underlying groundwater.

Where the discharge is to surface waters and risks to groundwater need not be considered, select 'None'

If the proposed groundwater protection is bespoke and/or a proprietary product and not generically described by the suggested measures, then a description of the protection and agreed user defined indices should be entered in the row below the drop down list

DESIGN CONDITIONS

1	2	3	4

		Pollution Mitigation Indices		
		Total Suspended Solids	**Metals**	**Hydrocarbons**
Select type of groundwater protection from the drop down list:	None			
If the proposed groundwater protection is bespoke/proprietary and/or the generic indices above are not considered appropriate, select 'Proprietary product' or 'User defined indices' and enter a description of the protection and agreed user defined indices in this row:				
	Groundwater Protection Pollution Mitigation Index	**0**	**0**	**0**

STEP 2C: Determine the Combined Pollution Mitigation Indices for the Runoff Area

This is an automatic step which combines the proposed SuDS Pollution Mitigation Indices with any Groundwater Protection Pollution Mitigation Indices

Combined Pollution Mitigation Indices

	Total Suspended Solids	Metals	Hydrocarbons
Combined Pollution Mitigation Indices for the Runoff Area	**0.7**	**0.7**	**0.75**

Note: If the total aggregated mitigation index is > 1 (which is not a realistic outcome), then the outcome is fixed at ">0.95". In this scenario, the proposed components are likely to have a very high mitigation potential for reducing pollutant levels in the runoff and should be sufficient for any proposed land use (note: where risk assessment is required, this outcome would need more detailed verification).

STEP 2D: Determine Sufficiency of Pollution Mitigation Indices for Selected SuDS Components

This is an automatic step which compares the Combined Pollution Mitigation Indices with the Land Use Hazard Indices, to determine whether the proposed components are sufficient to manage each pollutant category type

When the combined mitigation index exceeds the land use pollution hazard index, then the proposed components are considered sufficient in providing pollution risk mitigation.

In England and Wales, where the discharge is to protected surface waters or groundwater, an additional treatment component (ie over and above that required for standard discharges), or other equivalent protection, is required that provides environmental protection in the event of an unexpected pollution event or poor system performance. Protected surface waters are those designated for drinking water abstraction. In England and Wales, protected groundwater resources are defined as Source Protection Zone 1. In Northern Ireland, a more precautionary approach may be required and this should be checked with the environmental regulator on a site by site basis.

DESIGN CONDITIONS

Sufficiency of Pollution Mitigation Indices

Total Suspended Solids	Metals	Hydrocarbons
Sufficient	**Sufficient**	**Sufficient**

1

Reference to local planning documents should also be made to identify any additional protection required for sites due to habitat conservation (see *Chapter 7 The SuDS design process*). The implications of developments on or within close proximity to an area with an environmental designation, such as a Site of Special Scientific Interest (SSSI), should be considered via consultation with relevant conservation bodies such as Natural England

Note: In order to meet both Water Quality criteria set out in the SuDS Manual (Chapter 4), Interception should be delivered for all impermeable areas wherever possible. Interception delivery and treatment may be met by the same components, but Interception requires separate evaluation.

White Cross Offshore Windfarm Environmental Statement

Appendix 5.D: Onshore Export Cable Corridor Alignment Sheets

Index of Figures

GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
2. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO PREPARING ANY WORKING DRAWINGS OR COMMENCING ON SITE.
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LEGEND

CABLE ROUTE BY OPENCUT METHODOLOGY (CENTRELINE)

CABLE ROUTE BY TRENCHLESS METHODOLOGY (CENTRELINE)

CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

Rev	Date	Description	By	Chk
P02	01.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	19.06.23	ISSUED FOR INFORMATION	LP	GA

Amendments

Project

WHITE CROSS FLOATING WINDFARM

Title

ONSHORE CABLE ROUTE - ALIGNMENT SHEETS (SHEET 1 OF 5)

Client

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Suitability

INFORMATION S2

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Drawn By	**Date**	**Scales @ A0**
LP	JUNE 23	1:2000
Stockton Checker	**Stockton Approver**	**Date**

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FLO-WHI-DWG-0004	00

A0-Wat-SDL-S

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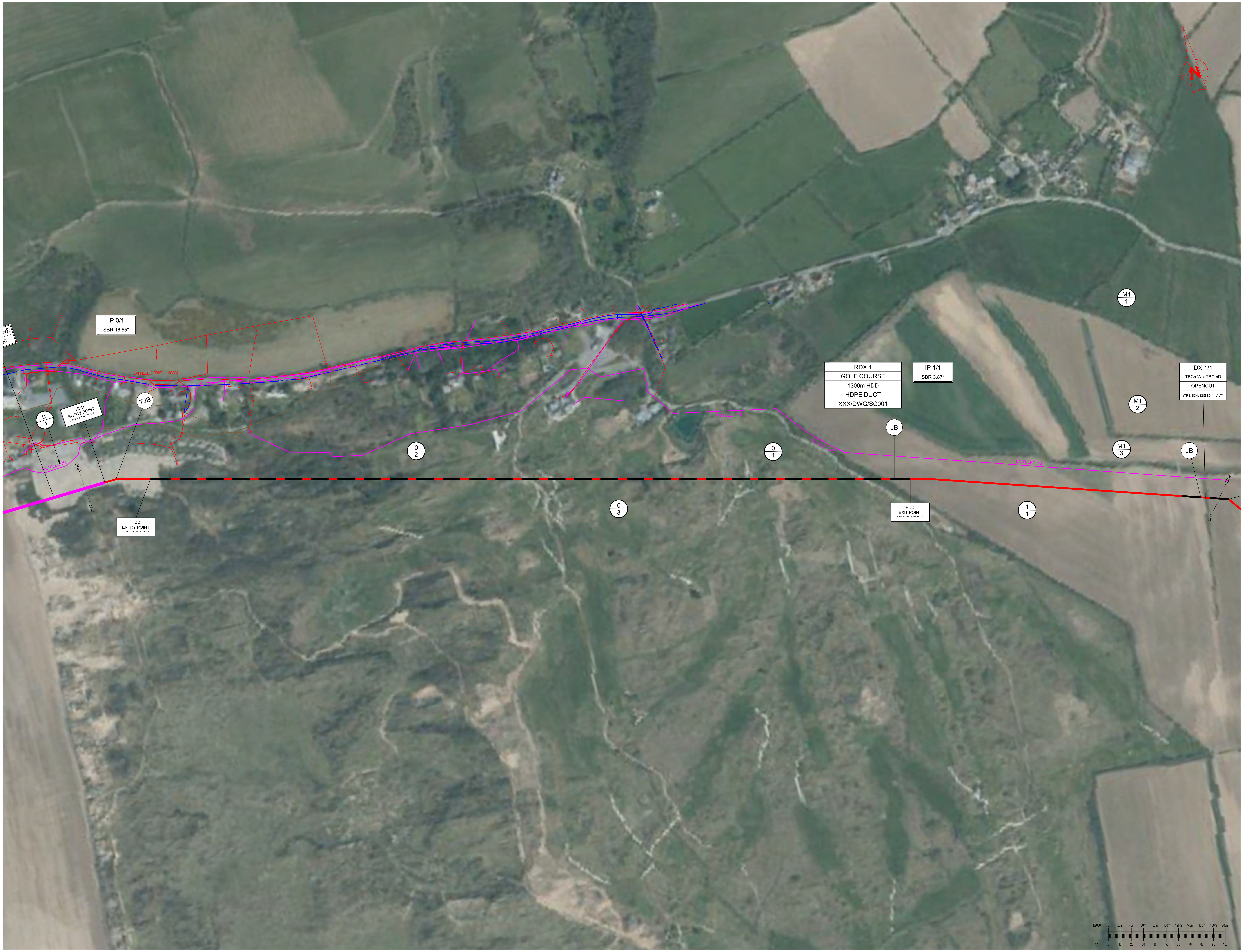

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CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

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Amendments

Project

WHITE CROSS FLOATING WINDFARM

Title

ONSHORE CABLE ROUTE - ALIGNMENT SHEETS (SHEET 2 OF 5)

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Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
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FLO-WHI-DWG-0005	00

A0-Wat-SDL-S

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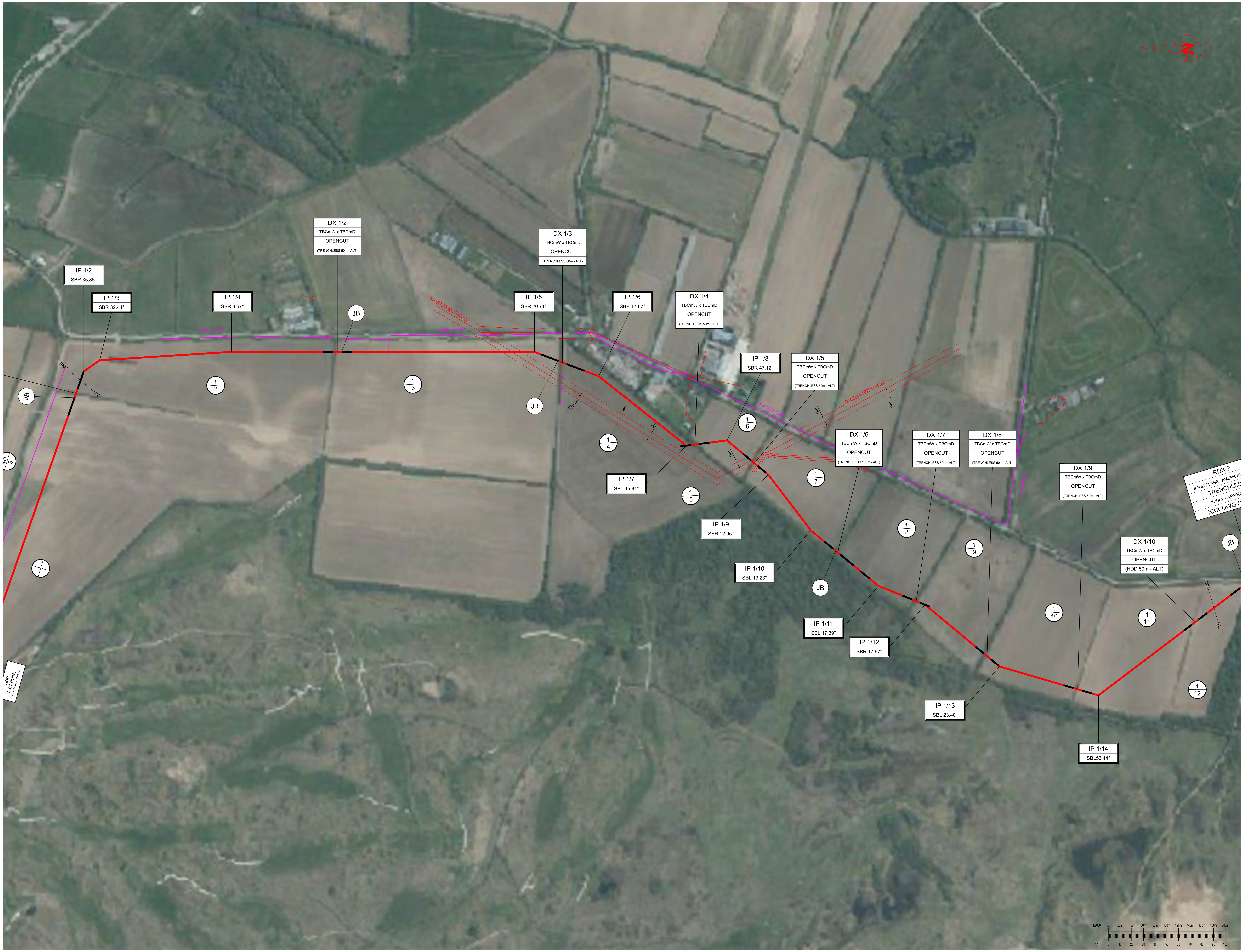

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CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

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Project
WHITE CROSS FLOATING WINDFARM

Title
ONSHORE CABLE ROUTE - ALIGNMENT SHEETS (SHEET 3 OF 5)

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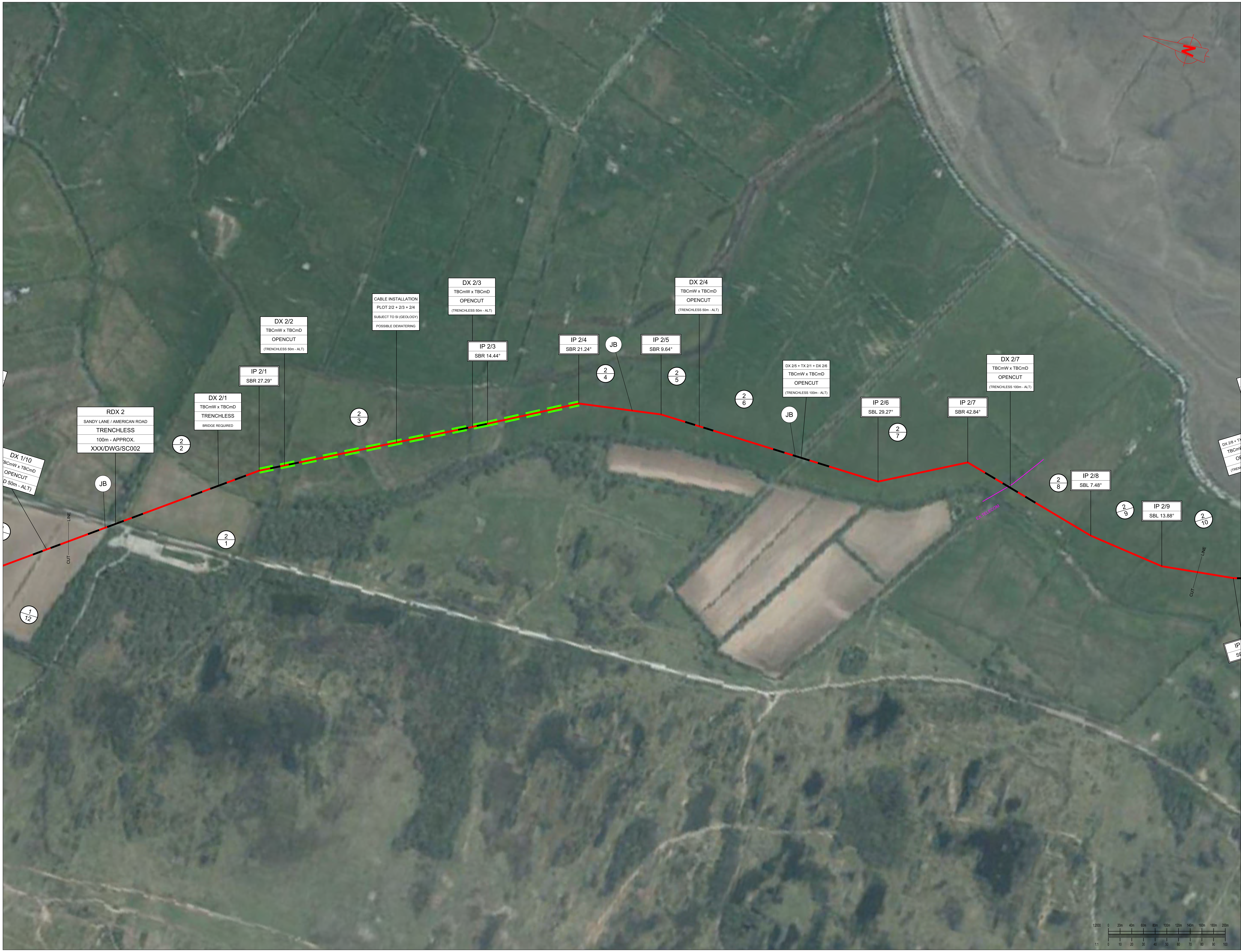

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- CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

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Project

WHITE CROSS FLOATING WINDFARM

Title

ONSHORE CABLE ROUTE - ALIGNMENT SHEETS (SHEET 4 OF 5)

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- CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

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Project
WHITE CROSS FLOATING WINDFARM

Title
ONSHORE CABLE ROUTE - ALIGNMENT SHEETS (SHEET 5 OF 5)

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Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
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Stockton Checker	Stockton Approver	Date

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CABLE ROUTE BY TRENCHLESS METHODOLOGY (CENTRELINE)

CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

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P02	11.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
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Project

WHITE CROSS FLOATING WINDFARM

Title

ONSHORE CABLE ROUTE - WORKING WIDTH ALIGNMENT SHEETS (SHEET 1 OF 5)

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Suitability: INFORMATION		S2
Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
Drawn By: LP	Date: JUNE 23	Scales @ A0: 1:2000
Stockton Checker:	Stockton Approver:	Date:

Project - Originator - Volume - Level - Type - Role - Number	Revision
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110-099-DRG-015	A01
FLO-WHI-DWG-0015	A1

