NORTH FALLS

Offshore Wind Farm

Outline Horizontal Directional Drill Method Statement and Contingency Plan (Tracked)

Document Reference:	7.15
Volume:	7
Date:	~~May~~ July 2025
Revision:	3~~2~~

Project Reference: EN010119

NORTH FALLS
Offshore Wind Farm

Project	North Falls Offshore Wind Farm
Document Title	Outline Horizontal Directional Drill Method Statement and Contingency Plan (Tracked)
Document Reference	7.15
Supplier	NFOW
Supplier Document ID	005275203

Revision	Date	Status/Reason for Issue	Originator	Checked	Approved
0	July 2024	Submission	NFOW	NFOW	NFOW
1	February 2025	Deadline 1	NFOW	NFOW	NFOW
2	May 2025	Deadline 5	NFOW	NFOW	NFOW
3	July 2025	Deadline 7	NFOW	NFOW	NFOW

Contents

Tables

Figures

Glossary of Acronyms

BGS	British Geological Society
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
EACN	East Anglia Connection Node (National Grid connection point)
EnvCoW	Environmental Clerk of Works
HDD	Horizontal Directional Drill
HDPE	High Density Polyethylene
LAT	Lowest Astronomical Tide
m	Meters (unit of length)
m3	Cubic meters (unit of volume)
mm	Millimetres (unit of length)
MFE	Mass Flow Excavation
OD	Ordinance Datum
OSPAR	Oslo and PARis convention
PLONOR	Pose Little or No Risk
pUXO	Potential UneXploded Ordnance
SSSI	Site of Special Scientific Interest
TJB	Transition Joint Bay
UXO	UneXploded Ordnance
WWII	World War Two

Glossary of Terminology

400kV onshore cable route	Onshore route within which the onshore substation to National Grid connection point onshore export cables and associated infrastructure would be located.
Haul road	The track along the onshore cable route used by construction traffic to access different sections of the onshore cable route.
Horizontal directional drill (HDD)	Trenchless technique to bring the offshore cables ashore at the landfall. The technique will also be used for installation of the onshore export cables at sensitive areas of the onshore cable route.
Landfall	The location where the offshore export cables come ashore at Kirby Brook.
Landfall compound	Compound at landfall within which HDD or other trenchless technique would take place.
Landfall search area	The area considered at PEIR, comprising the Essex coast between Clacton-on-Sea and Frinton-on-Sea within which the landfall is located.
Onshore cable corridor(s)	Onshore corridor(s) considered at PEIR within which the onshore cable route, as assessed at ES, is located.
Onshore cable route	Onshore route within which the onshore export cables and associated infrastructure would be located.
Onshore project area	The boundary within which all onshore infrastructure required for the Project will be located (i.e. landfall; onshore cable route, accesses, construction compounds; onshore substation and cables to the National Grid substation).
Onshore scoping area	The boundary in which all onshore infrastructure required for the Project will be located, as considered within the North Falls EIA Scoping Report.
Onshore substation	A compound containing electrical equipment required to transform and stabilise electricity generated by the Project so that it can be connected to the National Grid.
Onshore substation construction compound	Area set aside to facilitate construction of the onshore substation. Will be located adjacent to the onshore substation.
Onshore substation works area	Area within which all temporary and permanent works associated within the onshore substation are located, including onshore substation, construction compound, access, landscaping, drainage and earthworks.
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
Onshore substation zone	The area considered at PEIR, within which the onshore substation will be located.
PLONOR	OSPAR convention produces a list of substances used and discharged offshore which are considered to Pose Little or No Risk to the environment
Record Drawing	An historical drawing showing the as built infrastructure.

National Grid connection point	The grid connection location for the Project. National Grid are proposing to construct new electrical infrastructure (a new substation) to allow the Project to connect to the grid, and this new infrastructure will be located at the National Grid connection point.
National Grid substation connection works	Infrastructure required to connect the Project to the National Grid connection point.
Temporary construction compound	Area set aside to facilitate construction of the onshore cable route. Will be located adjacent to the onshore cable route, with access to the highway where required.
The Applicant	North Falls Offshore Wind Farm Limited (NFOW).
The Project Or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.
Trenchless crossing	Use of a technique to install limited lengths of cable below ground without the need to excavate a trench from the surface, used in sensitive areas of the onshore cable route to prevent surface disturbance. Includes techniques such as HDD.
Trenchless crossing compound	Areas within the onshore cable route which will house trenchless crossing (e.g. HDD) entry or exit points.

1 Introduction

1. This document sets out the outline methodology for HDD works proposed for the North Falls Offshore Wind Farm, covering both landfall and any onshore HDDs within the onshore cable route.
2. The works involve the drilling of bores (with the provisions for spare bore(s) in the event of a problem), from an entry pit one side of a constraint to an exit pit on the other, allowing the installation of ducts. The cables making up the export circuits can then be pulled in through these ducts.
3. For the landfall, the entry pit will be located onshore, with the exit in land below LAT offshore. Provision for 2 bores (with a provision for an additional bore in the event of a problem) will allow the offshore export cable to be pulled through ducts.
4. A detailed HDD Method Statement and Contingency Plan, based on the outline plan provided in this document, will be prepared prior to construction, and submitted to the local planning authority for approval. Preparation of the detailed HDD Method Statement and Contingency Plan is secured by DCO Requirement.
5. Following the submission of the DCO application, comments have been provided by stakeholders regarding the content of the Outline Horizontal Directional Drill Method Statement and Contingency Plan. Table 1-1 provides a summary of the amendments that have been made in response.

