FIVE ESTUARIES OFFSHORE WIND FARM

9.28 OUTLINE LANDFALL METHODOLOGY

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CONTENTS

FIGURES AND TABLES

DEFINITION OF ACRONYMS

Term	Definition
HDD	Horizontal Directional Drilling
LAT	Lowest astronomical tide
MFE	Mass Flow Excavator
MMO	Marine Management Organisation
TCC	Temporary Construction Compound
TJB	Transition Joint Bay
VE	Five Estuaries Offshore Wind Farm
UXO	Unexploded Ordinance

GLOSSARY OF TERMS

Term	Definition
Development Consent Order	An order made under the Planning Act 2008 granting development consent for a Nationally Significant Infrastructure Project (NSIP) which would be approved by the relevant Secretary of State (SoS).
Landfall	The landfall denotes the location where the offshore export cables are brought ashore and jointed to the onshore cable circuits in TJBs.
Mitigation	Mitigation measures are commitments made by the project to reduce and/or eliminate the potential for significant effects that may arise as a result of the project. Mitigation measures can be embedded (part of the project design) or secondarily added to reduce impacts through the assessment process.
Onshore ECC	The Onshore ECC is the working area for the onshore cable construction.
TJB	Transition Joint Bay is an underground concrete unit where the offshore cable is jointed to the onshore cable.

1 INTRODUCTION

1.1.1 This document sets out the expected outline methodology for the landfall works to be completed for the Five Estuaries Offshore Wind farm. The works primarily involve the drilling of two bores (with potential for a spare bore) from the onshore entry point to the offshore exit point to allow for the installation of ducts / pipes. Later the two installed ducts will provide safe and secure conduits to pull-in the export cables from offshore to onshore under the beach and sea defences.

1.2 PROJECT OVERVIEW

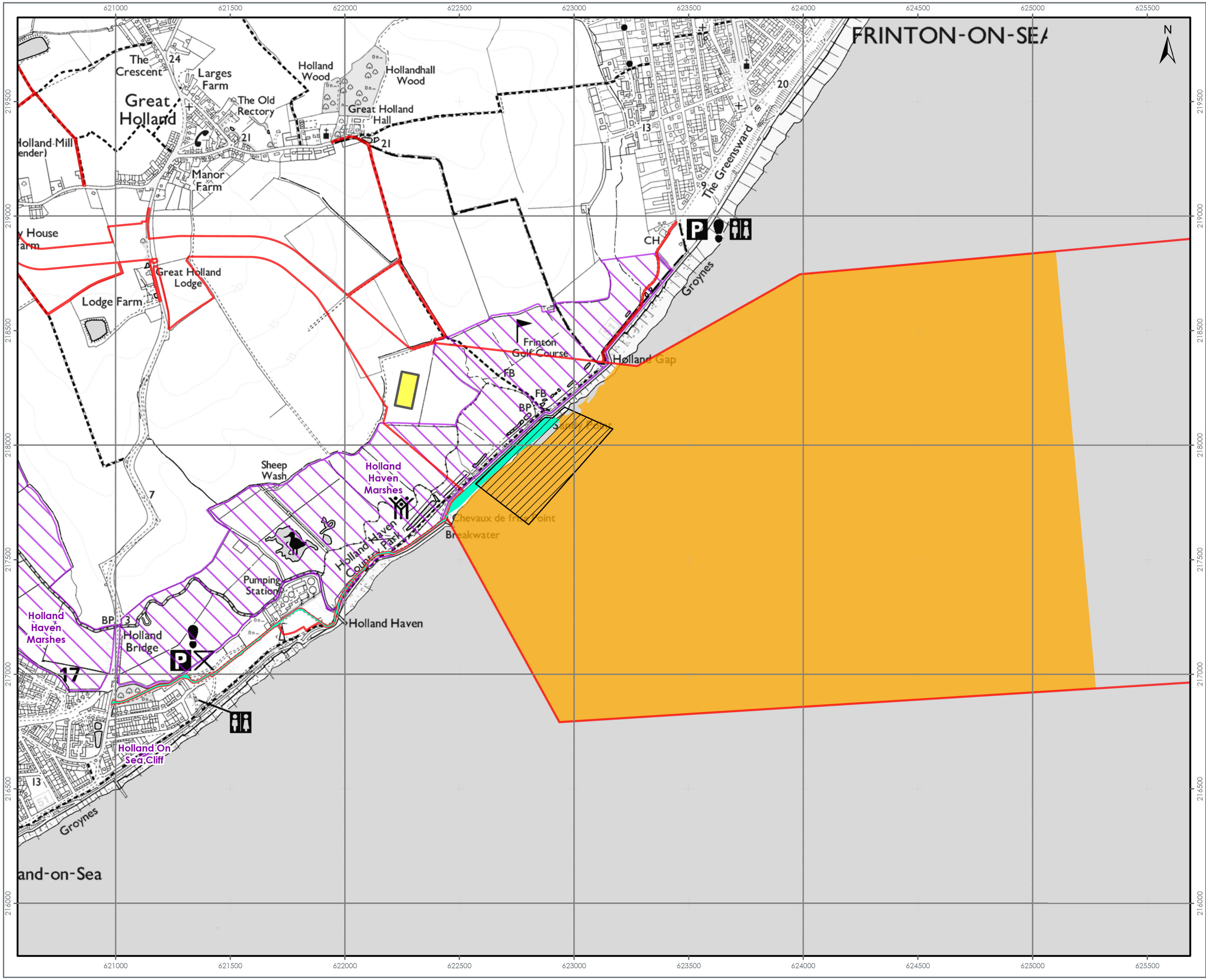
1.2.1 The Five Estuaries project is an extension to the existing Galloper Wind Farm. RWE are leading the development of Five Estuaries on behalf of the project partners. The project includes up to 79 new wind turbines. Development of the project commenced in 2020; earliest construction commencement would be in 2027 with the wind farm becoming operational by 2030.