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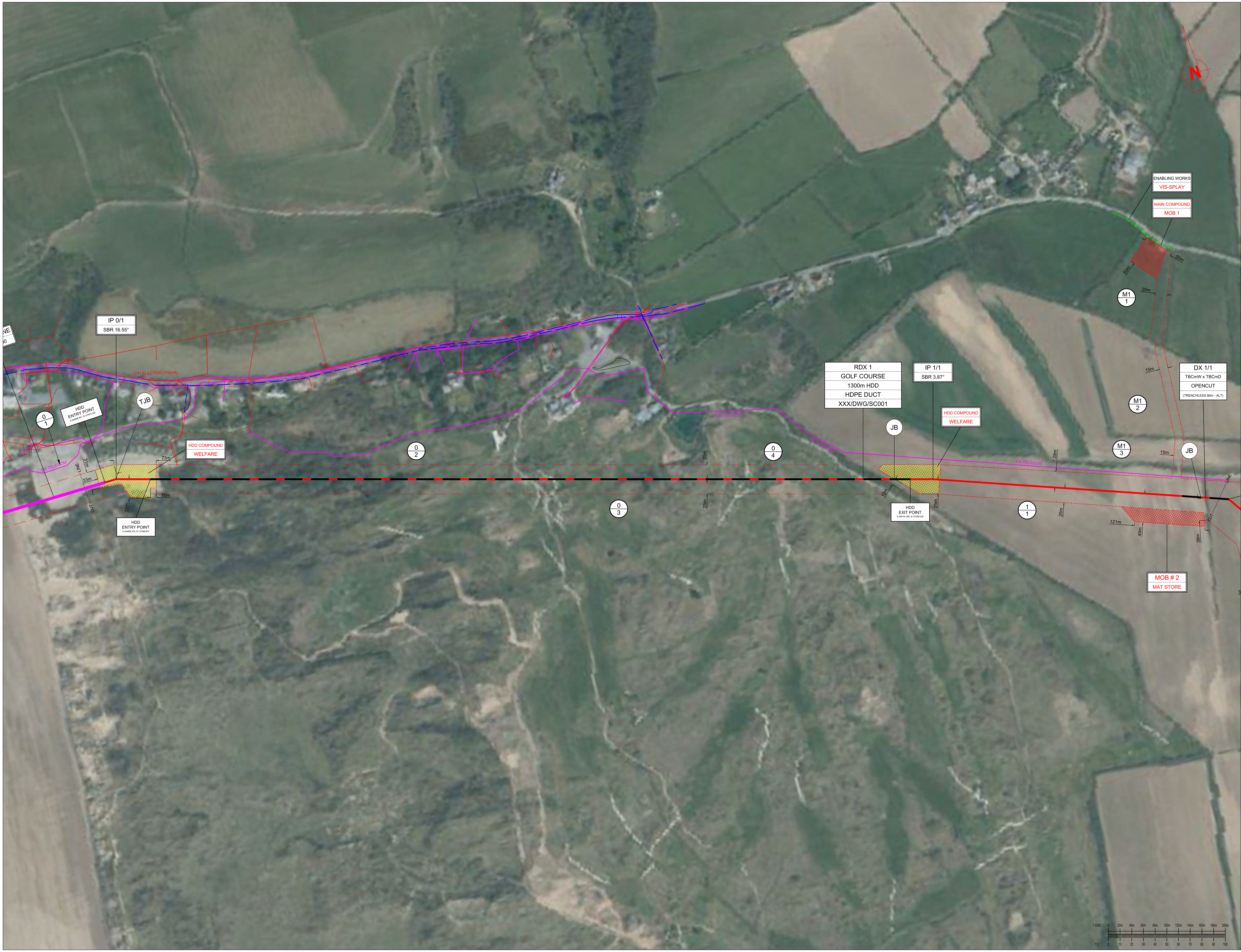

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LEGEND

CABLE ROUTE BY OPENCUT METHODOLOGY (CENTRELINE)

CABLE ROUTE BY TRENCHLESS METHODOLOGY (CENTRELINE)

CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

Rev	Date	Description	By	Chk
P03	14.08.23	MOB 1 AREA AMENDED. RE-ISSUED FOR INFORMATION	LP	GA
P02	11.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	15.06.23	ISSUED FOR INFORMATION	ED	GA

Amendments

Project

WHITE CROSS FLOATING WINDFARM

Title

ONSHORE CABLE ROUTE - WORKING WIDTH ALIGNMENT SHEETS (SHEET 2 OF 5)

Client

FLOTATION ENERGY LTD

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

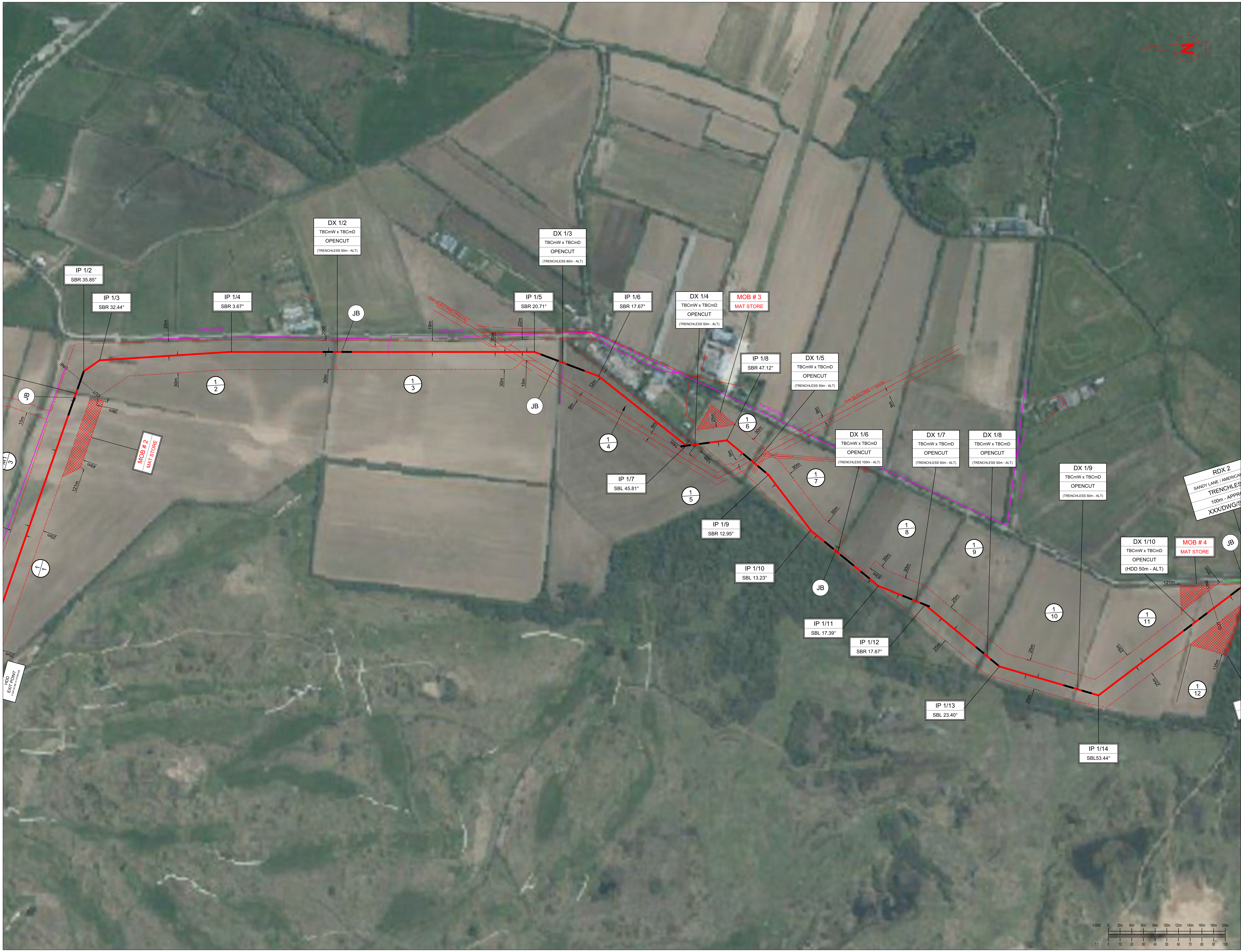
Suitability: INFORMATION S2

Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
Drawn By: LP	Date: JUNE 23	Scales @ A0: 1:2000
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-ZZ-ZZ-M3-91201	P02
110-099-DRG-016	A01
FLO-WHI-DWG-0016	A1

A0-Wat-SDL-S

File Path N:\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\91\



GENERAL NOTES

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LEGEND

- CABLE ROUTE BY OPENCUT METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY TRENCHLESS METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

Rev	Date	Description	By	Chk
P02	11.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	15.06.23	ISSUED FOR INFORMATION	ED	GA

Amendments

Project

WHITE CROSS FLOATING WINDFARM

Title

ONSHORE CABLE ROUTE - WORKING WIDTH ALIGNMENT SHEETS (SHEET 3 OF 5)

Client

FLOTATION ENERGY LTD

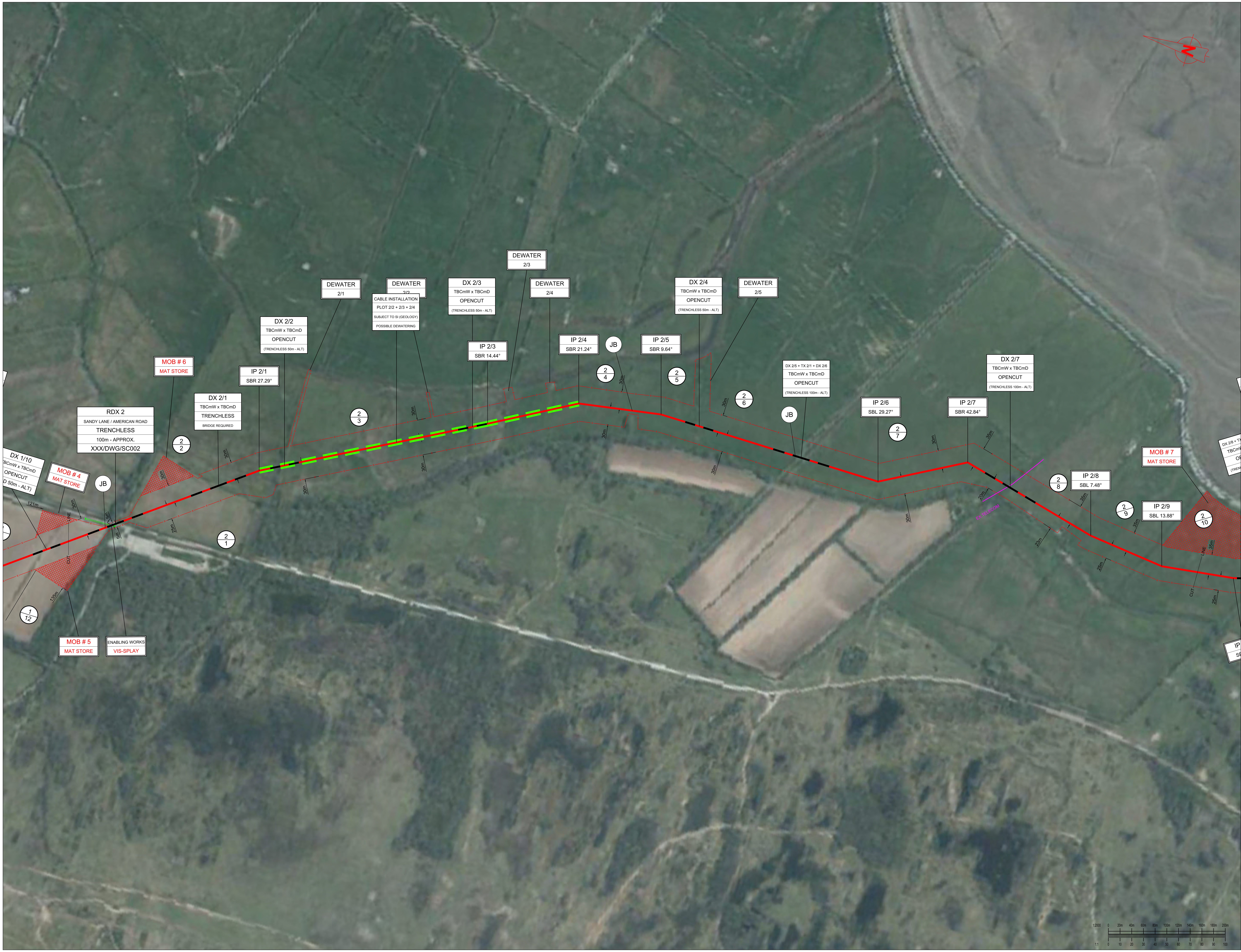
Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability: INFORMATION		S2
Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
Drawn By: LP	Date: JUNE 23	Scales @ A0: 1:2000
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-ZZ-ZZ-M3-91202	P02
110-099-DRG-017	A01
FLO-WHI-DWG-0017	A1

File Path N:\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\91\

A0-Wat-SDL-S



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LEGEND

- CABLE ROUTE BY OPENCUT METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY TRENCHLESS METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

Rev	Date	Description	By	Chk
P02	11.08.23	UPDATED FOR CLIENT COMMENTS. RE-ISSUE FOR INFORMATION	LP	CG
P01	15.06.23	ISSUED FOR INFORMATION	ED	GA

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
ONSHORE CABLE ROUTE - WORKING WIDTH ALIGNMENT SHEETS (SHEET 4 OF 5)

Client
FLOTATION ENERGY LTD

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability: INFORMATION	S2	
Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
Drawn By: LP	Date: JUNE 23	Scales @ A0: 1:2000
Stockton Checker:	Stockton Approver:	Date:

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-ZZ-ZZ-M3-91203	P02
110-099-DRG-018	A01
FLO-WHI-DWG-0018	A1

SDL_WC_WW_001_revA04 (WORKING WIDTH)

File Path N:\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\91\

GENERAL NOTES

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LEGEND

CABLE ROUTE BY OPENCUT METHODOLOGY (CENTRELINE)

CABLE ROUTE BY TRENCHLESS METHODOLOGY (CENTRELINE)

CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

Rev	Date	Description	By	Chk
P02	11.08.23	UPDATED FOR CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	15.06.23	ISSUED FOR INFORMATION	ED	GA

Amendments

Project

WHITE CROSS FLOATING WINDFARM

Title

ONSHORE CABLE ROUTE - WORKING WIDTH ALIGNMENT SHEETS (SHEET 5 OF 5)

Client

FLOTATION ENERGY LTD

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability

INFORMATION S2

Designed By LP	Director CG	Waterman Ref WIE12731-153
Drawn By LP	Date JUNE 23	Scales @ A0 1:2000
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-ZZ-ZZ-M3-91304	P02
110-099-DRG-019	A01
FLO-WHI-DWG-0019	A1

A0-Wat-SDL-S, SDL_WC_CL_001_revB01 (CENTRELINE), SDL_WC_SERV_001_revA03 (SERVICES)

File Path N:\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\91\

GENERAL NOTES

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LEGEND

- PROPOSED BOREHOLE LOCATIONS
- PROPOSED TRIAL PIT LOCATIONS
- PROPOSED RESISTIVITY SURVEY AREA
- CABLE ROUTE BY OPENCUT METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY TRENCHLESS METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

Rev	Date	Description	By	Chk
P02	02.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	19.06.23	ISSUED FOR INFORMATION	LP	GA

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
ONSHORE CABLE ROUTE - SI SHEETS (SHEET 1 OF 5)

Client
FLOTATION ENERGY LTD

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability: INFORMATION		S2
Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
Drawn By: LP	Date: JUNE 23	Scales @ A0: 1:2000
Stockton Checker:	Stockton Approver:	Date:

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-ZZ-ZZ-M3-91400	P02
110-099-DRG-007	A02
FLO-WHI-DWG-0009	00

A0-Wat-SDL-S

File Path N:\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\91\

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LEGEND

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- PROPOSED TRIAL PIT LOCATIONS
- PROPOSED RESISTIVITY SURVEY AREA
- CABLE ROUTE BY OPENCUT METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY TRENCHLESS METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

Rev	Date	Description	By	Chk
P02	02.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	19.06.23	ISSUED FOR INFORMATION	LP	GA

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
ONSHORE CABLE ROUTE - SI SHEETS (SHEET 2 OF 5)