Table 1-1 Summary of Outline Horizontal Directional Drill Method Statement and Contingency Plan Changes

HDD Method Statement Revision Number	Summary of Changes	Relevant Section of the HDD Method Statement
01	Additional text on the impact of bentonite release	Section 2.2 and 4.1
	Additional text to clarify length of landfall HDD	Section 3.1.2
	Additional text to clarify the approach to risk assessments for onshore HDDs	Section 3.1.5
	Removal of water abstractions from local water courses due to connectivity with SSSI	Section 3.4
	Additional text on sensitive receptors	Section 4.2.2
	Additional text to clarify alternative mitigation measures	Section 4.2.3
	Additional text, including a decision tree, to show indicative approach to clean up of a ‘breakout’ of bentonite	Section 4.2.5
	Additional text on pre-emptive mitigation	Section 4.2.5.1
	Additional section on the summary of requirements on Contractors	Section 4.4

HDD Method Statement Revision Number	Summary of Changes	Relevant Section of the HDD Method Statement
02	Additional text on walkovers	Section 4.2.3
	Additional text and amendment of Steps 1-5 of the example decision tree for bentonite release	Section 4.2.5 and Section 4.2.5.2
	Additional text to clarify the term ‘manual clean-up’	Section 4.2.5
	Additional text on ensuring no detrimental effects from the bentonite clean-up sequence	Section 4.2.5.2
	Additional text on mitigation measures	Section 4.2.3
	Additional text on entry and exit pit locations regarding sensitive environmental receptors	Section 4.2.5.1
03	Addressing minor typographical error in text in relation to clean-up	Section 4.2.5

1.1 Project overview

6. The North Falls Offshore Wind Farm project (herein ‘North Falls’ or ‘the Project’) is a proposed offshore wind farm located off the coast of Essex. The Project will comprise up to 57 turbines located 40km from the Essex coast. The power from the wind farm will be transmitted via export cables to a National Grid connection point located in the National Grid East Anglia Connection Node (EACN) substation near Lawford, Essex.
7. Power will be transmitted via two cables, and the landfall marks the point where the offshore export cables transition to onshore export cables, and are connected together at a Transition Joint Bay (TJB). To facilitate the connection of the cables, bores will be drilled between the onshore and offshore sections to allow cables to be installed.
8. The offshore export cables will make landfall between Holland-on-Sea and Frinton-on-Sea at Kirby Brook on the Essex coast (Figure 1.1). The landfall works will include:
    - Construction of the landfall compound;
    - Horizontal Directional Drilling (HDD) (including any entry pit construction works and dredging for the exit pit);
    - Construction of TJBs;
    - Installation of cable ducts
    - Installation of offshore export cables (cable pulling);
    - Installation of and jointing to onshore export cables;
    - Backfilling and re-instatement works.

9. An area for a single landfall compound has been identified as shown in Figure 1.1. This will include the locations for the entry pit and the TJB. The HDD exit pits will be located below LAT (sub-tidal). The selected landfall compound overlaps with the Five Estuaries landfall compound, and the final design of both compound and the HDD drill alignments will be co-ordinated to ensure adequate spacing.

10. The onshore export cable will extend from the TJB to the Project onshore substation and on to the EACN. At certain locations, constraints mean that HDD crossings of obstacles such as roads, watercourses and other environment constraints are required. Open cutting and trenching through these obstacles results in unacceptable impacts to the wider environment. The obstacles being crossed using HDD methodologies can be found in the Crossing Schedule (Doc. Ref 3.3.2). The works for this will include:

    - Construction of the temporary compounds;
    - Horizontal Directional Drilling (HDD) works including excavation of entry and exit pits;
    - Installation of cable ducts;
    - Construction of joint bays (if applicable);
    - Installation of export cables (cable pulling);
    - Jointing of cables;
    - Backfilling and re-instatement works.

2 Description Of Works

2.1 Horizontal Directional Drilling

11. Horizontal Directional Drilling (HDD) is the expected methodology to be used to carry out the landfall works. HDD is considered the most appropriate installation technique, for the following reasons:
    - As a technique for the landfall, it avoids interaction with the Holland Haven Marshes Site of Special Scientific Interest (SSSI) and Local Nature Reserve, mitigating potential impacts to these designated sites for nature conservation.
    - 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.
12. In addition to the landfall works, HDDs and other trenchless techniques will be used at some locations along the onshore cable route. HDDs negate the need for above ground construction works at the location of sensitive features, minimizing the impacts on environmental receptors e.g. mature trees and hedgerows, and other critical infrastructure e.g. roads.
13. HDDs involve 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.
14. 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.
15. Entry and exit pits must be excavated at either end of the HDD. For the landfall HDD, the drill start point will be in the entry pit in the landfall compound and will generally ream towards the offshore side. If an exit pit is not created for the landfall HDD, additional lowering works would be needed to bury and protect the completed installation.
16. HDDs can vary in length depending on the obstacle being crossed, ground conditions and, in the case of the landfall HDD, nearshore seabed variability profile.
17. Set up of the drilling rig and associated equipment will be undertaken in line with the working hours set out in the Outline Code of Construction Practice (Document Reference: 7.13). Some drills may require 24 hour working to prevent issues being caused by stopping works. For example, in addition to the landfall, this is expected to be at the A120 crossing and the Tendring Brook crossing.