1.2.2 The landfall denotes the location where the offshore export cables are brought ashore and jointed to the onshore export cables in Transition Joint Bays (TJBs) (located onshore).

1.2.3 The offshore export cables will make landfall between Holland-on-Sea and Frinton-on-Sea on the Essex coast (Figure 1.1). The works at the landfall include:

- Construction of the landfall compound;
- Horizontal Directional Drilling (HDD) works (or other suitable alternative trenchless techniques) including temporary construction of HDD exit pits in the intertidal or shallow subtidal;
- Intertidal trenching (this will only be required if the exit pits are located in the intertidal zone);
- Construction of TJBs;
- Installation of offshore export cables (cable pulling);
- Installation of and jointing to onshore export cables;
- Backfilling and re-instatement works.

1.2.4 A single landfall compound zone has been identified as shown in Figure 1.1. Two options for the location for the HDD exit pits are being considered either in the intertidal zone or below LAT (subtidal). The selected landfall compound zone overlaps with the North Falls landfall compound zone, and the final design of both the compounds and the HDD drill alignments will be co-ordinated to ensure adequate spacing



LEGEND

- Five Estuaries Order Limits – March 2024
- Landfall Exit Pit Sheet Piling Zone (if required)
- Potential Maximum Extent of Trenchless Works
- Temporary Beach Access Zone
- Indicative Landfall Compound
- Sites of Special Scientific Interest

0 200 400 800
Meters

Data Source:
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PROJECT TITLE:

FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:

Figure 1.1

Outline Landfall Methodology – Location Plan

VER	DATE	REMARKS	Drawn	Checked
1	11/03/2024	For Information	JB	-

DRAWING NUMBER: 005023945-01

SCALE: 1:15,000	PLOT SIZE: A3	DATUM: OSGB 1936	PROJECTION: British National Grid

FIVE ESTUARIES
OFFSHORE WIND FARM

1.3 HORIZONTAL DIRECTIONAL DRILLING

1.3.1 Horizontal Directional Drilling (HDD) is the expected methodology to be used to carry out the landfall works, but other trenchless techniques may be considered. For the purposes of this document it is assumed HDD techniques are used.

1.3.2 HDD is considered the most appropriate installation technique, for the following reasons:

- As a trenchless technique it avoids interaction with the Holland Haven SSSI, mitigating potential impacts to this environment.
- It is well proven in similar ground conditions, and the required profiles for the proposed HDDs are relatively simple, which allows high confidence in the suitability of the HDD technique for this location.

1.3.3 HDD involves drilling a long borehole underground using a drilling rig located within an onshore landfall compound. This technique avoids interaction with surface features and is used to install ducts through which cables can be pulled.

1.3.4 The basic HDD process involves the use of a drilling head controlled from the rig to drill a pilot hole along a predetermined profile to the exit point. If the exit is subtidal (in the seabed) the pilot hole is stopped few meters short of the exit point to prevent upsurge of sea water. The pilot hole is then widened (reamed) using larger drilling heads until the hole is wide enough to accommodate the cable ducts.

1.3.5 Entry and exit pits must be excavated at either end of the borehole: one in the landfall compound and one on the offshore side. HDDs can vary in length depending on the ground conditions. For Five Estuaries an indicative subtidal exit length of 1,100m is considered for purposes of assessment, but it is noted that HDDs up to 1,500m are considered achievable in suitable ground conditions.

1.3.6 It is assumed that the drill start point will be onshore and will ream towards the offshore environment.

1.3.7 Note: Open cut techniques is not included as an alternative methodology for connecting the offshore cables into the TJBs VE. There will be no direct interaction with the seawall or its toe as the drill will pass below.

Figure 1.2: Example of typical HDD equipment and entry pit

1.3.8 Set up of the drilling rig and associated equipment will be undertaken over 12 hr shifts 7 days per week; pilot hole, reaming, hole cleaning and pipeline pullback are expected to be executed on a 24hr basis in two 12hr shifts 7 days per week.

2 LOCAL CONDITIONS

2.1 GROUND CONDITIONS

2.1.1 The published geological map for the area, BGS Sheet 224 (2010), and the BGS GeoIndex Onshore (2022) show the site located on Alluvium superficial deposits which is underlain by London Clay Formation bedrock. Moreover, geotechnical boreholes investigations onshore along the approximate alignment of the planned HDDs have been undertaken by Five Estuaries to give detailed information on the geotechnical parameters and allow confirmation of the suitability of the HDD approach. The locations of these are shown in Figure 2.1.