Client
FLOTATION ENERGY LTD

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

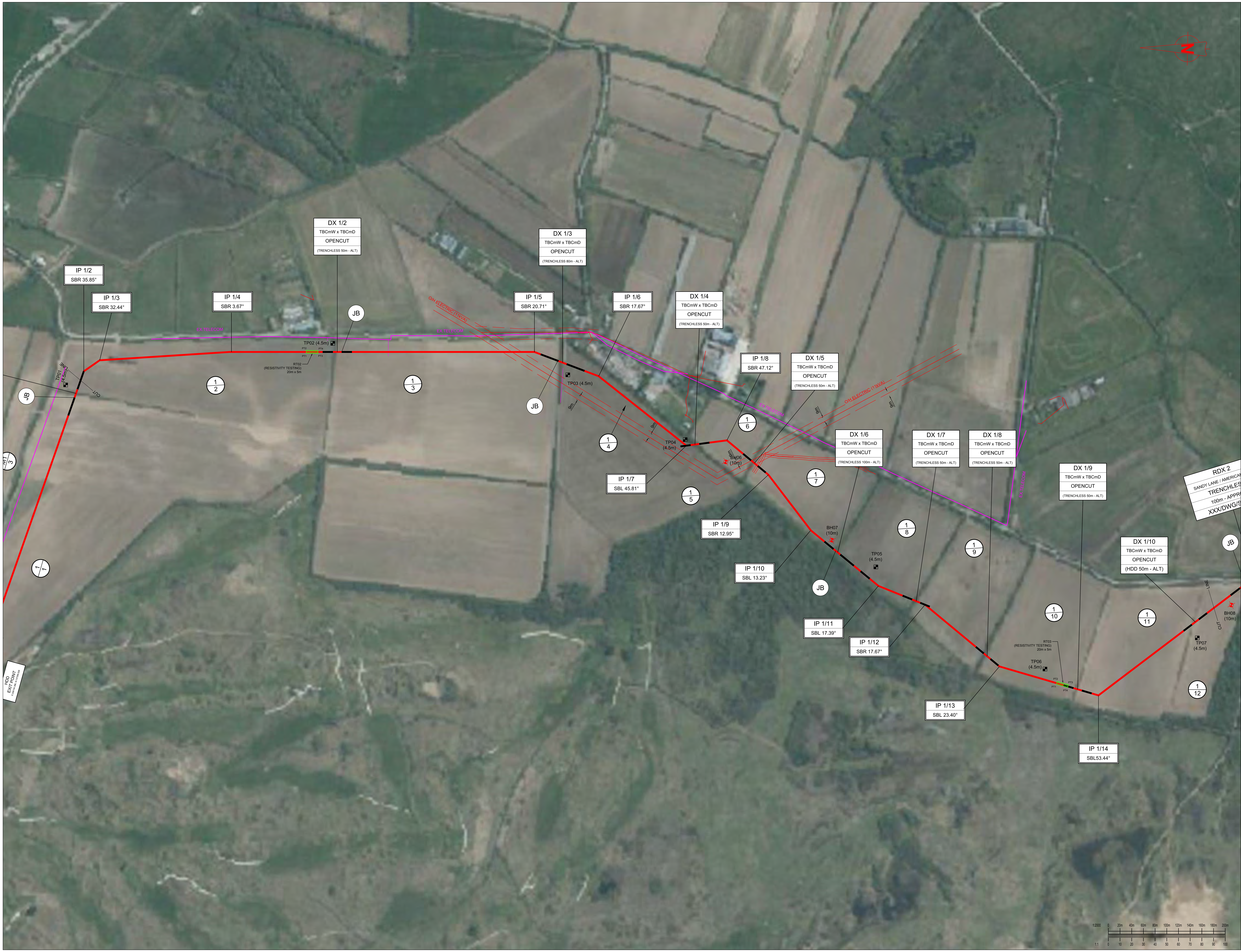
Suitability: INFORMATION S2

Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
Drawn By: LP	Date: JUNE 23	Scales @ A0: 1:2000
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-ZZ-ZZ-M3-91401	P02
110-099-DRG-008	A02
FLO-WHI-DWG-0010	00

A0-Wat-SDL-S

File Path N:\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\91\



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LEGEND

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PROPOSED TRIAL PIT LOCATIONS
PROPOSED RESISTIVITY SURVEY AREA
CABLE ROUTE BY OPENCUT METHODOLOGY (CENTRELINE)
CABLE ROUTE BY TRENCHLESS METHODOLOGY (CENTRELINE)
CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

Rev	Date	Description	By	Chk
P02	02.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	19.06.23	ISSUED FOR INFORMATION	LP	GA

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
ONSHORE CABLE ROUTE - SI SHEETS (SHEET 3 OF 5)

Client
FLOTATION ENERGY LTD

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability: INFORMATION		S2
Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
Drawn By: LP	Date: JUNE 23	Scales @ A0: 1:2000
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-ZZ-ZZ-M3-91402	P02
110-099-DRG-009	A02
FLO-WHI-DWG-0011	00

A0-Wat-SDL-S

File Path
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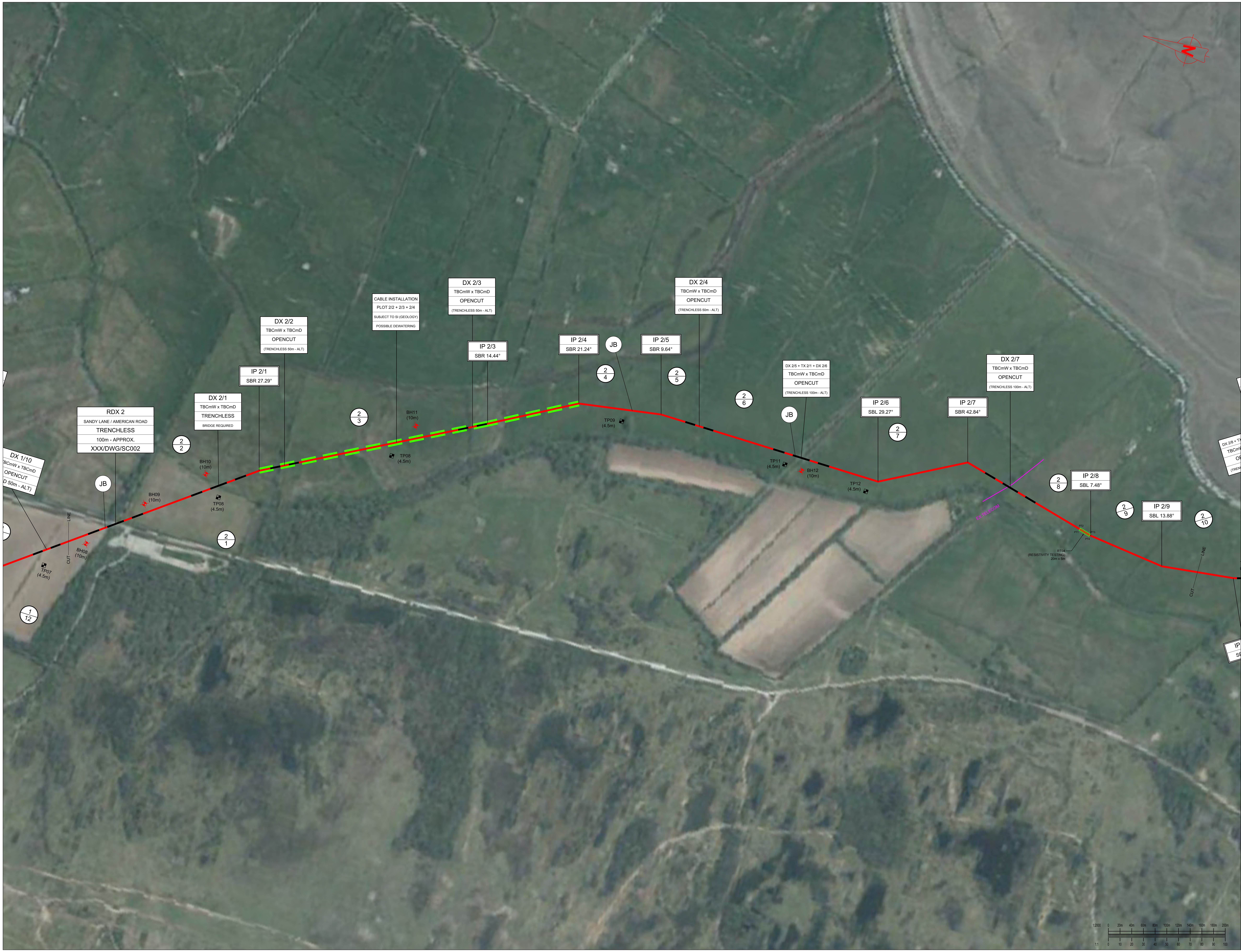

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LEGEND

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- PROPOSED TRIAL PIT LOCATIONS
- PROPOSED RESISTIVITY SURVEY AREA
- CABLE ROUTE BY OPENCUT METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY TRENCHLESS METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

Rev	Date	Description	By	Chk
P02	02.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	19.06.23	ISSUED FOR INFORMATION	LP	GA

Amendments

Project

WHITE CROSS FLOATING WINDFARM

Title

ONSHORE CABLE ROUTE - SI SHEETS (SHEET 4 OF 5)

Client

FLOTATION ENERGY LTD

waterman
STOCKTON

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability	
INFORMATION	S2

Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
Drawn By: LP	Date: JUNE 23	Scales @ A0: 1:2000
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-ZZ-ZZ-M3-91403	P02
110-099-DRG-010	A02
FLO-WHI-DWG-0012	00

File Path N:\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\91\

A0-Wat-SDL-S

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LEGEND

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- PROPOSED TRIAL PIT LOCATIONS
- PROPOSED RESISTIVITY SURVEY AREA
- CABLE ROUTE BY OPENCUT METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY TRENCHLESS METHODOLOGY (CENTRELINE)
- CABLE ROUTE BY UNDETERMINED METHODOLOGY (CENTRELINE)

Rev	Date	Description	By	Chk
P02	02.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	19.06.23	ISSUED FOR INFORMATION	LP	GA

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
ONSHORE CABLE ROUTE - SI SHEETS (SHEET 5 OF 5)

Client
FLOTATION ENERGY LTD

waterman
STOCKTON

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability: INFORMATION S2

Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
Drawn By: LP	Date: JUNE 23	Scales @ A0: 1:2000
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-ZZ-ZZ-M3-91404	P02
110-099-DRG-011	A02
FLO-WHI-DWG-0013	00

File Path N:\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\91\

A0-Wat-SDL-S, SDL_WC_CL_001_revB01 (CENTRELINE), SDL_WC_SERV_001_revA03 (SERVICES), SDL_WC_SI_001_revA02 (BH_TH_SI)

ONSHORE

OFFSHORE

This drawing should not be scaled. Dimensions to be verified on site.
Any discrepancies should be referred to the Engineer prior to work being put in hand.

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Rev	Date	Description	By	Chk
P02	11.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	28.07.23	ISSUED AS DRAFT FOR INFORMATION	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
CABLE LANDFALL OUTLINE HDD PLAN AND PROFILE

Client
FLOTATION ENERGY LTD

waterman
STOCKTON
Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability
FOR PLANNING SUBMISSION

Designed By LP	Director CG	Waterman Ref WIE12731-153
Drawn By LP	Date JULY 23	Scales @ A0 1:1250
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-LF-XX-M3-C-91001	P02
110-099-DRG-020	A01
FLO-WHI-LAY-0017	A1

A0-Wat-SDL-S

File Path N:\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\91\

This drawing should not be scaled. Dimensions to be verified on site.
Any discrepancies should be referred to the Engineer prior to work being put in hand.

Pickfords Wharf, Clink Street, London SE1 9DG t 020 7928 7888 f 03333 444 501

GENERAL NOTES

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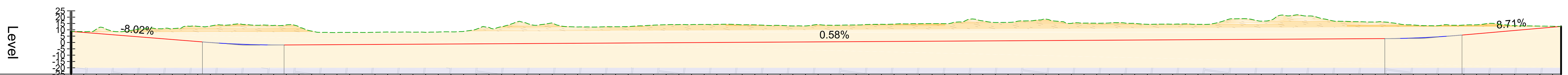
SITE COMPOUND LAYOUT KEY:
1. 50 KVA GENERATOR 2M X 2M
2. TOILET BLOCK 6M X 2M
3. DRY/CHANGE ROOM 6M X 2M
4. CANTEEN 6M X 2M
5. OFFICE 6M X 2M
6. OFFICE 6M X 2M
7. 21 TON TRACKED 360 EXCAVATOR
8. DRILL PIPE STORAGE 10M X 2M
9. HDD DRILL RIG 16M X 2M
10. POWER PACK 6M X 2M
11. CONTROL CABIN 6M X 2M
12. MUD LAB 3M X 2M
13. MUD ENTRY PIT 3M X 4M
14. HIGH PRESSURE MUD PUMP 6M X 2M
15. MUD MIXING TANK 7M X 2M
16. 350 KVA GENERATOR 5M X 2M
17. RECYCLING UNIT 6M X 2M
18. WATER STORAGE TANK 6M X 2M
19. DRY DRILLING FLUID STORAGE 4M X 10M
20. WORKSHOP 6M X 2M
21. STORES 6M X 2M

GOLF COURSE CROSSING - LONGSECTION
SCALE: H 1:2000,V 1:2000. DATUM: -25.000



Chainage	Existing Levels	Level Difference
0.000	8.743	-0.014
10.000	8.569	0.614
20.000	10.513	3.360
30.000	9.745	3.394
40.000	8.543	2.994
50.000	10.018	5.271
60.000	11.081	7.136
70.000	10.848	7.706
80.000	10.998	8.657
90.000	12.770	11.233
100.000	12.756	12.020
110.000	12.944	12.984
120.000	13.763	14.455
130.000	14.512	15.723
140.000	14.023	15.619
150.000	13.739	15.587
160.000	13.453	15.421
170.000	13.887	15.842
180.000	12.436	14.333
190.000	8.995	10.835
200.000	7.997	9.779
210.000	7.882	9.606
220.000	7.975	9.641
230.000	7.907	9.516
240.000	8.065	9.616
250.000	8.261	9.755
260.000	8.198	9.633
270.000	8.138	9.516
280.000	8.022	9.343
290.000	8.258	9.520
300.000	8.405	9.610
310.000	8.761	9.909
320.000	10.486	11.576
330.000	11.898	12.931
340.000	12.385	13.359
350.000	15.458	16.375
360.000	15.163	16.022
370.000	13.924	14.725
380.000	15.365	16.108
390.000	12.590	13.276
400.000	12.258	12.886
410.000	12.220	12.790
420.000	12.362	12.875
430.000	12.430	12.886
440.000	12.577	12.975
450.000	13.165	13.505
460.000	13.695	13.977
470.000	14.033	14.258
480.000	14.138	14.305
490.000	14.137	14.246
500.000	14.269	14.320
510.000	14.310	14.304
520.000	14.392	14.329
530.000	13.997	13.876
540.000	13.935	13.756
550.000	13.460	13.223
560.000	13.519	13.225
570.000	13.047	12.695
580.000	13.073	12.663
590.000	14.098	13.631
600.000	13.629	13.104
610.000	13.735	13.152
620.000	13.853	13.212
630.000	14.248	13.550
640.000	14.366	13.610
650.000	14.493	13.680
660.000	14.647	13.776
670.000	14.796	13.867
680.000	14.929	13.943
690.000	14.877	13.833
700.000	16.152	15.050
710.000	18.458	17.299
720.000	17.079	15.862
730.000	15.813	14.538
740.000	15.873	14.540
750.000	17.068	15.678
760.000	17.302	15.854
770.000	18.433	16.928
780.000	16.645	15.082
790.000	15.133	13.512
800.000	15.299	13.621
810.000	15.206	13.469
820.000	15.406	13.612
830.000	15.583	13.731
840.000	15.103	13.194
850.000	14.361	12.394
860.000	14.491	12.467
870.000	14.441	12.359
880.000	14.672	12.532
890.000	14.318	12.121
900.000	14.550	12.295
910.000	16.951	14.638
920.000	18.731	16.361
930.000	18.609	16.181
940.000	16.851	14.365
950.000	18.812	16.269
960.000	21.090	18.489
970.000	21.760	19.101
980.000	20.882	18.166
990.000	18.539	15.765
1000.000	16.761	13.930
1010.000	16.551	13.662
1020.000	16.336	13.389
1030.000	16.163	13.158
1040.000	15.989	12.923
1050.000	14.429	11.205
1060.000	13.817	10.303
1070.000	13.331	9.393
1080.000	13.353	8.857
1090.000	13.624	8.437
1100.000	13.759	7.750
1110.000	13.961	7.081
1120.000	15.095	7.344
1130.000	14.112	5.491
1140.000	13.297	3.805
1150.000	13.097	2.735
1160.000	12.951	1.718
1170.000	12.796	0.692
1176.745	12.740	0.049

Horizontal Geometry	L =1176.745			
Vertical Geometry	G =-8.022% L =103.742	R =750.000 K =7.500 L =64.488	G =0.577% L =869.295	R =750.000 K =7.500 L =60.976	G =8.707% L =78.827

GEOLOGY KEY
- BLOWN SANDS (SAND DUNES)
- DRIFT DEPOSITS
- ROCK

1:2000 0 20m 40m 60m 80m 100m 120m 140m 160m 180m 200m
1:1 0 10 20 30 40 50 60 70 80 90 100

Rev	Date	Description	By	Chk
P03	11.08.23	SITE COMPOUND LAYOUTS REMOVED. RE-ISSUED FOR INFORMATION AS PART OF PLANNING SUBMISSION	LP	CG
P02	10.03.23	TITLE UPDATED AND DRAFT BANNER REMOVED	LP	CG
P01	20.05.22	DRAFT ISSUE FOR INFORMATION ONLY	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
SAUNTON GOLF CLUB OUTLINE HDD PLAN AND PROFILE

Client
FLOTATION ENERGY LTD

waterman
STOCKTON

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t: 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability
FOR PLANNING SUBMISSION

Designed By LP	Director CG	Waterman Ref WIE12731-135
Drawn By LP	Date 20.05.22	Scales @ A0 AS NOTED
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-135-WIE-ZZ-XX-M3-C-91006	P03
110-099-DRG-021	A01
FLO-WHI-LAY-0018	A1

N:\Projects\WIE12731_Stockton_HDD\135 - White Cross Floating Windfarm\100\6_Design\C3D\ALIGNMENTS & PROFILE\