2.2 Bentonite

18. 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 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. In these concentrations, these do not impact on the toxicity of the bentonite.

19. It is not classified as hazardous under Classification Regulation (EC) No 1272/2008, and is not classified under Classification Directive 67/548/EEC, 1999/45/EC.

20. 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' (PLONOR). It is also understood that any chemical additives used in HDD for offshore wind farms 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.

21. Although non-toxic, in the event of 'breakout' of bentonite to the ground surface (the risk of which is discussed in more detail below), bentonite presents a potential risk of temporary smothering of aquatic or emergent plant species, before it disperses or is removed, temporarily impacting on aquatic or emergent plant species and those species which they support.

2.2.1 Uses

22. A composite made up of bentonite and water has the following functions when used as a drilling fluid:

- To remove cuttings from in front of the drill bit
- Power the mud motor
- To transport cuttings from the drill face through the annular space towards the surface
- Lubricate the drill string during drilling phases and HDPE strings during pull back
- Cooling the reamers (cutting tools)
- Hole stabilization

- Creation of a filter cake against the wall of the hole to minimize the risk of loss of drilling fluid or influx of groundwater penetration into the borehole

2.2.2 Bentonite Concentrations

23. The characteristics of drilling fluid, especially the viscosity, can be adjusted during the drilling phases by changing the structure of the composite.

24. The drilling fluid consists of a low concentration bentonite – water mixture. Depending on the formation to be drilled through, the concentration is between 13 litres (30kg) and 35 litres (80kg) of dry bentonite clay per m^3 of water.

2.2.3 Other Drilling Materials

25. Bentonite is the typical material used in HDD drilling, for the reasons stated above. Any alternative, should it be used, would need to have a lower impact on the environment than bentonite.

26. The HDD contractor must ensure that all drilling materials used are CEFAS (Centre for Environment, Fisheries and Aquaculture Science) 'GOLD' rated. This will prevent substitutions and provides a strong baseline for permissible chemicals as they have already undergone rigorous environmental testing.

2.3 Landfall Ground Conditions

27. 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 and subsequently shared with North Falls 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 and subsequently shared with North Falls

Notes:
Site Plan created using Professional incorporating Bing Maps included under licence with Bentley Ltd.

Scale: 1:2000

Surveyed By:

Surveyed Date:

Key:

Cable Percussion

SITE PLAN

SOCOTEC

Project ID: D2016-22

Project Title: Five Estuaries Offshore Wind Farm

Client: Five Estuaries Offshore Wind Farm Limited

Figure: A2

28. Detailed pre-construction 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.

29. Strata of the 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.

30. The Project has the option to install a casing to stabilise the entry sections of bore passing through the alluvium superficial deposits, should further geotechnical work suggest its use will minimise the risk of breakout. 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 of the HDD. The casing installed can either be temporary or permanent depending on requirement and ease of removal.

2.4 Other Landfall Considerations

31. The HDD alignments pass under the Holland Haven Marshes SSSI and LNR 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.

32. 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 cladded with concrete blocks.

33. 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.

2.5 Future Landfall Considerations

34. 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.

2.6 Cable Route Ground Conditions

35. For a number of key HDDs along the route (Little Clacton Road, railway crossing and Tendring Brook crossing), preliminary site investigations have taken place. This involved drilling boreholes to understand the soil on either side of the proposed drill. This has enabled the proposed profiles to align to the known strata of the soils, to minimise impacts with the obstacle being crossed.

36. In the case of the railway, specific settlement calculations have taken place to understand the impact of the drill from both North Falls and Five Estuaries on the railway tracks, ensuring no adverse effects occur. This has been submitted to Network Rail for technical clearance.

37. For all other HDDs, further investigation works will be carried out at the other crossings as needed at detailed design stage to ensure they are not going to have detrimental effect on the surrounding environment.

2.7 Other Cable Route Ground Conditions

38. As part of the Project’s design, NFOW has committed to using trenchless techniques at certain obstacles crossings along the onshore cable route during construction, in order to mitigate ecological, water resource and traffic and transport effects and well as effects on other assets during construction.

3 Methodology

3.1 Outline Method Statement

3.1.1 Landfall HDD Methodology

39. The working area for the drilling site within the landfall compound 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 onshore cable route. Following preparation, the HDD drilling spread, and welfare units will be mobilised and set up.
40. A temporary compound of size 150m x 75m will be used to construct the HDDs for both North Falls.
41. 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 prepared post consent.
42. 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.
43. 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.
44. 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.
45. 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.

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

47. 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 seabed 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.