Figure 2.1: Location of boreholes undertaken by Five Estuaries

2.1.2 Detailed pre-commencement surveys (such as further geophysical, geotechnical, ecological or archaeological surveys) will be carried out before works commence in the landfall. An analysis of the results of these surveys will then inform the final locations of TJBs and HDD alignments.

2.1.3 Strata of the Thames Group London Clay Formation are expected onshore and offshore at each of the landfall locations, and the majority of the HDD alignments will be within the London Clay Formation. The London Clay Formation provides strata which is stable and is generally a good stratum for driving tunnels and HDD's. Being the primary ground type within the London Basin, many HDDs, tunnels, and other underground excavations have been completed within London Clay.

2.1.4 The installation of a casing to stabilise the sections of bore passing through the alluvium superficial deposits will be considered. Casing diameter will need to be larger than the final HDD bore diameter. The inclusion of casing within the strata would mitigate risks from collapse of bore or frac-out of drilling fluid but has some impact on the duration and cost of the HDD. The casing installed can either be temporary or permanent depending on requirement and ease of removal.

2.2 OTHER CONSIDERATIONS

2.2.1 The HDD alignments pass under the Holland Haven Marshes SSSI and the Frinton Golf Club. No surface works are planned in these areas, although non-intrusive survey / monitoring operations may be undertaken in these areas.

2.2.2 Formal large coastal defences are present as an embankment raised above adjacent land. They are capped by a wave wall with rock armour on the seaward side. They incorporate some WWII era lookout posts ('pill boxes') and the landward-facing side faced with concrete blocks.

2.2.3 Sheet piling at the toe of the coastal defences is placed to act as scour protection against the action of waves and currents and is recorded on record drawings. Any HDD would need to cross underneath the sheet piling at a depth that gives sufficient confidence that there would not be a clash. Selected design/construction cross-section drawings have been provided by Environment Agency for the works in c. 1964/1965 and 1983. Their exact location and whether they fully represent the existing coastal defences is uncertain, but 2.5m to 3m long sheet piles are indicated on these drawings which would be expected for the type of structures constructed. The drawings suggest a sheet pile extending to a maximum c. -4mOD. The HDD alignments will be developed so they are at least a further 3m below this level, to ensure there will be no interaction with the sheet pile toe. For a sub-tidal exit, the depth below the sheet pile toe is likely to be considerably larger with the preliminary alignments based on a depth of approximately 12m below the sheet pile toe.

2.3 FUTURE CONSIDERATIONS

2.3.1 It is acknowledged that there is a possibility that a managed re-alignment of the coastal defences could be proposed and undertaken in the project lifetime. Whilst not possible to actively design for this given the lack of information available, such an approach would not introduce significant issues for the project. Electrical equipment including cables at the transition joint bay will be designed to consider saturation by groundwater, and potential infrequent flooding given the location and these are normal requirements. If the area were to be permanently submerged it would be reviewed whether any additional alterations to the installed infrastructure should be undertaken, but solutions are already available from the offshore elements of the project.

3 METHODOLOGY

Section 3.1 describes the methodology associated with the subtidal exit option. Section 3.2 then goes on to describe the differences if the inter-tidal option was taken forward.

3.1 OUTLINE METHOD STATEMENT – SUBTIDAL HDD

HDD CONCEPTUAL DESIGN

3.1.1 HDD profiles have been developed as shown in Figure 3.1, which represents a conceptual design for the landfall works. In Figure 3.1 six HDD alignments are shown. This allows for both the VE and North Falls projects including a spare drill for each. VE would be anticipated to comprise the southern three HDD bores.

3.1.2 The sub-tidal exit has been developed based on a drill length of 1,100m. The water depths at exit are approximately 3m LAT. Offshore the depth below seabed is typically c.15m, with the depth below the top of the seawall c.20m. As noted above longer lengths may be considered in the detailed design as deeper water depths are preferred for the offshore installation vessels.

HDD METHODOLOGY

3.1.3 The working area for the drilling site will be prepared in advance of equipment mobilisation. The area will be levelled, using a cut and fill operation if required and a suitable hardstanding created for placement of the HDD equipment. Access to the landfall compound will be from Clacton Road via the constructed temporary cable haul road along the cable corridor. Following preparation, the HDD drilling spread, and welfare units will be mobilised and set up.

3.1.4 The front anchor for the drill rig, required to resist the installation pushing / pulling forces will be constructed in accordance with the temporary works design calculations and drawings.

3.1.5 In advance of the commencement of drilling operations a drill entry pit (typical dimensions approximately 4.0m x 5.0m x 1.2m deep) will be excavated to collect drilling fluid returning to the surface. The pit sides will be battered back as necessary. Ground works on the entry side will typically be undertaken with a hydraulic excavator.

3.1.6 In upper soil layers a temporary casing may be installed if deemed required to seal shallow groundwater and support the drilling assembly through soft Alluvium. The casing may need to be extended above ground level to counter any risk from potential tidal surge.

3.1.7 Exit pits will be excavated or dredged to the required depth. An indicative size of 10m x 75m has been allowed for at this stage, with a depth of 2.5m. This will be typically done via backhoe dredger type vessel or an excavator mounted on a support barge. However, alternative methods including mass flow excavation may be considered. Prior to forming the exit pit any obstructions or boulders in the intended exit locations will be removed if required. Health and Safety investigations will be carried with respect to UXO in the area. Material which has been side cast into an underwater storage area running parallel to the excavated trench and will where possible be reused as backfill material.