File Path

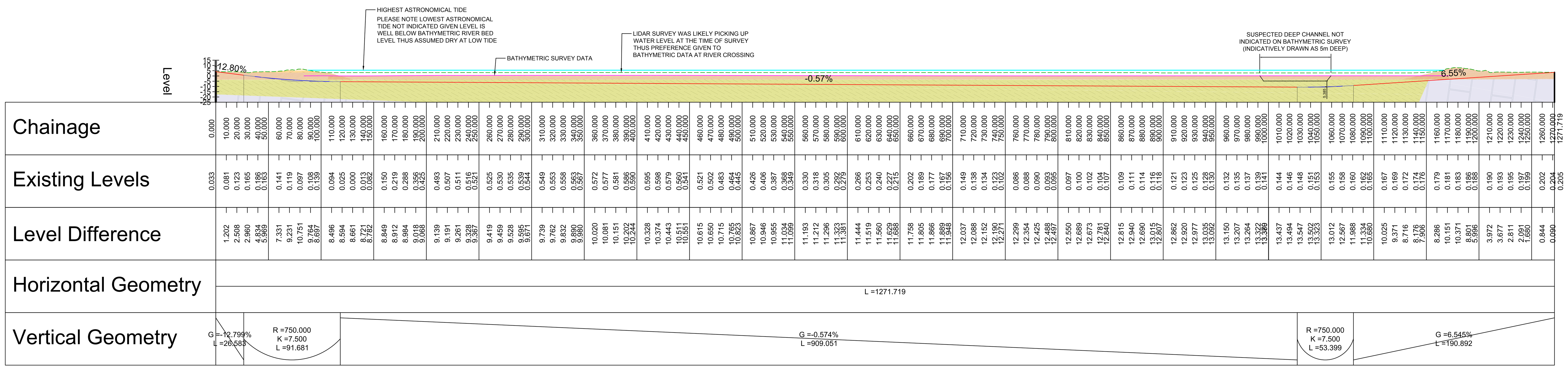
GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
2. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO PREPARING ANY WORKING DRAWINGS OR COMMENCING ON SITE.
3. THE CONTRACTOR MUST ENSURE AND WILL BE HELD RESPONSIBLE FOR THE OVERALL STABILITY OF THE BUILDING/STRUCTURE/EXCAVATION AT ALL STAGES OF THE WORK.
4. ALL WORK BY THE CONTRACTOR MUST BE CARRIED OUT IN SUCH A WAY THAT ALL REQUIREMENTS UNDER THE HEALTH AND SAFETY AT WORK ACT ARE SATISFIED.
5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

SITE COMPOUND LAYOUT KEY:
1. 50 KVA GENERATOR 2M X 2M
2. TOILET BLOCK 6M X 2M
3. DRY/CHANGE ROOM 6M X 2M
4. CANTEEN 6M X 2M
5. OFFICE 6M X 2M
6. OFFICE 6M X 2M
7. 21 TON TRACKED 360 EXCAVATOR
8. DRILL PIPE STORAGE 10M X 2M
9. HDD DRILL RIG 16M X 2M
10. POWER PACK 6M X 2M
11. CONTROL CABIN 6M X 2M
12. MUD LAB 3M X 2M
13. MUD ENTRY PIT 3M X 4M
14. HIGH PRESSURE MUD PUMP 6M X 2M
15. MUD MIXING TANK 7M X 2M
16. 350 KVA GENERATOR 5M X 2M
17. RECYCLING UNIT 6M X 2M
18. WATER STORAGE TANK 6M X 2M
19. DRY DRILLING FLUID STORAGE 4M X 10M
20. WORKSHOP 6M X 2M
21. STORES 6M X 2M

ILFRACOMBE TIDE GAUGE SITE	
TIDE LEVELS	ORDNANCE DATUM NEWLYN (mAOD)
HIGHEST ASTRONOMICAL TIDE	5.46
MEAN HIGH WATER SPRINGS	4.47
MEAN HIGH WATER NEAPS	2.19
MEAN LOW WATER NEAPS	-1.69
MEAN LOW WATER SPRINGS	-3.94
LOWEST ASTRONOMICAL TIDE	-4.89

RIVER CROSSING - LONGSECTION
SCALE: H 1:2000,V 1:2000. DATUM: -25.000



GEOLOGY KEY
- BLOWN SANDS (SAND DUNES)
- DRIFT DEPOSITS
- ESTUARINE DEPOSITS
- ROCK

1:2000 — 0, 20m, 40m, 60m, 80m, 100m, 120m, 140m, 160m, 180m, 200m
1:1 — 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

Rev	Date	Description	By	Chk
P03	11.08.23	SITE COMPOUND LAYOUTS REMOVED. RE-ISSUED FOR INFORMATION AS PART OF PLANNING SUBMISSION	LP	CG
P02	10.03.23	TITLE UPDATED & DRAFT BANNER REMOVED	LP	CG
P01	23.05.22	DRAFT ISSUE FOR INFORMATION ONLY	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
RIVER TAW OUTLINE HDD PLAN AND PROFILE

Client
FLOTATION ENERGY LTD

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t: 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability
FOR PLANNING SUBMISSION

Designed By LP	Director CG	Waterman Ref WIE12731-135
Drawn By LP	Date 20.05.22	Scales @ A0 AS NOTED
Stockton Checker	Stockton Approver	Date

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-135-WIE-ZZ-XX-M3-C-91003	P03
110-099-DRG-022	A01
FLO-WHI-LAY-0019	A1

File Path
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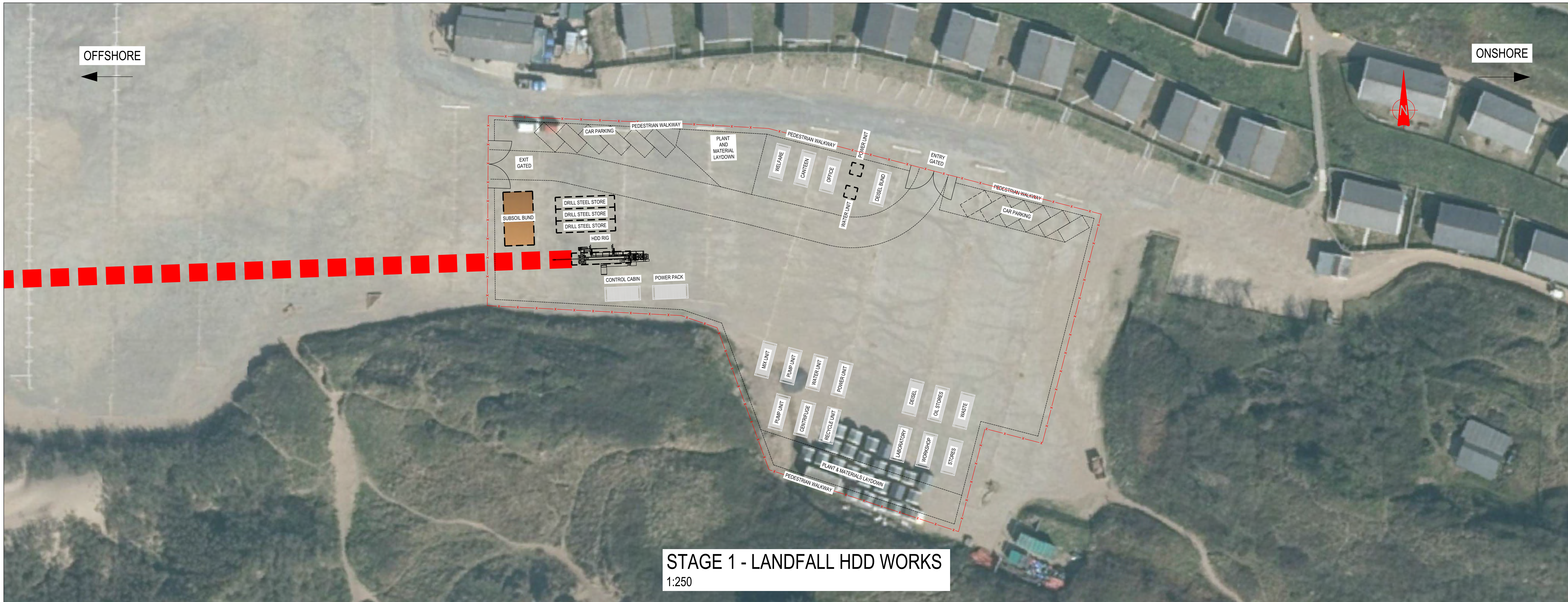

STAGE 1 - LANDFALL HDD WORKS
1:250

STAGE 2 - GOLF COURSE HDD WORKS
1:250

GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
2. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO PREPARING ANY WORKING DRAWINGS OR COMMENCING ON SITE.
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4. ALL WORK BY THE CONTRACTOR MUST BE CARRIED OUT IN SUCH A WAY THAT ALL REQUIREMENTS UNDER THE HEALTH AND SAFETY AT WORK ACT ARE SATISFIED.
5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

Rev	Date	Description	By	Chk
P02	11.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	21.07.23	ISSUED FOR INFORMATION	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
HDD SITE COMPOUND LAYOUT (LANDFALL / GOLF COURSE CROSSINGS)

Client
FLOTATION ENERGY LTD

waterman
STOCKTON
Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability: INFORMATION	S2	
Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
Drawn By: LP	Date: JULY 23	Scales @ A0: 1:250
Stockton Checker:	Stockton Approver:	Date:

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-GC-XX-DR-C-90001	P01
110-099-DRG-013	A01
FLO-WHI-LAY-0013	A1

File Path
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GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
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5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

Rev	Date	Description	By	Chk
P02	11.08.23	UPDATED WITH CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	CG
P01	24.07.23	ISSUED FOR INFORMATION	LP	CG

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
HDD SITE COMPOUND LAYOUT (RIVER TAW CROSSING)

Client
FLOTATION ENERGY LTD

waterman
STOCKTON

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

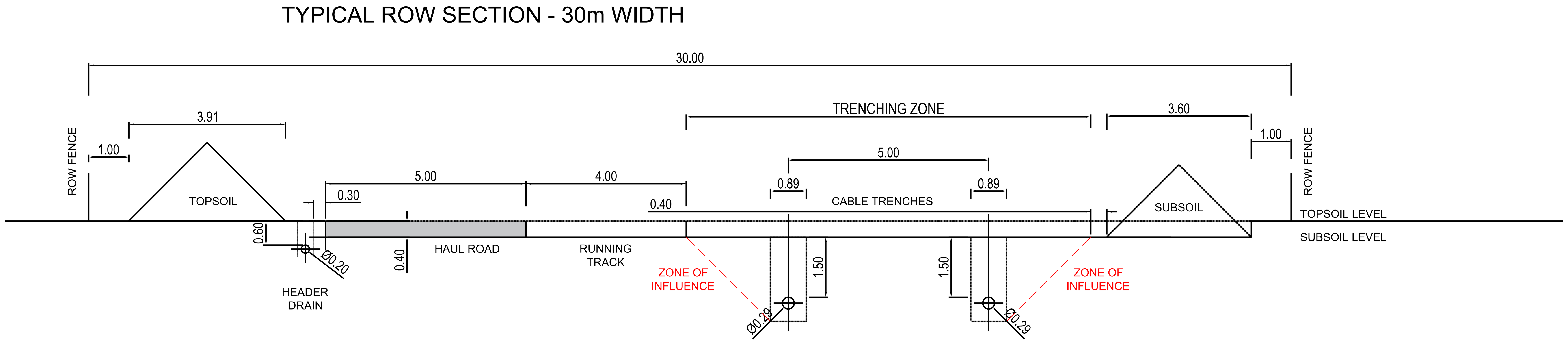
Suitability
INFORMATION S2

Designed By LP	Director CG	Waterman Ref WIE12731-153
Drawn By LP	Date JULY 23	Scales @ A0 1:200
Stockton Checker	Stockton Approver	Date

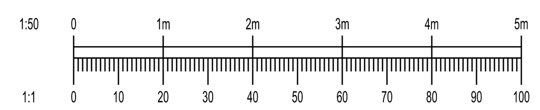
Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-RT-XX-DR-C-90001	P02
110-099-DRG-014	A01
FLO-WHI-LAY-0014	A1

File Path N:\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\90\

A0-Wat-SDL-S



TYPICAL ROW SECTION
SHOWING ROW ARRANGEMENT
WITH CABLE SPACING
@ MINIMUM 5m.



GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
2. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO PREPARING ANY WORKING DRAWINGS OR COMMENCING ON SITE.
3. THE CONTRACTOR MUST ENSURE AND WILL BE HELD RESPONSIBLE FOR THE OVERALL STABILITY OF THE BUILDING/STRUCTURE/EXCAVATION AT ALL STAGES OF THE WORK.
4. ALL WORK BY THE CONTRACTOR MUST BE CARRIED OUT IN SUCH A WAY THAT ALL REQUIREMENTS UNDER THE HEALTH AND SAFETY AT WORK ACT ARE SATISFIED.
5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.

Rev	Date	Description	By	Chk
P03	15.08.23	NOTES CHANGED AS PER CLIENT COMMENTS. RE-ISSUED FOR INFORMATION	LP	GA
P02	11.08.23	CONSTRUCTION STRIP WIDTH REDUCED. RE-ISSUED FOR INFORMATION	LP	CG
P01	19.06.23	ISSUED FOR INFORMATION	LP	GA

Amendments

Project
WHITE CROSS FLOATING WINDFARM

Title
ONSHORE CABLE ROUTE - TYPICAL CONSTRUCTION STRIP CROSS SECTION

Client
FLOTATION ENERGY LTD

waterman
STOCKTON

Broxden House Broxden Business Park Lamberkine Drive Perth PH1 1RA
t 01738 449 801
mail@watermangroup.com www.watermangroup.com

Suitability		
INFORMATION		S2
Designed By: LP	Director: CG	Waterman Ref: WIE12731-153
Drawn By: LP	Date: JUNE 23	Scales @ A0: 1:50
Stockton Checker:	Stockton Approver:	Date:

Project - Originator - Volume - Level - Type - Role - Number	Revision
12731-153-WIE-ZZ-ZZ-M3-91001	P03
110-099-DRG-001	A01
FLO-WHI-DWG-0003	A1

A0-Wat-SDL-S

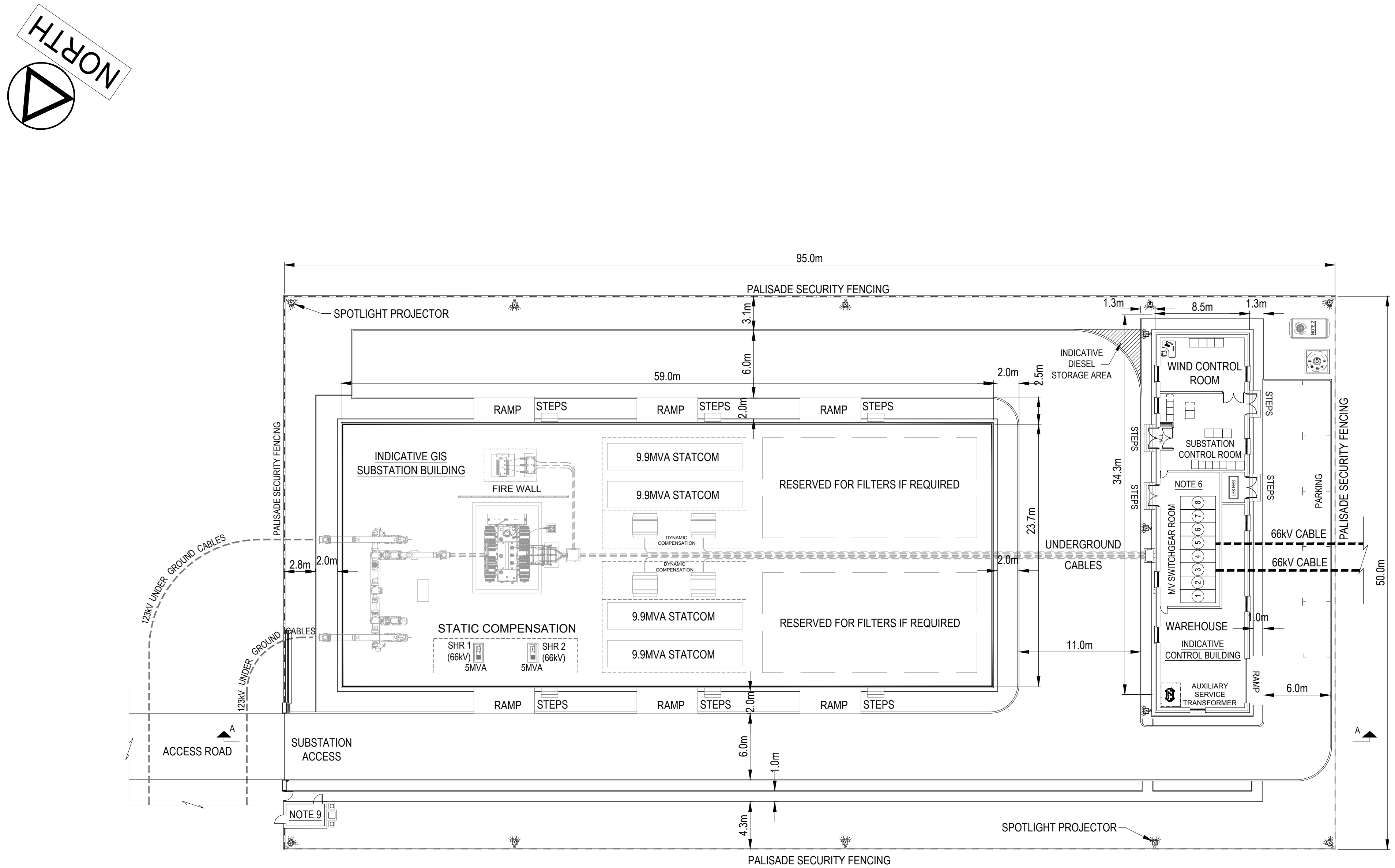
File Path \\H-ph\wiel\Projects\WIE12731_Stockton_HDD\153 - White Cross Phase 2\7_CAD\91\