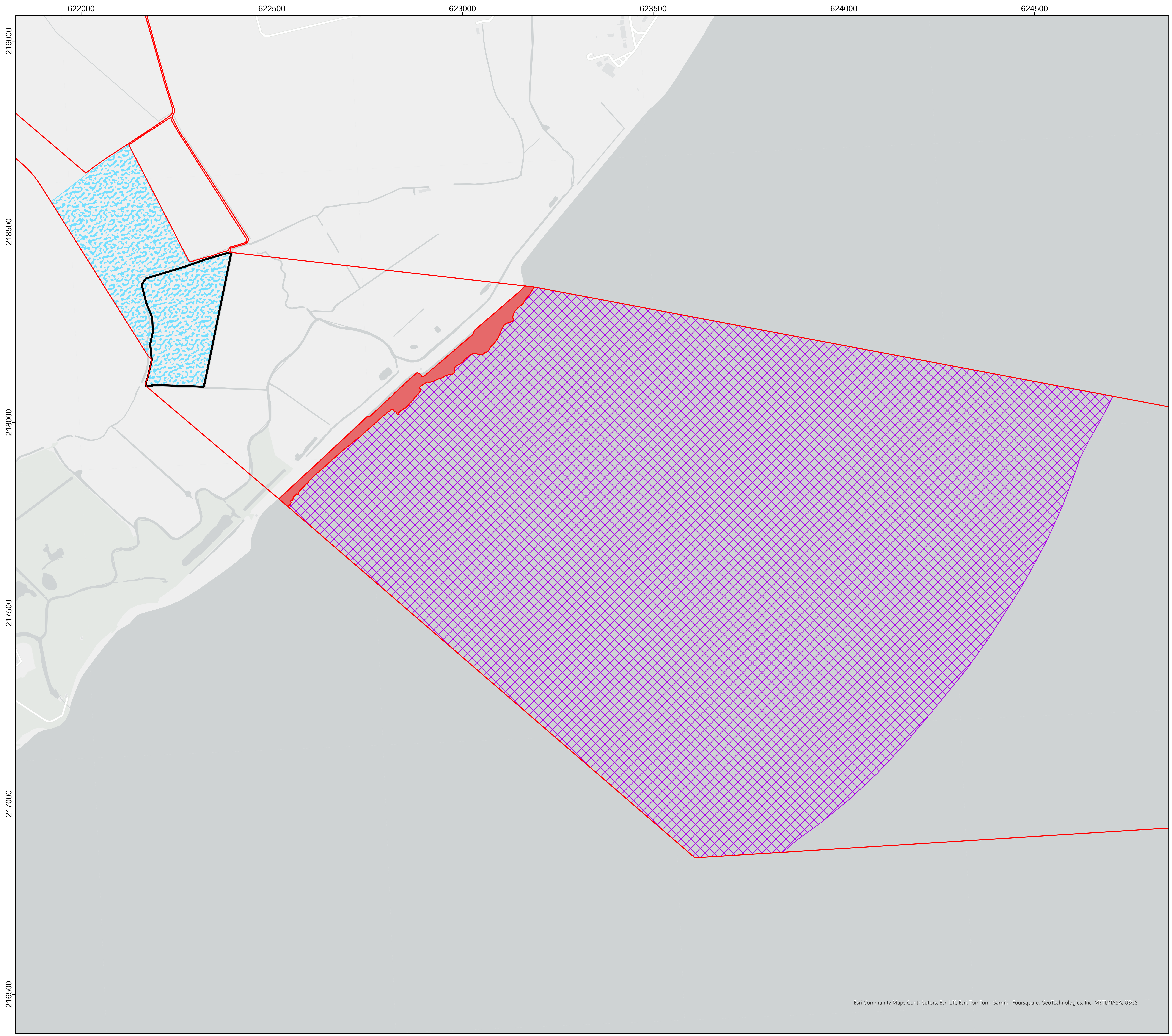
48. Reaming operations will be undertaken to enlarge the pilot hole sufficiently to a diameter suitable to accept the duct. Typically the bore will be enlarged to 30-40% larger diameter than the cable duct. Multiple reaming operations will be repeated to progressively enlarge the bore. Typically the 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, a minor amount of drill fluid will escape to the sea from the bore due to the cutting head breaking the seabed and thus releasing pressure. As the drilling fluid is only slightly higher pressure than the hydrostatic pressure of the sea water and is denser that sea water, any release would pool in the lowest point. It would be captured in the exit pit, with only any overflow released into the tidal stream.

3.1.2 Landfall HDD Conceptual Design

49. For North Falls, an indicative subtidal exit length of 1,100m is considered for purposes of assessment. This is based on the depth needed to pass under sea defences whilst ensuring that the entry pit is outside of any environmental designations and the exit point is at a reasonable water depth such that the marine spread can access the exit pit without major offshore impacts. This is in line with other offshore wind farms, where typically 1km is planned.

50. It is noted that, in theory, HDDs up to 1,500m are considered achievable in suitable ground conditions. For North Falls, the HDD profile and associated ground conditions are shown in Figure 3-2, should contain the pressure of the bentonite. The majority of the HDD length is in stiff London Clay. Locations of critical aspects are shown in Figure 3-1.