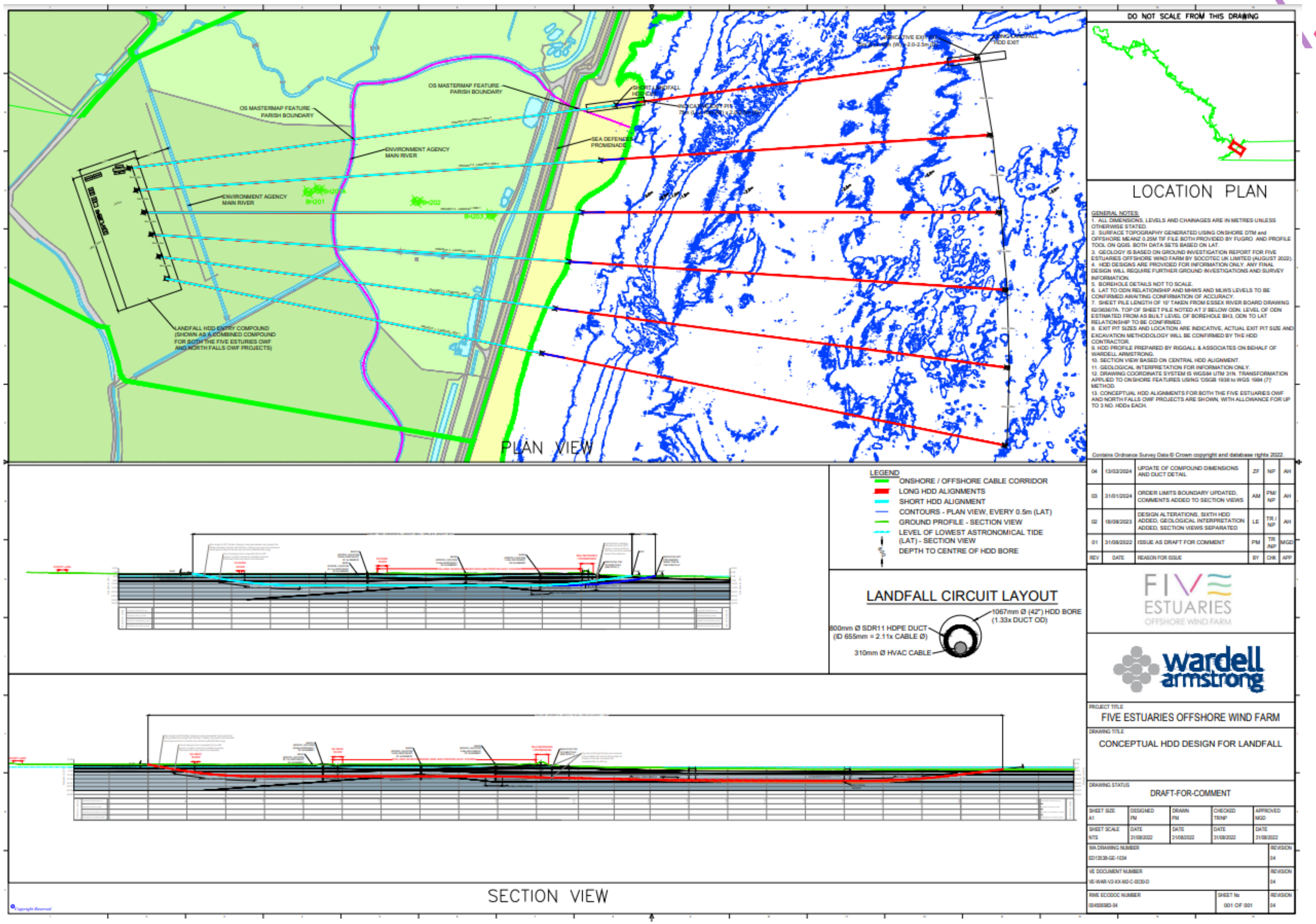

Figure 3.1: Conceptual HDD Designs (Subtidal and Intertidal options)

3.1.8 The pilot hole will be drilled to achieve the designed HDD profile. Power to the drill bit is provided by the mud motor which is powered by the flow of drilling fluid through the motor, the pilot hole is advanced as the drill rig pushes drill pipe into the ground. In addition to the power provided to the drill bit the drilling fluid exiting at the drill head fluidises the surrounding soil forming a void for the drill string to be advanced in to. Steering of the pilot hole is undertaken by the steering engineer who instructs the driller to perform any required steering corrections to maintain the designed profile.

3.1.9 Regular survey operations to confirm the correct alignment will be undertaken.

3.1.10 As the exit point is subtidal, the pilot hole operations will typically continue until a point approximately 20m short of the proposed drill exit point where the pilot hole will be halted. Final punch out onto the beach will not be undertaken until the hole has been enlarged (reamed) to the required final diameter. This is undertaken to prevent drilling fluid escaping onto the seabed during reaming and cleaning operations, this method also minimises the duration the marine spread is required to on station.

3.1.11 Reaming operations will be undertaken to enlarge the pilot hole sufficiently to a diameter suitable to accept the duct. Typically the bore will be enlarged to 30-40% larger diameter than the cable duct. Multiple reaming operations will be repeated to progressively enlarge the bore. Typically the hole will initially be reamed to within 30-50m short of the drill exit. Once fully reamed to this diameter, the pilot hole assembly will be used to drill the 30-50m "plug." During this punch out operation, some drill fluid will escape from the bore.