WHITE CROSS

White Cross Offshore Windfarm Environmental Statement

Appendix 5.E: Onshore Substation Indicative Designs

Index of Figures



NOTES

1. LAYOUT OF CONTROL BUILDING AND SWITCHYARD CAN BE MODIFIED TO ADAPT TO ACCESS, TEE LINE OUTPUT DIRECTION ETC, BUT PHILOSOPHY MUST BE KEPT UP
2. LAYOUT OF WATER TANK AND SEALED TANK MUST BE ADAPTED ACCORDING TO APPLICABLE LEGISLATION.
3. NUMBER OF CAPACITOR BANKS ACCORDING TO PERFORMANCE ENGINEERING DEPARTMENT CALCULATION.
4. SPOTLIGHT PROJECTORS SHOWN ARE INDICATIVE ONLY FOR PLANNING PURPOSES. FINAL NUMBER AND LOCATIONS WILL DEPEND ON FINAL DESIGN
5. AUXILIARY SERVICE TRANSFORMER MV TERMINALS SHALL BE OUTDOOR PLUG-IN ANGLE TERMINAL.
6. PALISADE SECURITY GATE & FENCING AROUND PERIMETER OF SITE.
7. MV CABLES TO BE PULLED THROUGH DUCTS LAID UNDER EAST SIDE OF CONTROL BUILDING INTO MV SWITCHGEAR ROOM.
8. EXPORT CABLES TO BE PULLED THROUGH DUCTS LAID UNDER WEST SIDE OF SUBSTATION BUILDING TO EXPORT PYLON.
9. LAYOUT OF METERING ROOM WILL BE LOCATED ACCORDING TO UTILITY REQUIREMENTS.
10. FOR SECTION A-A DETAILS REFER TO DRAWING 808165-01-EL-LAY-0001-011

0 5m 10m 15m 20m

Scale 1:500 @ A3

FLOATATION DRAWING NUMBER
FLO-WHI-LAY-0005

Rev	Description	By	Chk'd	App'd	Date
F	DRAWING SCALE CHANGED TO 1:500. NORTH ARROW & SCALE BAR ADDED.	PMcG	AW	AW	10.08.23
E	BUILDINGS ACCESS STEPS AND RAMPS ADDED.	PMcG	AW	AW	06.07.23
D	GENSET & DIESEL STARAGE AREA AMENDED. EIGHTH MV SWITCHGEAR ADDED.	PMcG	MS	AW	01.06.23
C	SUBSTATION SIZE AMENDED. CONTROL BUILDING RELOCATED. ACCESS ROADS & FENCELINES AMENDED.	PMcG	MS	AW	05.05.23
B	SUBSTATION SIZE AMENDED. CONTROL BUILDING RELOCATED. ACCESS ROADS AMENDED.	PMcG	MS	AW	14.04.23
A	ISSUED FOR REVIEW	PMcG	MS	AW	28.03.23

Job Title

WHITE CROSS
OFFSHORE WINDFARM

Drg Title

FLOOR PLAN
INDICATIVE GIS
ENCLOSED SUBSTATION
(OPTION A)

wood.

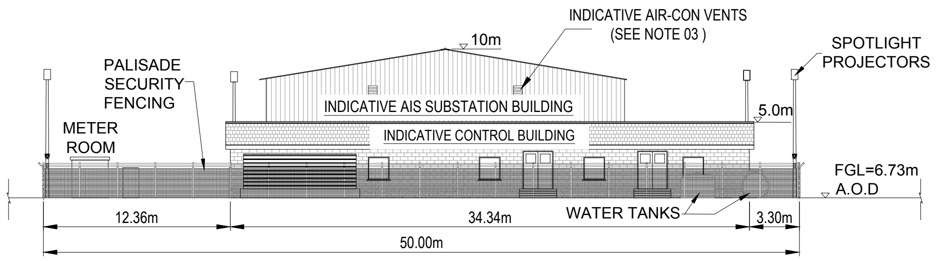
St Vincent Plaza, 319 St Vincent Street, Glasgow, G2 5LP
tel: +44 (0) 141 227 1700 www.woodplc.com

Scale	Date	Size
1:500	MARCH 2023	A3

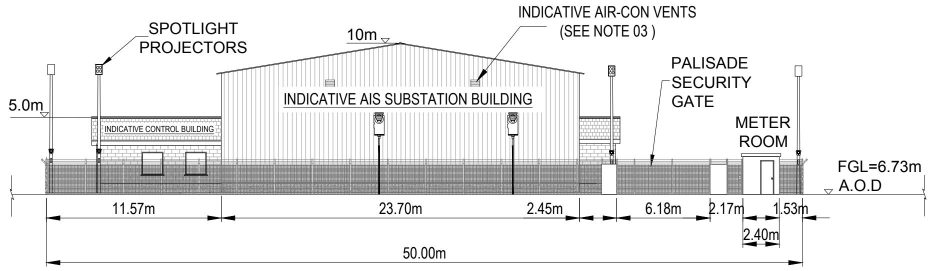
Drawn	Checked	Approved
PMcG	MS	AW

Status: PRELIMINARY

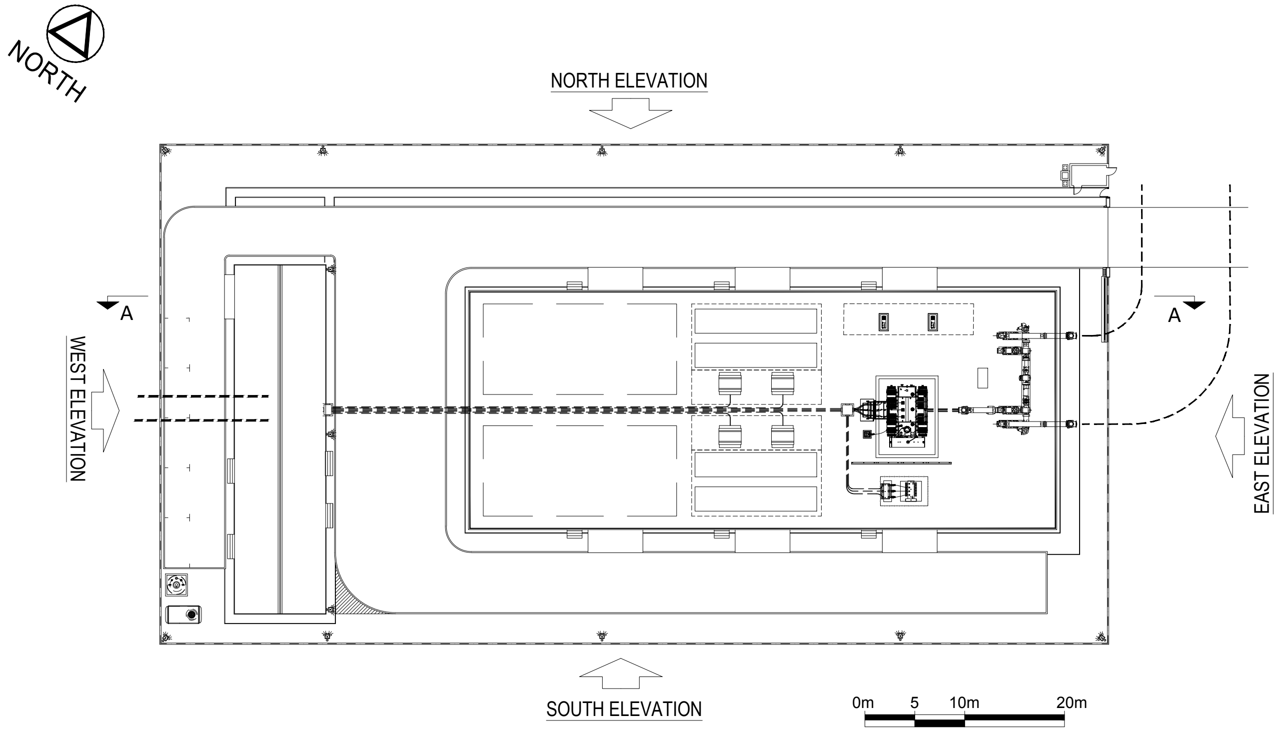
Drawing No. 808165-01-EL-LAY-0001-010 Revision F



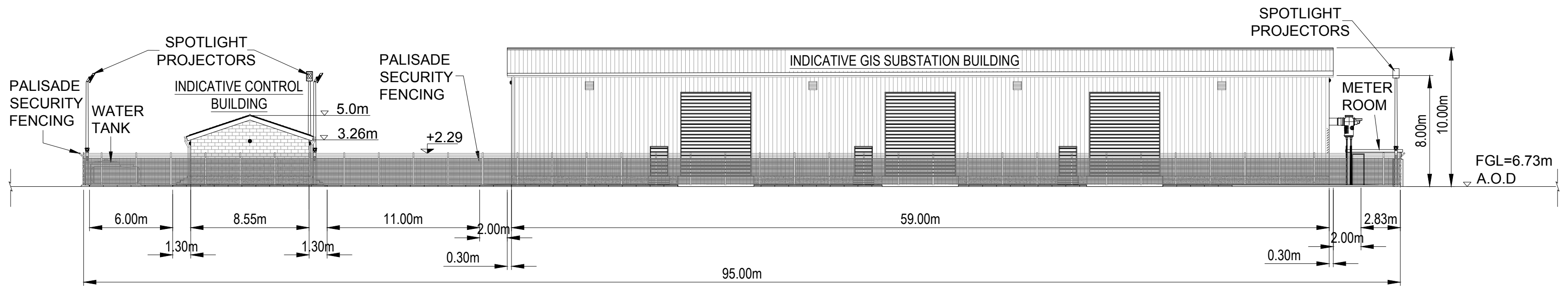
WEST ELEVATION



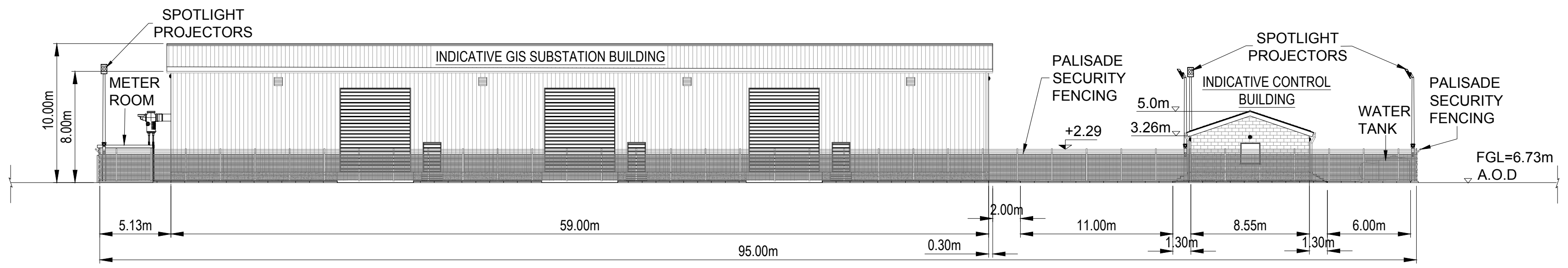
EAST ELEVATION



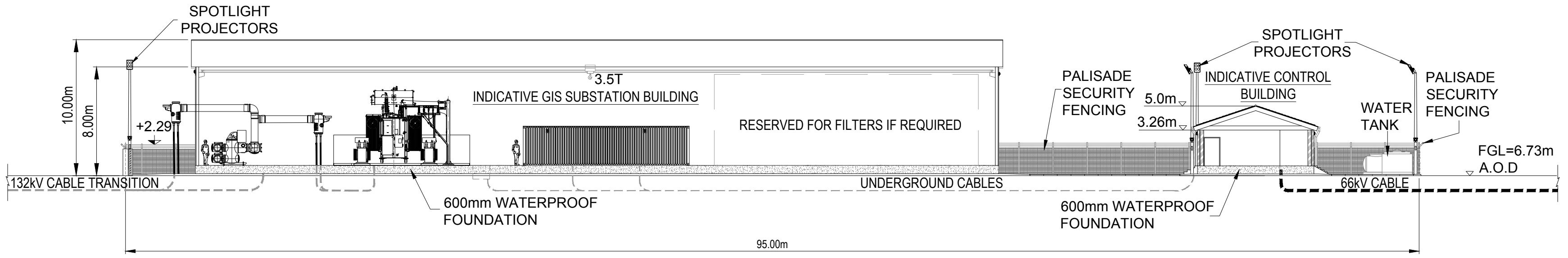
KEY PLAN - N.T.S
(SEE NOTE 1)



SOUTH ELEVATION



NORTH ELEVATION



SECTION A-A

NOTES

1. FOR LAYOUT PLAN VIEW REFER TO DRAWING No. 808165-01-EL-LAY-0001-010.
2. PALISADE SECURITY GATE & FENCING AROUND PERIMETER OF SITE.
3. AIR CONDITIONING VENTS SHOWN ARE INDICATIVE ONLY FOR PLANNING PURPOSES. FINAL NUMBER AND LOCATIONS WILL DEPEND ON FINAL BUILDING DESIGNS.
4. SPOTLIGHT PROJECTORS SHOWN ARE INDICATIVE ONLY FOR PLANNING PURPOSES. FINAL NUMBER AND LOCATIONS WILL DEPEND ON FINAL DESIGN.

0 5m 10m 15m 20m

Scale 1:500 @ A3

FLOATATION DRAWING NUMBER
FLO-WHI-LAY-0006

Rev	Description	By	Chk'd	App'd	Date
G	KEY PLAN ROTATED 180 DEG. PROFILES VIEWS RENAMED. FINISHED GROUND LEVEL ADDED.	PMcG	AW	AW	31.08.23
F	DRAWING SCALE CHANGED TO 1:500. NORTH ARROW & SCALE BAR ADDED.	PMcG	AW	AW	10.08.23
E	PROFILE VIEWS 1, 2, 3 & 4 ADDED. SECTION A-A AMENDED.	PMcG	AW	AW	06.07.23
D	CONTROL BUILDING HEIGHTS ADDED.	PMcG	MS	AW	01.06.23
C	SUBSTATION RE-SIZED. CONTROL BUILDING RELOCATED. ACCESS ROADS & FENCELINES AMENDED.	PMcG	MS	AW	05.05.23
B	SUBSTATION & CONTROL BUILDING LAYOUTS AMENDED. FLOTATION DRAWING NUMBER ADDED.	PMcG	MS	AW	02.05.23
A	ISSUED FOR REVIEW	PMcG	MS	AW	27.03.23

Job Title

WHITE CROSS
OFFSHORE WINDFARM

Drg Title

ELEVATION & CROSS SECTION DRAWING
INDICATIVE GIS ENCLOSED SUBSTATION
(OPTION A)

wood.