Figure 3-1 Locations of Landfall HDD infrastructure



Legend

- Order Limits
- Max extents of HDD drill and exit pit
- Intertidal zone
- TJB and entry pit
- Landfall compound

0 0.05 0.1 0.2 0.3 nm

0 75 150 300 450 m

N

Data source:
© Crown copyright and database rights 2024 Ordnance Survey 0100031673

Drawing Title

Landfall Area

Rev	Date	Remarks	Drwn	Chkd
00	15/07/2024	First issue	FC	DR

Drawing Number

NF-T-DES-0015-0002

Scale	Plot Size	Datum	Projection
1:5,000	A1	OSGB36	BNG

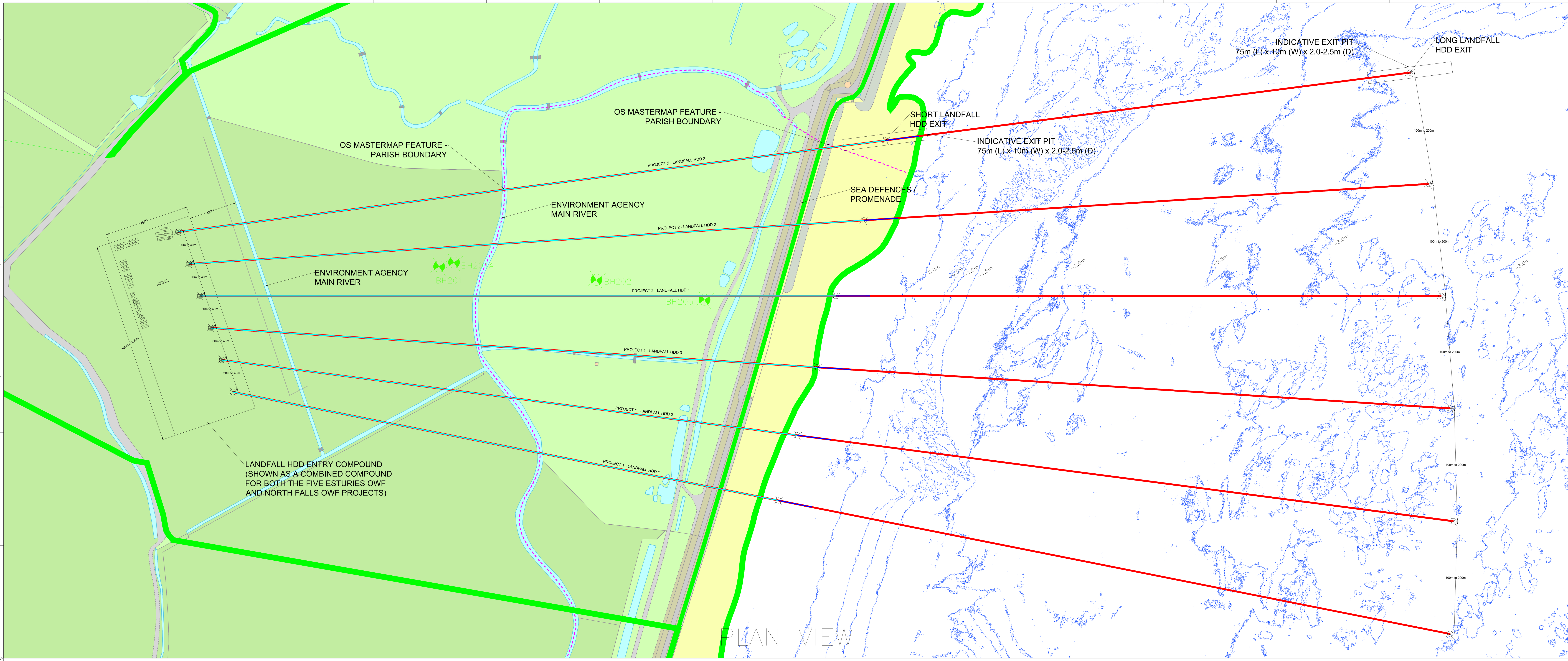
NORTH FALLS
Offshore Wind Farm

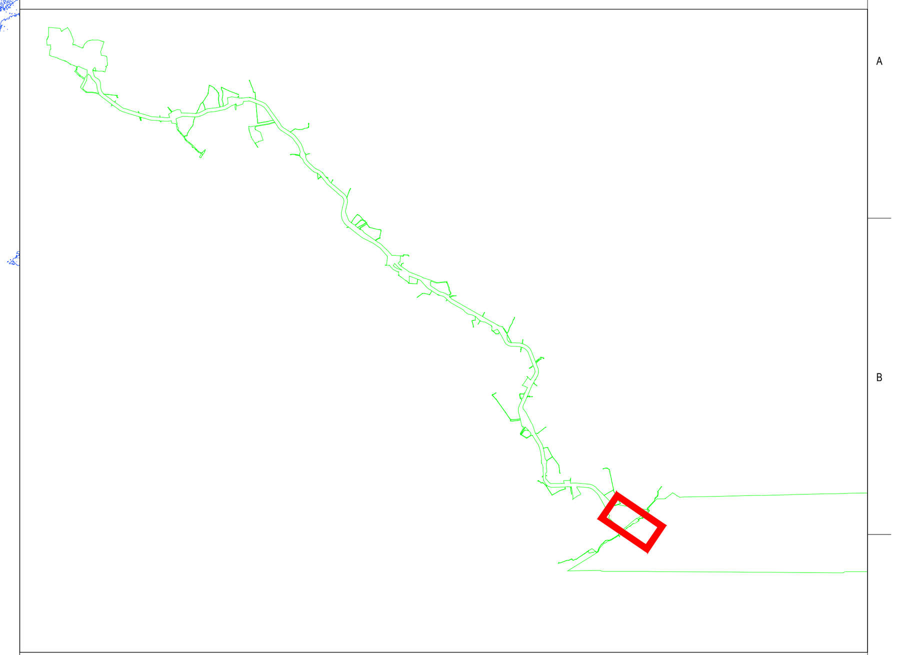
File ref: D:\NorthFalls\FormalDrawings\Terrestrial\T_Design\NF-T-DES-0015-WorkPlans\NF-T-DES-0015.aprx