PIPE STRINGING / PULL IN

3.1.12 The required cable duct could be delivered to site by the following methods:

- By sea in a continuous length (Marine)
- On road in typically 6 or 12m pipe lengths (Land)

3.1.13 Once the drilling operation has taken place, the ducts will be pulled through the drilled holes. For a pull in from offshore the ducts will most likely be constructed off-site, then sealed and floated to site by tugs, then be pulled back through the boreholes either by the HDD rig itself, or by separate winches. There is also the potential to pull / push the ducts from onshore to offshore through the drilled borehole in which case the ducts would be built up (strung) along the corridor. In this case typically each of the cable ducts would need to be butt-fusion welded to form a single string.

3.1.14 For sea delivery all operations to handle and move the cable ducts would require marine support; as a minimum a tow and trail tug would be required. A sheltered storage location would need identified.

3.1.15 The cable duct will typically be pulled by the drilling rig, as drill pipes are pulled and removed at the rig the cable duct is advanced through the drilled hole. This procedure is repeated until the pulling head appears in the drill entry pit at the drill rig site. During the pullback operation some drilling fluid will inevitably escape from the bore around the exit point. This cannot be avoided as the cable duct displaces the drilling fluid as it enters the HDD bore.

3.1.16 Once the cable duct has been installed into the HDD bore a messenger wire will be installed into the duct and tied off to the flange on the duct end. The duct will need a smooth transition onto the seabed to ensure the cable integrity is maintained. The transition could be formed by pre-excavating a trench around the proposed HDD exit point prior to the completion of drilling or by locally lowering each duct once installation is completed.

3.1.17 Once the transition profile has been excavated then mattresses (or rock bags) will typically be lowered onto the duct to push it down onto the seabed and protect it. The duct end will be buoyed off to ensure it can be easily located for the cable installation.

3.1.18 Prior to cable installation, the ducts will need to be re-exposed to pull in the cable using a MFE to remove any accumulated loose sediment and rock bags and/ or mattresses would be retrieved.

CABLE PULL IN

3.1.19 Prior to cable installation, the temporary protection would need to be recovered and the ducts exposed.

3.1.20 For pull in of the Offshore cables into the installed ducts, the seabed may require preparation in the areas where the export cable installation vessel is likely to rest on the seabed at low tide periods. This would include flattening of any seafloor features (i.e. sandwaves), removal of boulders and pUXOs. Each circuit would require up to 4 laydown areas (hence 8 total), with a indicative total maximum seabed preparation area of 57,600m2 and an indicative depth of 1m

3.1.21 Once the cable is ready to be installed and the duct is excavated to the required depth the following offshore construction activities can commence:

- Remove the blank flange,
- Trench the seabed to the required depth and to a location agreed with the cable laying vessel for the handover of the messenger wire,
- Run the messenger wire to the cable laying vessel to connect to the pulling head on the cable,
- The messenger wire will be pulled into the pre-excavated trench,
- Pulling operations can commence once all parties have established good lines of communication,
- Once the cable is pulled through the duct the cable laying vessel can commence offshore works to the windfarm,
- The cable and duct can then be backfilled from the HDD exit location to the handover location,
- The as-built survey can then be performed,
- The marine spread is then de-mobilised.

3.1.22 The duct ends will need to be fitted with a split blank flange to provide a seal and prevent sediment entering the duct.

3.1.23 Once installation is complete, the subtidal exit pits will be backfilled with sidecast material or left to naturally backfill.

3.1.24 Cable protection may need to be installed on areas where the target trenching depth isn't achieved. Cable protection will be buried in the intertidal section and out to 1,600 m seaward of MHWS will not consist of loose rock or gravel

3.2 OUTLINE METHOD STATEMENT – INTERTIDAL HDD

HDD DESIGN

3.2.1 HDD profiles have been developed as included in Figure 3.1, which represents a conceptual design for the landfall works. As for the sub-tidal six HDD alignments (three for VE and three for North Falls are shown).

3.2.2 The inter-tidal exit has been developed based on a drill length of 570m. The exit locations are around low water mark with the depth below the top of the seawall approximately 15m.

METHODOLOGY

3.2.3 The methodology is generally similar to the sub-tidal option with the following identified differences.

3.2.4 A Temporary Construction Compound (TCC) to support works on the beach may be required and a location has identified adjacent to the promenade at the eastern end of Manor Way. If this is required the area will be levelled, using a cut and fill operation if required and a suitable hardstanding created for placement of equipment.

3.2.5 It is proposed that access for equipment and workers to the beach will be made via Manor Way and then along the existing track along the seawall. The existing slipway would be used for access to the beach. Some local repairs or strengthening to the slipway may be undertaken as preparatory works if required.

3.2.6 During the landfall HDD works, public access will be maintained on the beach wherever possible (outside the works area and open-cut works). Suitable means will be made available for the public to pass around the HDD works area.

3.2.7 There are no maintained or visibly intact groynes on the beach, although it is envisaged some fragments of old groynes may be present. Where necessary these will be removed to allow construction of the exit pits.