St Vincent Plaza, 319 St Vincent Street, Glasgow, G2 5LP
tel: +44 (0) 141 227 1700 www.woodplc.com

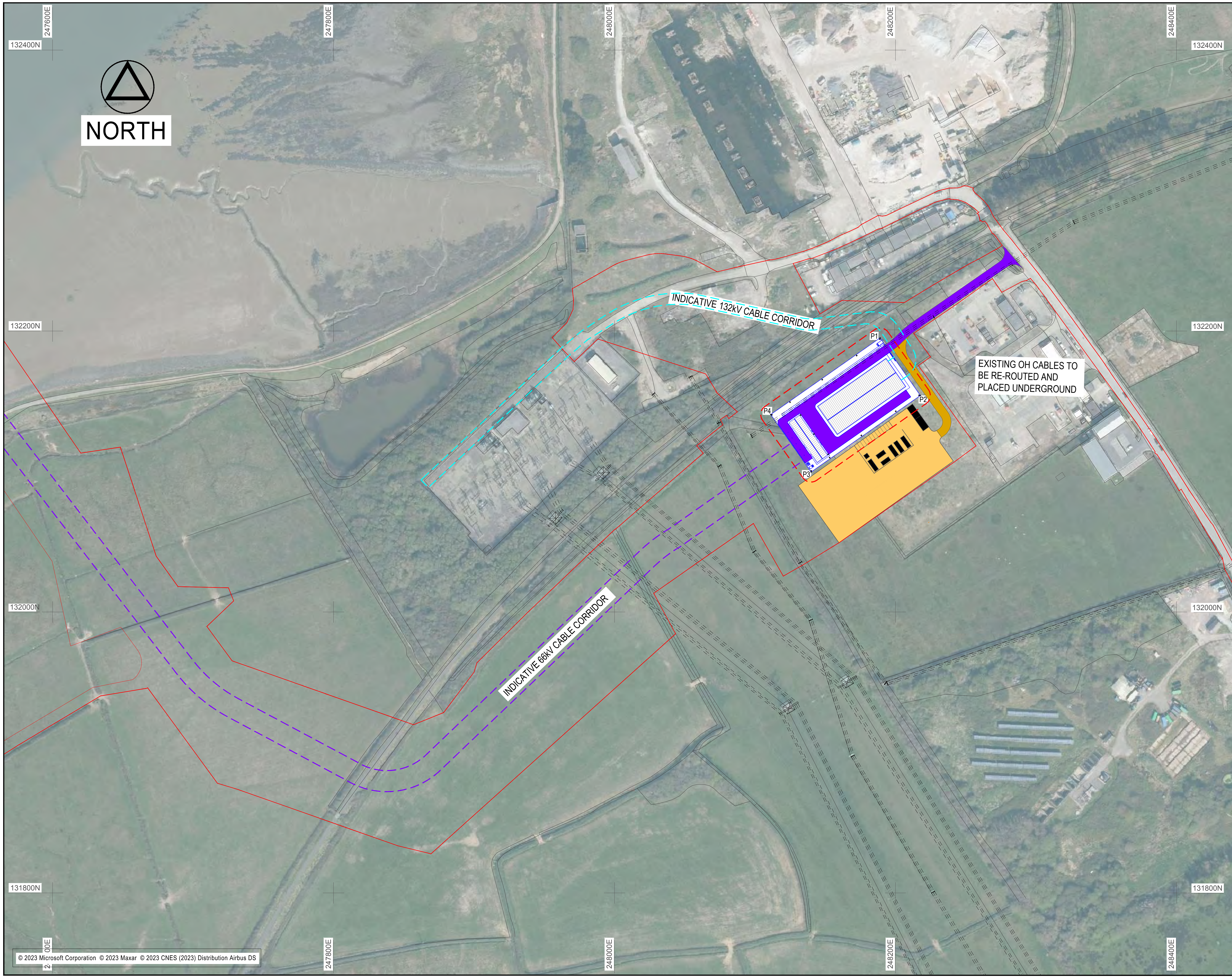
Scale	Date	Size
1:500	MARCH 2023	A3

Drawn	Checked	Approved
PMcG	MS	AW

Status

PRELIMINARY

Drawing No.	Revision
808165-01-EL-LAY-0001-011	G



KEY

- PROJECT RED LINE BOUNDARY
- PERMANENT ACCESS ROAD
- PROPOSED SUBSTATION
- TEMPORARY CONSTRUCTION COMPOUND
- TEMPORARY CONSTRUCTION ACCESS ROAD
- EXISTING OVERHEAD CABLES
- INDICATIVE BUFFER SLOPE

PROPOSED SUBSTATION COORDINATES		
PNT	EASTING	NORTHING
P1	248189.01E	132195.08N
P2	248217.70E	132154.12N
P3	248139.89E	132099.62N
P4	248111.20E	132140.57N

0 20m 40m 60m 80m 100m
Scale 1:2500 @ A3

FLOATATION DRAWING NUMBER
FLO-WHI-LAY-0007

Rev	Description	By	Chk'd	App'd	Date
G	KEY AMENDED. SCALE BAR ADDED	PMcG	AW	AW	10.08.23
F	RED LINE SITE BOUNDARY AMENDED.	PMcG	AW	AW	03.08.23
E	RED LINE SITE BOUNDARY ADDED. SUBSTATION RELOCATED AND COORDINATES UPDATED.	PMcG	AW	AW	11.07.23
D	SUBSTATION ACCESS ROAD TIE-IN AMENDED.	PMcG	AW	AW	04.07.23
C	LAYOUT AND ORIENTATION CHANGED AND RELOCATED. SLOPE ZONE ADDED.	PMcG	MS	AW	18.05.23
B	SUBSTATION & TEMP CONSTRUCTION COMPOUND AMENDED & RELOCATAED. FLOATATION DRAWING NUMBER ADDED.	PMcG	MS	AW	14.04.23
A	ISSUED FOR REVIEW	PMcG	MS	AW	27.03.23

Job Title

WHITE CROSS
OFFSHORE WINDFARM

Drg Title

LAYOUT PLAN
INDICATIVE GIS ENCLOSED SUBSTATION
(OPTION A)

wood.

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Scale	Date	Size
1:2500	MARCH 2023	A3

Drawn	Checked	Approved
PMcG	MS	AW

Status: PRELIMINARY

Drawing No.: 80816501-01-EL-LAY-0001-012 Revision: G

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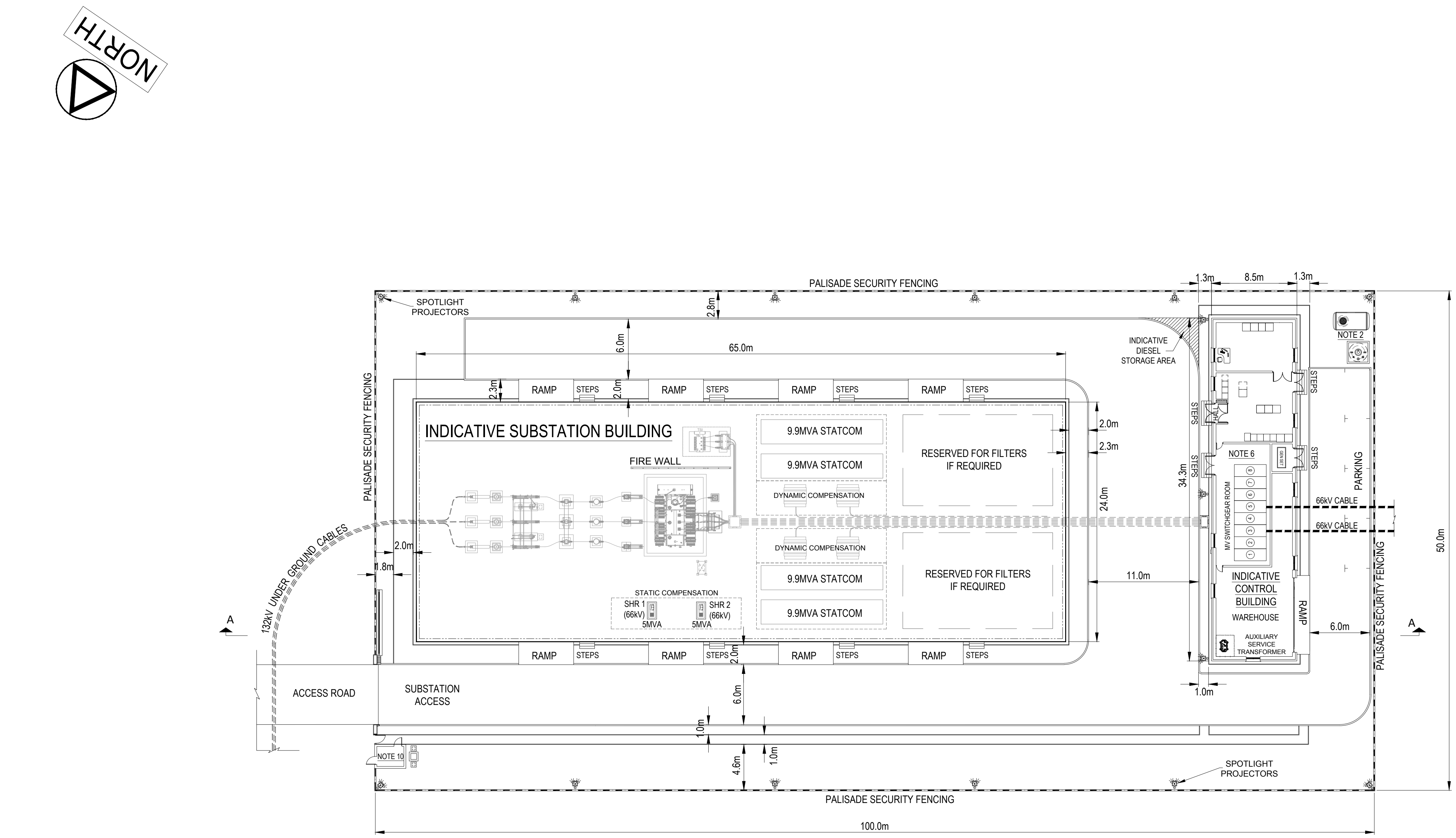

NOTES

1. LAYOUT OF CONTROL BUILDING AND SUBSTATION SWITCHYARD CAN BE MODIFIED TO ADAPT TO ACCESS, TEE LINE OUTPUT DIRECTION ETC, BUT PHILOSOPHY MUST BE KEPT UP.
2. LAYOUT OF WATER TANK AND SEALED TANK MUST BE ADAPTED ACCORDING TO APPLICABLE LEGISLATION.
3. NUMBER OF CAPACITOR BANKS ACCORDING TO PERFORMANCE ENGINEERING DEPARTMENT CALCULATION.
4. DISTANCES BETWEEN PHASES MUST BE HIGHER THAN 1.75m BUT NEVER HIGHER THAN THE DISTANCE BETWEEN PHASES DISCONNECTOR.
5. THE BEDPLATE BUILT FOR MV CUBICLES HAS TO BE PREPARED TO INSTALL AN ADDITIONAL CUBICLE.
6. AUXILIARY SERVICE TRANSFORMER MV TERMINALS SHALL BE OUTDOOR PLUG-IN ANGLE TERMINAL.
7. THE CONNECTION BETWEEN THE HV/MV TRANSFORMER AND THE HV SURGE ARRESTER SHALL BE THROUGH CABLE, AVOIDING THE RIGID BARS CONNECTION.
8. SPOTLIGHT PROJECTORS SHOWN ARE INDICATIVE ONLY FOR PLANNING PURPOSES. FINAL NUMBER AND LOCATIONS WILL DEPEND ON FINAL DESIGN
9. POST INSULATOR MUST BE INSTALLED.
10. LAYOUT OF COUNTERS ROOM WILL BE LOCATED ACCORDING TO UTILITY REQUIREMENTS.
11. FOR SECTION A-A DETAILS REFER TO DRAWING 808165-01-EL-LAY-0001-007.

0 5m 10m 15m 20m
Scale 1:500 @ A3

FLOATATION DRAWING NUMBER
FLO-WHI-LAY-0001

Rev	Description	By	Chk'd	App'd	Date
G	NOTE 8 AMENDED. DRAWING TITLE AMENDED.	PMcG	AW	AW	10.08.23
F	BUILDING STEPS & ACCESS RAMPS ADDED.	PMcG	AW	AW	07.07.23
E	GENSET & DIESEL STARAGE AREA AMENDED. EIGHTH MV SWITCHGEAR ADDED.	PMcG	MS	AW	01.06.23
D	SUBSTATION SIZE AMENDED. CONTROL BUILDING RELOCATED. ACCESS ROADS & FENCELINES AMENDED.	PMcG	MS	AW	17.05.23
C	CONTROL BUILDING RE-LOCATED AND ACCESS ROADS AMENDED TO SUIT. FLOATATION DRAWING NUMBER ADDED.	PMcG	MS	AW	21.04.23
B	DRAWING TITLE AMENDED.	PMcG	MS	AW	14.03.23
A	ISSUED FOR REVIEW	PMcG	MS	AW	01.03.23

Job Title

WHITE CROSS
OFFSHORE WINDFARM

Drg Title

FLOOR PLAN
INDICATIVE AIS ENCLOSED SUBSTATION
(OPTION B)

wood.

St Vincent Plaza, 319 St Vincent Street, Glasgow, G2 5LP
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Scale	Date	Size
1:500	MARCH 2023	A3

Drawn	Checked	Approved
PMcG	MS	AW

Status
PRELIMINARY

Drawing No. 808165-01-EL-LAY-0001-006
Revision G

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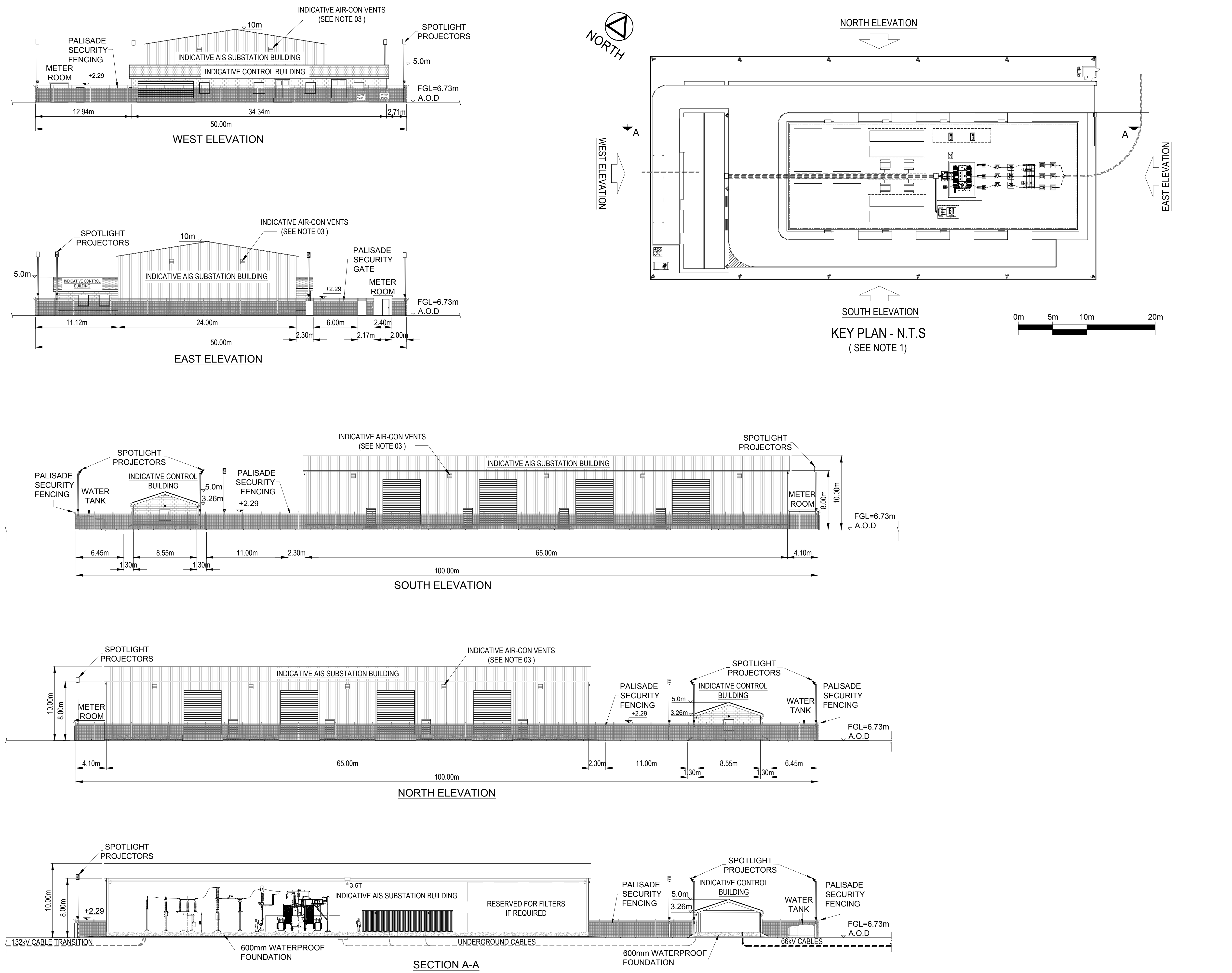

NOTES

1. FOR LAYOUT PLAN VIEW REFER TO DRAWING No. 808165-01-EL-LAY-0001-006.
2. PALISADE SECURITY GATE & FENCING AROUND PERIMETER OF SITE.
3. AIR CONDITIONING VENTS SHOWN ARE INDICATIVE ONLY FOR PLANNING PURPOSES. FINAL NUMBER AND LOCATIONS WILL DEPEND ON FINAL BUILDING DESIGNS.
4. SPOTLIGHT PROJECTORS SHOWN ARE INDICATIVE ONLY FOR PLANNING PURPOSES. FINAL NUMBER AND LOCATIONS WILL DEPEND ON FINAL DESIGN.

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Scale 1:500 @ A3

FLOATATION DRAWING NUMBER
FLO-WHI-LAY-0002

Rev	Description	By	Chk'd	App'd	Date
H	KEY PLAN ROTATED 180 DEG. PROFILES VIEWS RENAMED. FINISHED GROUND LEVELS ADDED.	PMcG	AW	AW	31.08.23
G	DRAWING SCALE CHANGED TO 1:500 NORTH ARROW & SCALE BAR ADDED.	PMcG	AW	AW	10.08.23
F	PROFILE VIEWS 1,2,3 & 4 ADDED. SECTION A-A AMENDED.	PMcG	AW	AW	07.07.23
E	CONTROL BUILDING HEIGHTS ADDED.	PMcG	MS	AW	01.06.23
D	SUBSTATION RE-SIZED. CONTROL BUILDING RELOCATED. ACCESS ROAD & FENCELINES AMENDED.	PMcG	MS	AW	17.05.23
C	SUBSTATION BUILDING AMENDED. CONTROL BUILDING RE-LOCATED. FLOATATION DRAWING NUMBER ADDED	PMcG	MS	AW	21.04.23
B	DRAWING TITLE AMENDED.	PMcG	MS	AW	14.03.23
A	ISSUED FOR REVIEW	PMcG	MS	AW	01.03.23

Job Title

WHITE CROSS
OFFSHORE WINDFARM

Drg Title

ELEVATION & CROSS SECTION DRAWING
INDICATIVE AIS ENCLOSED SUBSTATION
(OPTION B)

wood.