51. HDD profiles have been developed by Five Estuaries for both projects, which has subsequently shared with North Falls, as shown in Figure 3-2. This design allows for either an intertidal or subtidal exit, as per Five Estuaries requirements. North Falls has committed to a subtidal HDD exit, and hence the intertidal exit will not be used for North Falls. In Figure 3-2 six HDD alignments are shown. This allows for the North Falls and Five Estuaries projects space for a spare drill each should it be required. North Falls would be expected to comprise the northern three HDD bores.

Figure 3-2 Landfall profiles

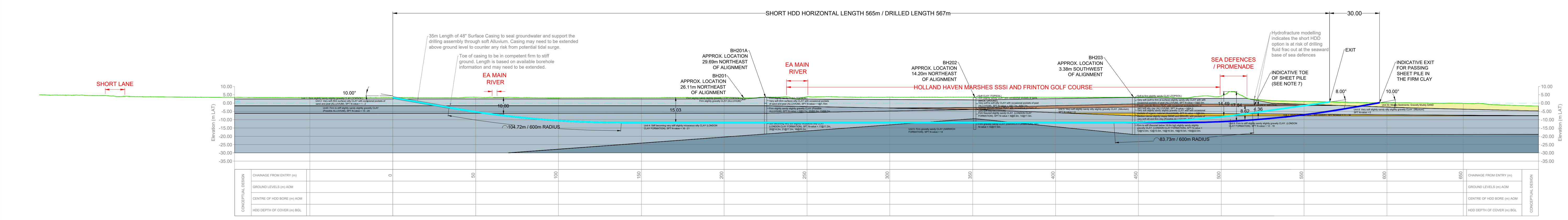
DO NOT SCALE FROM THIS DRAWING





LOCATION PLAN

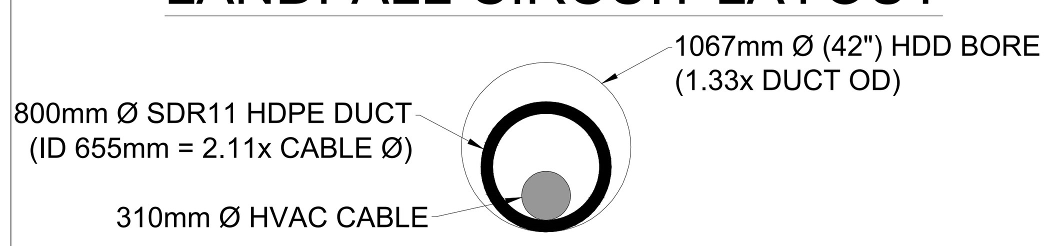
GENERAL NOTES:
1. ALL DIMENSIONS, LEVELS AND CHAINAGES ARE IN METRES UNLESS OTHERWISE STATED.
2. SURFACE TOPOGRAPHY GENERATED USING ONSHORE DTM and OFFSHORE MEANZ 0.25M TIF FILE BOTH PROVIDED BY FUGRO AND PROFILE TOOL ON QGIS. BOTH DATA SETS BASED ON LAT.
3. GEOLOGY IS BASED ON GROUND INVESTIGATION REPORT FOR FIVE ESTUARIES OFFSHORE WIND FARM BY SOCOTEC UK LIMITED (AUGUST 2022).
4. HDD DESIGNS ARE PROVIDED FOR INFORMATION ONLY. ANY FINAL DESIGN WILL REQUIRE FURTHER GROUND INVESTIGATIONS AND SURVEY INFORMATION.
5. BOREHOLE DETAILS NOT TO SCALE.
6. LAT TO ODN RELATIONSHIP AND MHWS AND MLWS LEVELS TO BE CONFIRMED AWAITING CONFIRMATION OF ACCURACY.
7. SHEET PILE LENGTH OF 10' TAKEN FROM ESSEX RIVER BOARD DRAWING 62/3636/7A. TOP OF SHEET PILE NOTED AT 3' BELOW ODN. LEVEL OF ODN ESTIMATED FROM AS BUILT LEVEL OF BOREHOLE BH3, ODN TO LAT RELATIONSHIP TO BE CONFIRMED.
8. EXIT PIT SIZES AND LOCATION ARE INDICATIVE, ACTUAL EXIT PIT SIZE AND EXCAVATION METHODOLOGY WILL BE CONFIRMED BY THE HDD CONTRACTOR.
9. HDD PROFILE PREPARED BY RIGGALL & ASSOCIATES ON BEHALF OF WARDELL ARMSTRONG.
10. SECTION VIEW BASED ON CENTRAL HDD ALIGNMENT.
11. GEOLOGICAL INTERPRETATION FOR INFORMATION ONLY.
12. DRAWING COORDINATE SYSTEM IS WGS84 UTM 31N. TRANSFORMATION APPLIED TO ONSHORE FEATURES USING 'OSGB 1936 to WGS 1984 (7)' METHOD.
13. CONCEPTUAL HDD ALIGNMENTS FOR BOTH THE FIVE ESTUARIES OWF AND NORTH FALLS OWF PROJECTS ARE SHOWN, WITH ALLOWANCE FOR UP TO 3 NO. HDDs EACH.