3.2.8 As the exit pits will be excavated in the intertidal zone it may be possible to construct them with land based plant, typically a tracked excavator. Excavation and construction of any temporary support (e.g. sheet piles) needed would most likely be undertaken during low tide, and tidal windows will need to be carefully managed.

3.2.9 It may be deemed preferred to work from an anchored or spud barge which can dry out on the beach, to enable working at all stages of tide.

3.2.10 As noted above sheet piles may be used to provide temporary support to the exit pit or reduce water intrusion to the exit pits (although it is not envisaged a fully water tight cofferdam would be established).

3.2.11 Sheet piles consist of sheets of metal and may be installed temporally by vibropiling or impact piling. Such piling activities would need supported by a crane, typically a crawler crane either land based or mounted on a barge. If sheet piled exit pits are required, the HDD would exit within them. It is assumed that the sheet piled exit pits would not retain all of the drilling fluid but may reduce the volume released to the marine environment (see above).

3.2.12 It is proposed that the sheet piled exit pits may be installed anywhere seaward of the sea defence structures (including the wall and rock armour). Sheet piled exit pits would be around exit pits, and so the exit pit dimensions dictate the size of the sheet piled exit pits. The volume of sediment removed is included in the exit pit volumes.

3.2.13 Sheet piles are typically removed by standard method of pulling with excavator/pile driver using driver in reverse mode.

Table 3.1: Design envelope for piling for sheet piled exit pits installation

Parameter	Design Envelope
Indicative hammer energy for sheet piled exit pits installation (kJ)	300 (assumes a 60 kJ soft start for 10 mins, thereafter progressively ramping up over 20 mins to full power)
Sheet pile width (mm)	750
Total number of sheet piles	660
Maximum number of piles to be installed per day (in proportion to the total duration of the exit pit construction operation, this includes set-up and supporting operations).	8
Driving time per sheet pile (hr)	A maximum of 30mins driving time per pile (incl the soft start) is assumed for modelling. However, sheet piles typically get installed as sets (of 5 to 8) and a single pile may not necessarily get fully driven before starting the adjacent ones.

3.2.14 Open-cut cable installation may be required seaward of the exit pits. Open-cut installation in the intertidal zone could be carried out using one or more methods described for the offshore export cables in the offshore project description (with the exception of jetting and MFE in the intertidal areas).

3.2.15 Once installation is complete intertidal exit pits will be back-filled to the natural beach level.

3.3 CABLE / DUCT DETAILS

3.3.1 For consent purposes an outer cable diameter of upto 310mm is conservatively assumed.

3.3.2 The internal diameter and wall thickness of the duct required for cable installation will be dependent on the diameter of the cable pulling head and the thermal dissipation of the cable when it is operational. For the maximum size cable considered, the following indicative duct sizes are considered as presented in Table 3.2. Smaller ducts may be able to used once the detailed design is progressed.

Table 3.2: Indicative Duct Details

Wind Farm	Duct Size	Pilot Drill Type	Bore Diameter	Bore / Duct Ratio
Five Estuaries	DN800, SDR11	17.5” Tricone	1219mm	1.30

3.4 DRILLING MUD / FLUSH VOLUMES

3.4.1 Drilling fluid is used to lubricate and cool the drill bit and string, suspend, and carry away the drill cuttings, also to make the drill string buoyant and to stabilise the borehole. Bentonite is a non-toxic, inert, natural clay mineral (mainly montmorillonite) with ability to absorb water and increase its own volume by several times, forming a gelatinous and viscous fluid. With addition of water, it forms drilling fluid, used in Horizontal Directional Drilling (HDD). The drilling fluid may also contain minor amounts of other additives, e.g., polymers, soda ash, and xanthan gum (typically <0.1%) to control the fluid viscosity and regulate pH depending on the pH of the water supply.

3.4.2 The maximum design envelope for drilling mud which could be released to the environment is presented in Table 3.3.

Table 3.3: MDS for release of drilling mud

Parameter	Design Envelope
Maximum number of bores	3
Realistic case drilling mud volume based on forward ream (from the beach to offshore) per bore (m^3)	677
Realistic case drill cuttings based on forward ream (from the beach to offshore) per bore (m^3)	50
Worst case drilling mud volume based on back ream (from offshore towards the beach) per bore (m^3)	4,940
Worst case drill cuttings volume based on back ream (from offshore towards the beach) per bore (m^3)	900
Total volume of drilling mud which could be released (m^3)	14,820
Total volume of drill cuttings which could be released (m3)	2,700
Maximum drilling mud volume to be released per tidal cycle (m3)	500

3.4.3 It should also be noted that bentonite, as the primary component other than fresh water, is inert and recognised by CEFAS as being fully biodegradable and is on the Oslo/Paris convention ''List of Substances Used and Discharged Offshore which are considered to Pose Little or No Risk to the Environment''. It is also understood that any chemical additives used in HDD for offshore windfarms do not need to be on the CEFAS approved list, and an offshore chemicals permit is not required. However, the activity may still need to be covered by the relevant licence and any conditions that are specified in this license will need to be adhered to.

3.5 HDD WATER SUPPLY

3.5.1 A quantity of water will be required for the onshore HDD works 24 hours a day 7 days a week. Potential supply methods are:

- Water Tanker - Water can be transported to site using water tankers provided by a local company. The HDD site could have water storage containers that would need to be filled by the tankers.
- Abstraction from adjacent watercourses.