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Scale	Date	Size
1:500	MARCH 2023	A3

Drawn	Checked	Approved
PMcG	MS	AW

Status

PRELIMINARY

Drawing No.	Revision
808165-01-EL-LAY-0001-007	H

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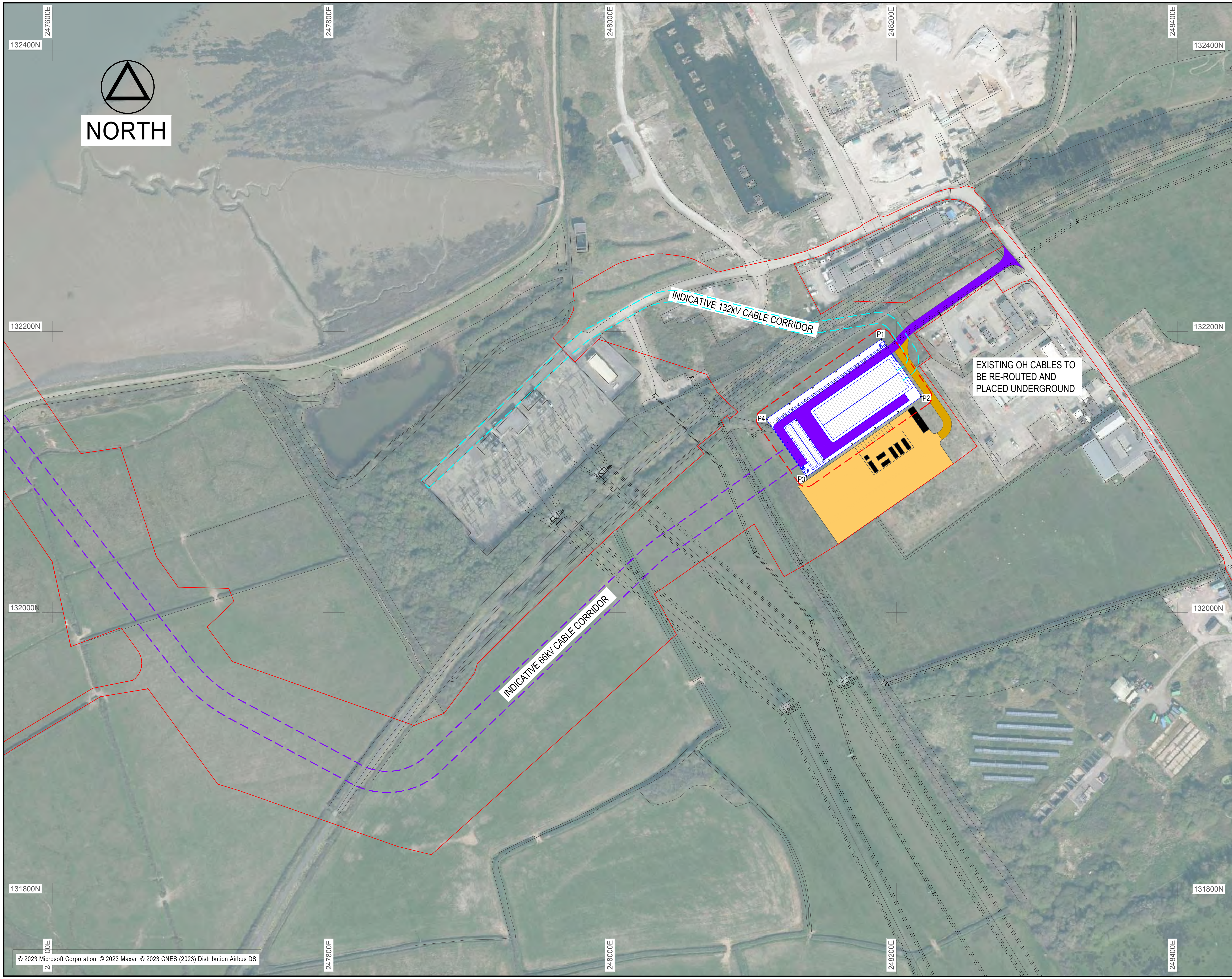

KEY

- PROJECT RED LINE BOUNDARY
- PERMANENT ACCESS ROAD
- PROPOSED SUBSTATION
- TEMPORARY CONSTRUCTION COMPOUND
- TEMPORARY CONSTRUCTION ACCESS ROAD
- EXISTING OVERHEAD CABLES
- INDICATIVE BUFFER SLOPE

PROPOSED SUBSTATION COORDINATES

PNT	EASTING	NORTHING
P1	248189.51E	132194.72N
P2	248218.07E	132153.68N
P3	248135.99E	132096.56N
P4	248107.42E	132137.61N

0 20m 40m 60m 80m 100m

Scale 1:2500 @ A3

FLOATATION DRAWING NUMBER
FLO-WHI-LAY-0003

Rev	Description	By	Chk'd	App'd	Date
H	KEY AMENDED. SCALE BAR ADDED.	PMcG	AW	AW	10.08.23
G	RED LINE BOUNDARY AMENDED.	PMcG	AW	AW	03.08.23
F	RED LINE BOUNDARY ADDED. SUBSTATION RELOCATED AND COORDINATES UPDATED.	PMcG	AW	AW	11.07.23
E	SUBSTATION ACCESS ROAD TIE-IN AMENDED.	PMcG	AW	AW	04.07.23
D	LAYOUT AND ORIENTATION CHANGED AND RELOCATED. SLOPE ZONE ADDED.	PMcG	MS	AW	18.05.23
C	SUBSTATION & TEMP CONSTRUCTION COMPOUND AMENDED. FLOATATION DRAWING NUMBER ADDED.	PMcG	MS	AW	21.04.23
B	DRAWING TITLE AMENDED. CABLE CORRIDORS AMENDED. SUBSTATION COORDINATES ADDED.	PMcG	MS	AW	14.03.23
A	ISSUED FOR REVIEW	PMcG	MS	AW	01.03.23

Job Title

WHITE CROSS
OFFSHORE WINDFARM

Drg Title

LAYOUT PLAN
INDICATIVE GIS ENCLOSED SUBSTATION
(OPTION B)

wood.

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Scale	Date	Size
1:2500	MARCH 2023	A3

Drawn	Checked	Approved
PMcG	MS	AW

Status: PRELIMINARY

Drawing No.: 80816501-01-EL-LAY-0001-008 — Revision: H

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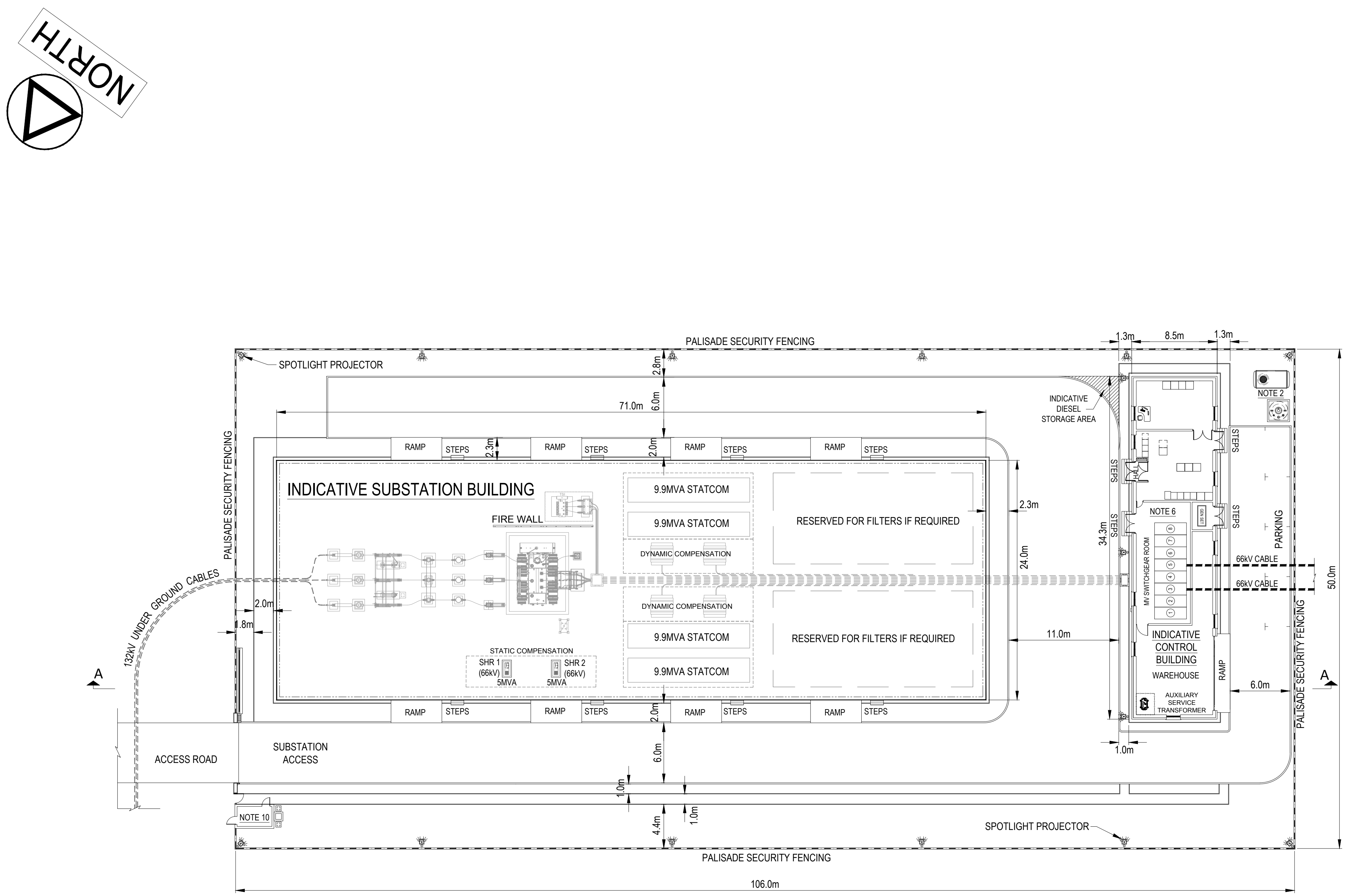

NOTES

1. LAYOUT OF CONTROL BUILDING AND SUBSTATION SWITCHYARD CAN BE MODIFIED TO ADAPT TO ACCESS, TEE LINE OUTPUT DIRECTION ETC, BUT PHILOSOPHY MUST BE KEPT UP.
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11. FOR SECTION A-A & PROFILE DETAILS REFER TO DRAWING No.808165-01-EL-LAY-0001-015.

0 5m 10m 15m 20m

Scale 1:500 @ A3

FLOATATION DRAWING NUMBER
FLO-WHI-LAY-0009

Rev	Description	By	Chk'd	App'd	Date
G	DRAWING TITLE AMENDED. NORTH ARROW & SCALE BAR ADDED. NOTE 8 AMENDED.	PMcG	AW	AW	10.08.23
F	BUILDING STEPS & ACCESS RAMPS ADDED.	PMcG	AW	AW	05.07.23
E	GENSET & DIESEL STARAGE AREA AMENDED. EIGHTH MV SWITCHGEAR ADDED.	PMcG	MS	AW	01.06.23
D	SUBSTATION RE-SIZED. CONTROL BUILDING RELOCATED. ACCESS ROADS & FENCELINES AMENDED TO SUIT.	PMcG	MS	AW	05.05.23
C	SUBSTATION SIZE REDUCED. CONTROL BUILDING RELOCATED. ACCESS RELOCATED.	PMcG	MS	AW	14.04.23
B	STATIC & DYNAMIC COMPENSATOR AREAS & LABELS ADDED.	PMcG	MS	AW	20.03.23
A	ISSUED FOR REVIEW	PMcG	MS	AW	15.03.23

Job Title

WHITE CROSS
OFFSHORE WINDFARM

Drg Title

FLOOR PLAN
INDICATIVE AIS ENCLOSED SUBSTATION
WITH ADDITIONAL EQUIPMNET SPACE
(OPTION C)

wood.

St Vincent Plaza, 319 St Vincent Street, Glasgow, G2 5LP
tel: +44 (0) 141 227 1700 www.woodplc.com

Scale	Date	Size
1:500	MARCH 2023	A3
Drawn: PMcG / Checked: MS	Approved: AW	

Status

PRELIMINARY

Drawing No. 808165-01-EL-LAY-0001-014 — Revision G

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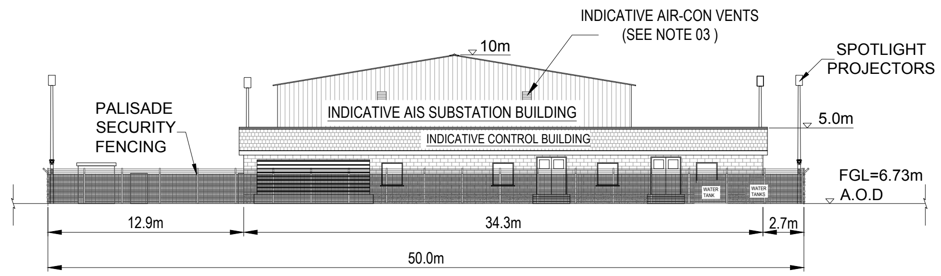
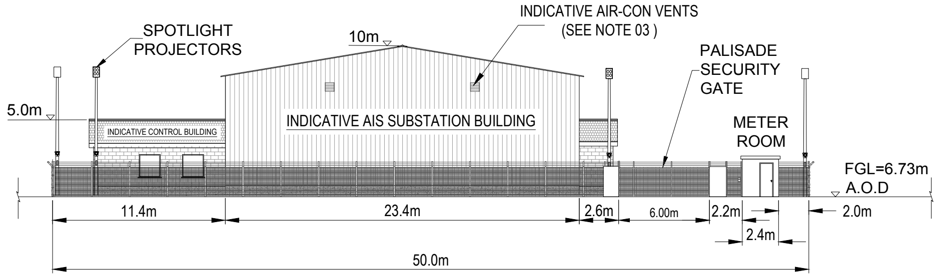
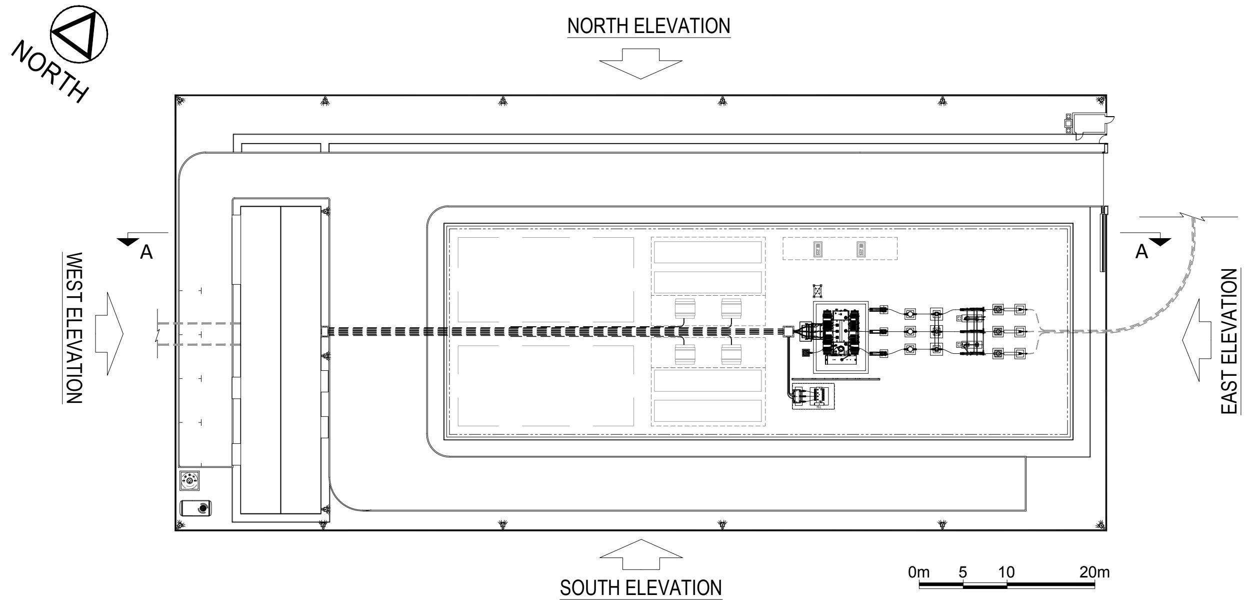