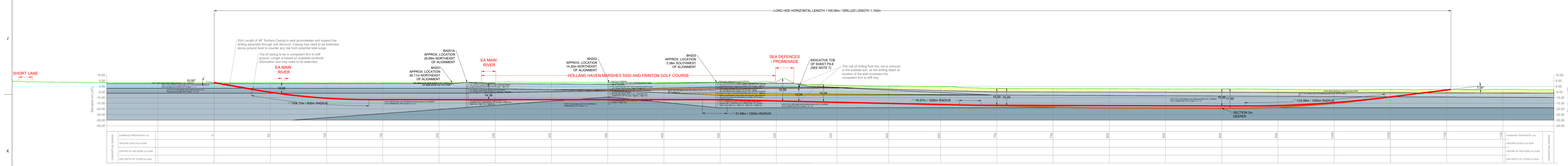


LEGEND

(green line)	ONSHORE / OFFSHORE CABLE CORRIDOR
(red line)	LONG HDD ALIGNMENTS
(cyan line)	SHORT HDD ALIGNMENT
(blue line)	CONTOURS - PLAN VIEW, EVERY 0.5m (LAT)
(green line)	GROUND PROFILE - SECTION VIEW
(cyan dashed line)	LEVEL OF LOWEST ASTRONOMICAL TIDE (LAT) - SECTION VIEW
6.00	DEPTH TO CENTRE OF HDD BORE

LANDFALL CIRCUIT LAYOUT





REV	DATE	REASON FOR ISSUE	BY	CHK	APP
04	13/02/2024	UPDATE OF COMPOUND DIMENSIONS AND DUCT DETAIL	ZF	NP	AH
03	31/01/2024	ORDER LIMITS BOUNDARY UPDATED, COMMENTS ADDED TO SECTION VIEWS	AM	PM/ NP	AH
02	18/08/2023	DESIGN ALTERATIONS, SIXTH HDD ADDED, GEOLOGICAL INTERPRETATION ADDED, SECTION VIEWS SEPARATED	LE	TR / NP	AH
01	31/08/2022	ISSUE AS DRAFT FOR COMMENT	PM	TR /NP	MGD

FIVE ESTUARIES OFFSHORE WIND FARM

wardell armstrong

PROJECT TITLE
FIVE ESTUARIES OFFSHORE WIND FARM

DRAWING TITLE
CONCEPTUAL HDD DESIGN FOR LANDFALL

DRAWING STATUS
DRAFT-FOR-COMMENT

SHEET SIZE	DESIGNED	DRAWN	CHECKED	APPROVED
A1	PM	PM	TR/NP	MGD
SHEET SCALE	DATE	DATE	DATE	DATE
NTS	31/08/2022	31/08/2022	31/08/2022	31/08/2022

WA DRAWING NUMBER		REVISION
ED13538-GE-1034		04
VE DOCUMENT NUMBER		REVISION
VE-WAR-V2-XX-M2-C-0030-D		04
RWE ECODOC NUMBER	SHEET No	REVISION
004506983-04	001 OF 001	04

52. 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 drill profile passes at a depth below seabed of up to 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.

3.1.3 Landfall Duct Stringing / Pull In

53. 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) – these would need to be welded together on land to enable them to be pushed through the bore.

54. Once the drilling operation has taken place, the ducts will be pushed or pulled through the drilled holes depending on whether the ducts are onshore or offshore respectively. 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 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.

55. 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.

56. 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.

57. 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.

58. 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.

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

3.1.4 Landfall Cable Pull In

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

61. A winch would be set up onshore to pull the cable through the duct. A Dead Man's Anchor would be set up alongside the winch to prevent too much movement of the winch if an incident occurs during cable pull in. The anchor would typically be sheet piles driven into the ground.

62. 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 an indicative total maximum seabed preparation area of 57,600m^2 and an indicative depth of 1m.

63. 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,
    - The cable and trench 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.

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

65. Temporary protection may be required during any breaks in construction, to ensure the works can be recovered.

66. Once cable installation is complete, if subtidal exit pits were created, these will be backfilled with sidecast material or left to naturally backfill. If no exit pit was created, the ducts and cables would need to be lowered.

3.1.5 Onshore Cable Route HDD Methodology

67. Generally, onshore cable route HDDs will follow a very similar methodology to those of the landfall. The key differences are the drills are shorter, meaning the

drills take a shorter period of time, and there will be access both ends of the HDD.

68. Access will be taken along the haul road, accessing from the public highway via a temporary construction compound.

69. A temporary drilling compound will be set up either side of the crossing, with the compound the drill is launched from known as the entry pit, and the receiving compound called the exit pit. The size of these compounds depends on the length of the drill. The entry pit compound could be as big as 75m x 150m for both North Falls and Five Estuaries for longer length drills, reducing in size as the length reduces. The exit pits compound will generally be 75m x 150m irrespective of length.