3.6 EQUIPMENT DETAILS

3.6.1 The main items of plant and equipment required on the HDD rig site are listed below:

- Drilling Rig
- Drill Cabin
- Pipe Rack c/w Drill pipe
- Mud Pump
- Drilling Fluid Active Tank
- Drilling Fluid Mixing Tank
- Drilling Fluid Recycling Plant
- Water Storage Tanks
- Stores container
- 375kVA & 20kVa Generators
- Drilling Fluid Re-Circulation Pump
- Hydraulic Excavator

3.6.2 Additional earthworks equipment will be required during establishment of the compound.

3.7 MARINE SPREAD REQUIREMENTS (OFFSHORE)

3.7.1 Depending on the preference of the selected drilling contractor, the HDD support vessel could comprise an anchored barge, spud leg or jack up vessel. The primary duties of the vessel are to support the drilling operations during the final punch-out on to the seabed, duct installation and temporary protection of the HDPE duct prior to export cable installation.

3.7.2 An anchored vessel would need a minimum of a 4-point anchor system and would need to be supported by an anchor handling vessel. A spud leg barge would need spuds long enough for the maximum anticipated water depth. A jack up would need legs of a sufficient length to allow the vessel to be jacked sufficiently clear of the highest water level.

3.7.3 The main items of marine support plant and equipment required for the HDD works will depend on the contractor but may include:

- Flat Topped Barge
- Support Tug
- Point Mooring System c/w Mooring Winches, Anchor Wires and Anchors
- Crawler Crane
- Crew Transfer Vessel
- Dive Spread and / or Remote Operated Vehicle (ROV)
- Welfare Facilities
- HDD Make-up / Break-Out Vice
- Light Towers
- Containment for drilling fluid release
- Pumping system and hoses for drilling fluid recovery

3.8 KEY MATERIALS

3.8.1 The following key materials are expected to be used during the works:

- Ducts (typically HDPE)
- Drilling fluid as described in section 3.4
- Rock bags / mattresses for temporary stabilisation of exit pits
- Sheet piles if used

3.9 CO-ORDINATION

3.9.1 Coordination with North Falls has identified that both projects can use the same landfall location and the projects have an aligned cable corridor running inland from this. This approach is expected to allow minimisation of impacts. The landfall compound area identified has sufficient space to accommodate both projects, and if the HDD drilling works were undertaken at the same time adjacent compounds would be established,

3.9.2 The Co-ordination Document (Volume 9, Report 30) sets out three delivery scenarios and details how these are secured through the two Build Options in the Development Consent Order.

3.9.3 For the scenario 1 the expected coordinated construction methodology would consist of:

- One civil contractor installing haul road(s) to landfall and potentially undertaking enabling type works for the landfall compounds
- Separate project specific HDD contractors (which may be the Offshore Cable Contractor) undertaking the landfall HDDs and constructing transition joint bays

3.9.4 The common haul road allows reduction of a number of impacts. The use of separate HDD contractors results from the fact that commonly the offshore export cable contractor will undertake the landfall HDD works, and there are number of interfaces between the offshore vessel activities and the landfall / HDD arrangements. Due to expected differences in offshore project design some differences in requirements are therefore expected.

3.9.5 For scenario 2 co-ordination could be similar to scenario 1 if the programmes allow the haul road to be re-used, although under this scenario the second project would remove the haul road. If the programmes do not allow haul road use, scenario 2 would become similar to scenario 3 which is the standalone delivery scenario.

4 RISKS AND CONTROL MEASURES

4.1 KEY RISKS

4.1.1 The works involve a number of standard construction risks that will need carefully managed through the construction phase to allow a successful operation.

4.1.2 The following risks with the potential to impact other stakeholders have been identified in Table 4.1.

Table 4.1 Risk Assessment

Risk	Potential Impacts	Risk before Mitigation (H / M / L)	Control Measures / Mitigations	Risk after Mitigation (H / M / L)
Failure of HDD technique	Damage, work delays, economic impact on the project	M	Geotechnical investigation carried to confirm the expected ground conditions, with further geotechnical investigations to be undertaken in nearshore regions Strata is generally well suited to HDD technique, and for this reason the risk of HDD techniques not being suitable is seen as very low. Open trenching across the SSSI and alternative crossing techniques of the seawall would have significant impacts, and are not proposed as alternatives due to the impacts of these. Conceptual design has provided for a spare bore in case of any issues with deviation, isolated cobbles, unexpected manmade feature. This is the primary mitigation for a failed HDD bore. In the event of a failure detailed lessons learnt and investigation will be undertaken before further bores are undertaken. Robust contractor selection process	L

Risk	Potential Impacts	Risk before Mitigation (H / M / L)	Control Measures / Mitigations	Risk after Mitigation (H / M / L)
			Appropriate construction monitoring including use of specialist advisors in both the current planning phase and future construction phases.	
HDD entry compound susceptible to seawater flooding (due to ground level being lower than high storm surges and risk of seawater flowing through ducts / drill pipes / HDD bore during a phase of drilling)	Damage, work delays, economic impact on the project, potential flooding to adjacent land	M	Forecasts / will be monitored and work planning will look to programme works for lower risk months where practicable Dewatering systems to be used in excavations Appropriate mitigation measures to allow temporary (during construction) and permanent sealing of the bore will be developed. Options include: • Installation of a casing (sealed with the surrounding ground) allows sealing of the bore during drilling. • Grouting of the bore during drilling • Installation of a seal at the onshore end (e.g. grouting the first 30m to plug the end of the bore) • Elevation of the drill pad above temporary storm surge levels Robust contractor selection process	L