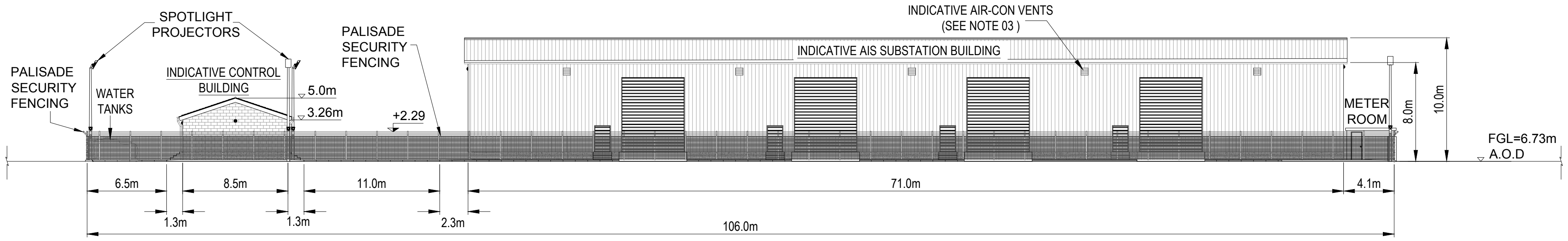
WEST ELEVATION



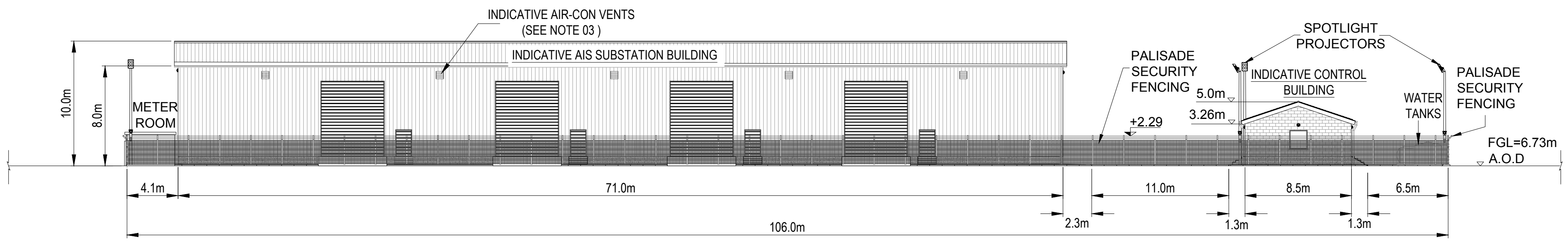
EAST ELEVATION



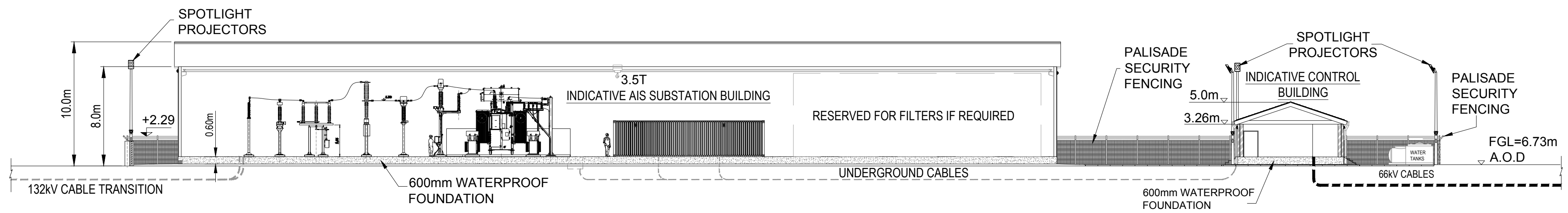
KEY PLAN - NTS
(SEE NOTE 1)



SOUTH ELEVATION



NORTH ELEVEATION



SECTION A-A

NOTES

1. FOR LAYOUT PLAN VIEW REFER TO DRAWING No. 808165-01-EL-LAY-0001-014.
2. PALISADE SECURITY GATE & FENCING AROUND PERIMETER OF SITE.
3. AIR CONDITIONING VENTS SHOWN ARE INDICATIVE ONLY FOR PLANNING PURPOSES. FINAL NUMBER AND LOCATIONS WILL DEPEND ON FINAL BUILDING DESIGNS.
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0 5m 10m 15m 20m
Scale 1:500 @ A3

FLOATATION DRAWING NUMBER
FLO-WHI-LAY-0010

Rev	Description	By	Chk'd	App'd	Date
H	KEY PLAN ROTATED 180 DEG. PROFILE VIEWS RENAMED. FINISHED GROUND LEVELS ADDED.	PMcG	AW	AW	31.08.23
G	DRAWING SCALE CHANGED TO 1:500 NORTH ARROW & SCALE BAR ADDED.	PMcG	AW	AW	10.08.23
F	PROFILE VIEWS 1,2,3 & 4 ADDED. SECTION A-A AMENDED.	PMcG	AW	AW	05.07.23
E	CONTROL BUILDING HEIGHTS ADDED.	PMcG	MS	AW	01.06.23
D	SUBSTATION RE-SIZED. CONTROL BUILDING RELOCATED. ACCESS ROAD & FENCELINES AMENDED.	PMcG	MS	AW	05.05.23
C	SUBSTATION & CONTROL BUILDING AMENDED. FLOTATION DRAWING NUBER ADDED.	PMcG	MS	AW	14.04.23
B	KEYPLAN UPDATED.	PMcG	MS	AW	20.03.23
A	ISSUED FOR REVIEW	PMcG	MS	AW	16.03.23

Job Title

WHITE CROSS
OFFSHORE WINDFARM

Drg Title

ELEVATION & CROSS SECTION DRAWING
INDICATIVE AIS ENCLOSED SUBSTATION
WITH ADDITIONAL EQUIPMENT SPACE
(OPTION C)

wood.

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Scale	Date	Size
1:500	MARCH 2023	A3

Drawn	Checked	Approved
PMcG	MS	AW

Status

PRELIMINARY

Drawing No. 808165-01-EL-LAY-0001-015

Revision H

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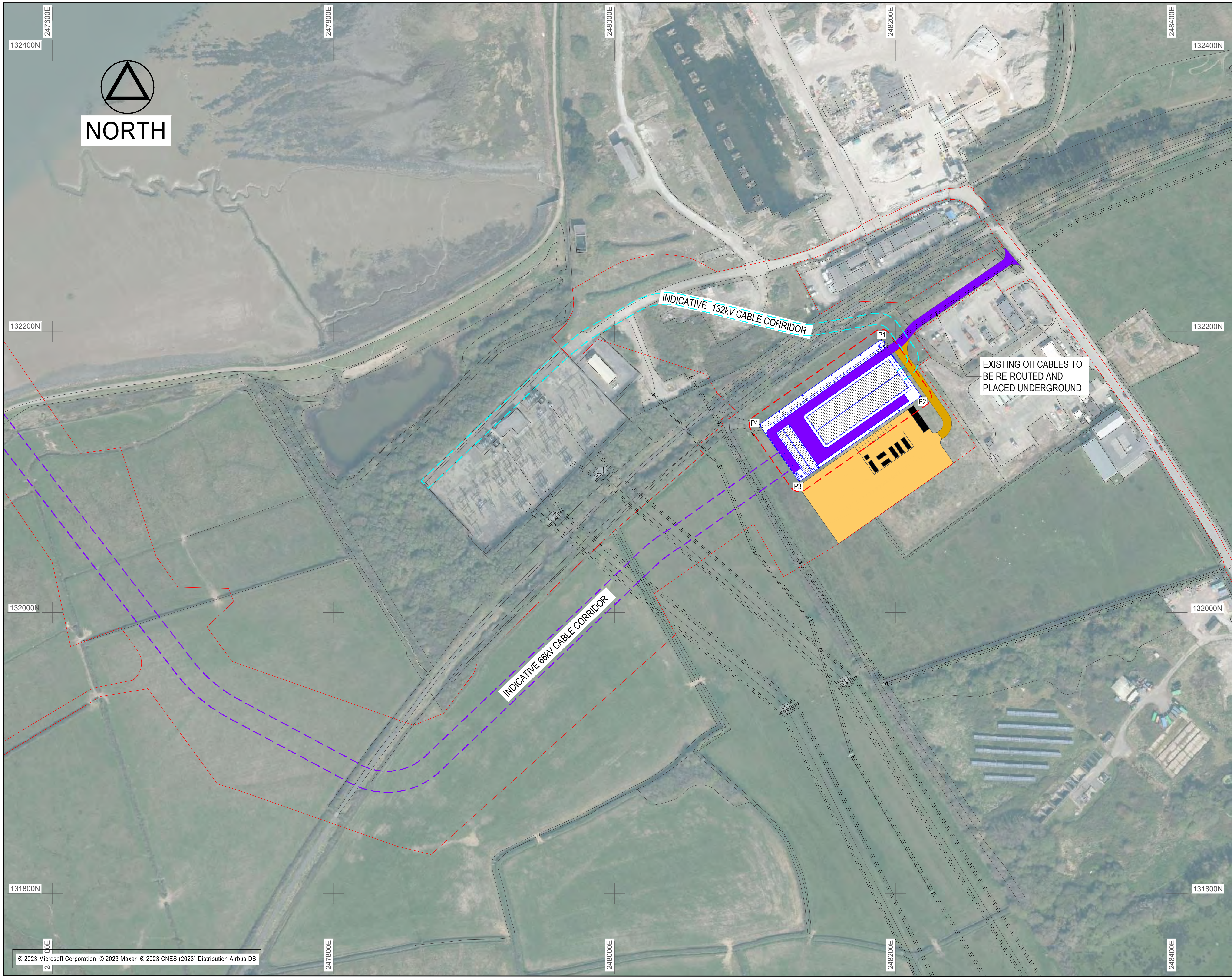

KEY

- PROJECT RED LINE BOUNDARY
- PERMANENT ACCESS ROAD
- PROPOSED SUBSTATION
- TEMPORARY CONSTRUCTION COMPOUND
- TEMPORARY CONSTRUCTION ACCESS ROAD
- EXISTING OVERHEAD CABLES
- INDICATIVE BUFFER SLOPE

PROPOSED SUBSTATION COORDINATES

PNT	EASTING	NORTHING
P1	248189.79E	132194.32N
P2	248218.15E	132153.76N
P3	248131.29E	132093.01N
P4	248102.92E	132133.58N

0 20m 40m 60m 80m 100m

Scale 1:2500 @ A3

FLOATATION DRAWING NUMBER
FLO-WHI-LAY-0011

Rev	Description	By	Chk'd	App'd	Date
G	KEY AMENDED. SCALE BAR ADDED. ACCESS ROAD COLOUR AMENDED.	PMcG	AW	AW	10.08.23
F	RED LINE SITE BOUNDARY AMENDED.	PMcG	AW	AW	03.08.23
E	RED LINE SITE BOUNDARY ADDED. SUBSTATION RELOCATED AND COORDINATES UPDATED.	PMcG	AW	AW	11.07.23
D	SUBSTATION ACCESS ROAD TIE-IN AMENDED.	PMcG	AW	AW	04.07.23
C	LAYOUT AND ORIENTATION CHANGED AND RELOCATED. SLOPE ZONE ADDED.	PMcG	MS	AW	18.05.23
B	SUBSTATION & TEMP COMPOUND AMENDED & RELOCATED. FLOATATION DRAWING NUMBER ADDED.	PMcG	MS	AW	14.04.23
A	ISSUED FOR REVIEW	PMcG	MS	AW	16.03.23

Job Title

WHITE CROSS
OFFSHORE WINDFARM

Drg Title

LAYOUT PLAN
INDICATIVE AIS ENCLOSED SUBSTATION
WITH ADDITIONAL EQUIPMENT SPACE
(OPTION C)

St Vincent Plaza, 319 St Vincent Street, Glasgow, G2 5LP
tel: +44 (0) 141 227 1700 www.woodplc.com

Scale	Date	Size
1:2500	MARCH 2023	A3

Drawn	Checked	Approved
PMcG	MS	AW

Status: PRELIMINARY

Drawing No.	Revision
80816501-01-EL-LAY-0001-016	G

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White Cross Offshore Windfarm Environmental Statement

Appendix 5.F: Project Parameters Table

Appendix 5.F Project Parameters Table

Table 5F.1 shows the over-arching project parameters for Onshore Project.

Table 5F.1 Onshore Project parameters

Parameters	Minimum	Maximum
Export Cables		
Number cable circuits	1	2
Circuit voltage	66kV	132kV
No. drills per trenchless crossing	1	2
No. trenches for opencut	1	2
Offshore Export Cable		
Total length Offshore Export Cable (installed above MLWS) (m)	N/A	860
Total horizontal length trenchless technique at Landfall (m)	60	1,850[1]
Total horizontal length opencut technique at Landfall (m)	N/A	800[2]
Transition Joint Bay dimensions (length x width x height) (m)	20 x 5 x 2	20 x 8 x 2
No. Transition Joint Bay	N/A	1
Onshore Export Cable		
Total length (m)	N/A	8,000
Total length major trenchless crossings (m)	N/A	2,500[3]
Total length opencut (m)	N/A	5,500
Onshore Cable Corridor		
Cable trench width per cable (m)	0.89	4
Cable trench depth (m)	1.6	1.9
Cable construction width (onshore corridor) (m)	12	60

Parameters	Minimum	Maximum
Cable construction width at trenchless crossings (m)	7	15
Depth to top of buried infrastructure (ducts) (m)	1.2	1.5
Depth to top of jointing bay (m)	1.2	1.5
Jointing bay dimensions (length x height) (m)	N/A	12 x 4 x 1.5
No. jointing bay	15	30
Link box dimensions (length x width x height) (m)	2 x 2 x 1	3 x 3 x 2
No. of link box	15	30
Compounds, haul road, working width		
Construction compound areas (m2) [4]	13,680	16,000
Mobilisation areas (m^2)	N/A	30,000
Haul road width (m)	5	8
Haul road length (m)	N/A	6,500
Running track width	N/A	4
White Cross Onshore Substation		
Substation operational footprint area (m^2)	4,750	5,300
Substation building dimensions (length x width) (m)	59 x 23	71 x 24
Substation building area (m^2)	1,357	1,704
Substation building height (m)	N/A	10
Control building dimensions (length x width) (m)	N/A	35 x 9
Control building height (m)	N/A	8
Control building area (m^2)	N/A	315
External equipment height (m)	N/A	10
Finished Floor Level (m AOD)	N/A	6.73
Building platform area (m^2)	N/A	7,700

Footnotes:
1 – Landfall Option 3 includes 1,000m below MLWS which is assessed in the Offshore ES
2 – Opencut include 700m on the beach/intertidal area, and 100m onshore
3 – Combined length Golf Course and Taw Estuary Crossings
4 – Includes all compounds to support the Onshore Project

WHITE CROSS

White Cross Offshore Windfarm Environmental Statement

Appendix 5.G: Crossing Schedule

Appendix 5.G Crossing Schedule

Table 5G.1 shows crossing schedule for the Onshore Export Cable. It should be viewed alongside the Onshore Cable Route – Working Width Alignment Sheets (*Figures 6 to 10* within **Appendix 5.D**)

Table 5G.1 Onshore Export Cable crossing schedule

Crossing Number	Cable Installation Method	Haul Road Crossing Method
RDX 1	Major Trenchless	N/A
DX 1/1	Opencut	Culvert
DX 1/2	Opencut	Culvert
DX 1/3	Opencut	Culvert
DX 1/4	Opencut	Culvert
DX 1/5	Opencut	Culvert
DX 1/6	Opencut	Culvert
DX 1/7	Opencut	Culvert
DX 1/8	Opencut	Culvert
DX 1/9	Opencut	Culvert
DX 1/10	Opencut	Culvert
RDX 2 (Sandy Lane)	Trenchless	Crossing Point (Access 8a/b)
DX 2/1	Trenchless	Bridge
DX 2/3[1]	Opencut/Trenchless	Culvert /Bridge/ Floating Road
DX 2/4[1]	Opencut/Trenchless	Culvert /Bridge/ Floating Road
DX 2/5[2]	Opencut/Trenchless	Culvert /Bridge
TX 2/1[2]	Opencut/Trenchless	Culvert /Bridge
DX 2/6[2]	Opencut/Trenchless	Culvert /Bridge
DX 2/7	Opencut	Culvert
DX 2/8[3]	Opencut/Trenchless	Culvert /Bridge
TX 2/2[3]	Opencut/Trenchless	Culvert /Bridge
DX 2/9[3]	Opencut/Trenchless	Culvert /Bridge
RDX 3	Major Trenchless	N/A
RVX 1 (River Taw)	Major Trenchless	N/A
DX 3/1	Opencut	Culvert

Crossing Number	Cable Installation Method	Haul Road Crossing Method
DX 3/2	Opencut	Culvert
TX 3/1 (Tarka Trail)	Trenchless	Crossing Point (Access 16a/b)
DX 3/2[4]	Trenchless	N/A
OH ELEC[4]	Trenchless	N/A
DX 3/3	Trenchless	N/A
TX 3/2 (Tarka Trail)	Trenchless	N/A

Footnotes:

1 – construction techniques within the Braunton Marshes will be confirmed following detailed design and may include trenchless techniques and bridges/floating roads

2 – these are all in close proximity and crossing method would be determined following detailed design, if crossed as a group trenchless/bridge crossing methods would be used

3 – these are all in close proximity and crossing method would be determined following detailed design, if crossed as a group trenchless/bridge crossing methods would be used

4 – trenchless technique will be used to reduce risks associated with working in close proximity to overhead lines, haul road would be constructed using appropriate safety measures (such as 'goal posts')