Risk	Potential Impacts	Risk before Mitigation (H / M / L)	Control Measures / Mitigations	Risk after Mitigation (H / M / L)
			Appropriate risk and emergency management procedures	
HDD entry compound susceptible to surface water and ground water flooding	Flooding of HDD compound resulting in damage, work delays and having economic impact	H	Forecasts / will be monitored and work planning will look to programme works for lower risk months where practicable Dewatering systems to be used in excavations Casings can be used to upper groundwater bearing strata to serve as protection from groundwater flooding. Robust contractor selection process Appropriate risk and emergency management procedures	L
Breakout of drilling fluid to the surface during pilot drilling	Potential impacts to local environment (e.g. SSSI), Delay to programme, economic impact	M	Hydrofracture modelling has been undertaken by a specialist HDD contractor for the proposed (conceptual) HDD alignment options. The modelling indicates a low risk of breakout along the length of the HDD under the SSSI and golf course, with some potential for breakout immediately adjacent to the offshore end which is typical due to naturally softer sediments. As some drilling fluid loss to sea is anticipated as a result of the process this is not foreseen as significantly changing the expected impacts.	M / L (M – offshore end; L – sections under SSSI and golf course)

Risk	Potential Impacts	Risk before Mitigation (H / M / L)	Control Measures / Mitigations	Risk after Mitigation (H / M / L)
			Contractor selection process Appropriate construction methodology (continuous monitoring of drilling progress, fluid returns and volumes) etc to be applied to reduce risk of any unplanned drilling fluid losses. Robust risk assessments and method statements including suitable contingency planning (e.g. availability of additives to help seal fissures) will be considered in pre-construction planning Bentonite is recognised by CEFAS as being fully biodegradable. It is an inert natural clay mineral. Acceptability of any additives shall be approved in advance by relevant authorities.	
Risk of affecting structural integrity of sea defences	Subsidence / settlement of seawall leading to structural integrity issues Potential increased flooding risks to local areas	M	Current indicative design shows the depth below top of sea wall of between c.15 to 20m, in competent strata namely medium to stiff clay. Final depth of drill will be chosen to give a safety margin below the anticipated depth of sheet pile toe, to cover potential as-built variations.	L

Risk	Potential Impacts	Risk before Mitigation (H / M / L)	Control Measures / Mitigations	Risk after Mitigation (H / M / L)
			Preliminary settlement calculations have been carried out, and further calculations (and potentially monitoring) will be carried out to confirm no adverse settlement effects would be expected on the seawall. Appropriate construction methodology (continuous monitoring of drilling progress, fluid returns and volumes) etc to be applied in line with breakout prevention when drilling below the seawall.	

4.2 CONTROL MEASURES AND MONITORING DURING DRILLING

4.2.1 During drilling activities, the downhole fluid pressures will be continuously monitored to ensure the downhole pressure does not exceed the anticipated overburden pressure at any point along the drilled profile. Any sudden losses in downhole pressure will be investigated as a potential break-out.

4.2.2 Regular walkovers will be undertaken to check for visible leakage of drilling fluid along the line of the drilled profile.

4.2.3 If a large bentonite breakout does occur drilling operations will be stopped, and the Environmental Advisor and site response team contacted. The Risk Assessment and Method Statement will identify what to do, for example initial actions, where possible, will be to:

- contain the flow of drilling fluid using a combination of materials including straw bales, sedimatts and teram.
- Clean up drilling fluid and remove from site

4.2.4 Once the initial actions to contain the flow of drilling fluid have been undertaken an assessment of the potential causes and remediation measures will be established.

- Possible control measures will include:
- Pumping of a loss control additive to seal the area of breakout
- Grouting of the bore and re-drilling
- Once the area of breakout has been sealed drilling operations will continue.

4.2.5 The fluid that returns to the surface at rig side will be recycled during drilling operations (treated with shale-shakers, de sanders and de silters) in order to keep the raw material consumption and disposal volumes as low as possible. The fluid properties will be regularly monitored to ensure the fluid design is appropriate for the ground conditions being drilled through.

4.3 EMERGENCY RESPONSE

4.3.1 Emergency response procedures will be developed prior to the works commencing. These will include contact details for all key contacts in the case of an emergency (e.g. Environmental Agency, MMO etc), and this information will be disseminated to the site teams.

4.3.2 As noted above response procedures for potential risks (such as drilling fluid breakout) will be developed and included in the Risk Assessment and Method Statement for the works and emergency response plans.

FIVE ESTUARIES OFFSHORE WIND FARM

PHONE	0333 880 5306
EMAIL	fiveestuaries@rwe.com
WEBSITE	www.fiveestuaries.co.uk
ADDRESS	Five Estuaries Offshore Wind Farm Ltd Windmill Hill Business Park Whitehill Way, Swindon, SN5 6PB
COMPANY NO	Registered in England and Wales company number 12292474