70. The process for the drill will be similar to the landfall drills, however, the presence of the exit pit allows for containment of fluid. Therefore, punchout can occur much sooner, rather than waiting for the hole to be large enough.

71. The number of drills will depend on detailed design. Due to the number of cables (there are 3 power cables per circuit onshore rather than 1 cable offshore), it is possible to either drill 1 large bore per circuit or 3 smaller bores. The time taken will depend on the size of the bores required, as larger bores will need to be reamed a more times compared to smaller bores.

72. Where possible, risk assessments for HDDs will be combined due to the similarities of the bores at different locations.

3.1.6 Differences with onshore cable ducts

73. The installation process of an onshore HDD is very similar to that of a landfall HDD, however the complexity is significantly reduced due to the shorter length, relatively easy access at each end of the drill and smaller bores. The major differences relate to the lack of a need for a marine spread, with cable drums provided by the cable delivery vehicles, and no need for any remedial burial.

74. The drilling process will be similar, with pilot holes drilled and reamed to a larger size as required by the design. Cables will then be pulled through using a winch, in a similar manner to the landfall drill.

3.2 Cable / Duct Details

3.2.1 Landfall

75. For consent purposes an outer cable diameter of up to 310mm for the three-core offshore cable is conservatively assumed. This requires one drill per circuit.

76. 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, a duct/bore ratio of 1.30 is expected, with a bore diameter of 1219mm.

3.2.2 Onshore

77. For consent purposes an outer cable diameter of up to 200mm for the single core onshore cable is conservatively assumed. This means there is the optionality for one larger drill per circuit, or 3 smaller drills per circuit. The exact design will depend on detailed design from the contractor.

78. Similar to the landfall, the internal diameter and wall thickness will depend on the diameter of the cable pulling head and the thermal dissipation when it is operational. For the maximum cable considered, a duct bore ration of

3.3 Drilling Fluid / Flush Volumes

3.3.1 Landfall volumes

79. Due to the nature of a punch out, some drilling fluid will be lost to sea. This is due to the sudden release of pressure in the bore caused by the punching out of the drill head.

80. The maximum design envelope for drilling mud which could be released to the sea in the event of a breakout is presented in Table 3-1. This includes both the loss due to punchout and the passive release.

Table 3-1 Parameters for 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 (m3)	677
Realistic case drill cuttings based on forward ream (from the beach to offshore) per bore (m3)	50
Worst case drilling mud volume based on back ream (from offshore towards the beach) per bore (m3)	4940
Worst case drill cuttings volume based on back ream (from offshore towards the beach) per bore (m3)	900
Worst case total volume of drilling mud which could be released for all 3 bores (m3)	14,820
Worst case total volume of drill cuttings which could be released for all 3 bores (m3)	2,700
Maximum drilling mud volume to be released per tidal cycle (m3)	500

3.3.2 Onshore volumes

81. For onshore HDD drills, the volume of mud required is significantly less. This is because the bores are smaller (as the cables are smaller), and the lengths are significantly shorter, typically up to 250-300m onshore compared to a drill of 1100m for the landfall drill.

82. Furthermore, the exit pit allows for the collection of any mud released during punchout, resulting in a negligible loss of mud to the environment.

83. The exact volumes of mud used for the onshore drills will vary between drills due to the differences in length. They will need to be calculated once the detailed design of the drills has been carried out.

3.4 HDD Water Supply

84. 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.

3.5 Equipment Details

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

    - Drilling Rig
    - Drill Cabin
    - Pipe Rack with 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

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

3.6 Marine Spread Requirements (Offshore)

87. 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.

88. 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.

89. 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

3.7 Key Materials

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

- Ducts (typically HDPE)
- Drilling fluid as described in section 2.2
- Temporary protection for ducts/exit pit stabilisation

3.8 Co-Ordination With Five Estuaries

91. Coordination with Five Estuaries has identified that both projects can use the same landfall location and the projects have an aligned onshore cable route running inland from this. This approach is expected to allow minimisation of

impacts. The landfall compound identified has sufficient space to accommodate both projects, and if the HDD drilling works were undertaken at the same time adjacent compounds could be established,

92. A Coordination Report (Doc ref: 2.5) has been developed detailed how North Falls has co-ordinated with other projects. The report sets out three delivery scenarios ('Scenarios 1 – 3') and details how these are secured through the Development Consent Order.

93. For Scenario 1, the expected coordinated construction methodology would consist of:

- One civil contractor installing haul road(s) to landfall to allow landfall construction traffic to access their construction zones, and potentially undertaking enabling type works for the landfall compounds.
- Likely to be separate project specific HDD contractors (which may be the Offshore Cable Contractor) undertaking the landfall HDDs and constructing transition joint bays.

94. 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.

95. The common haul road allows a reduction of a number of construction impacts to the local community.

96. For Scenario 2 co-ordination would include, if the programmes allow, for the haul road to be re-used. The first project would install the haul road prior to its activities, and the second project would remove it after the completion of theirs. If the programmes are sufficiently separate such that leaving the haul roads in place causes an impact on the landowners, this scenario would become akin to Scenario 3, which is the standalone delivery scenario.

4 Risks And Control Measures

4.1 Key Risks

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

98. The most likely risk is a failure of containment resulting in a release of bentonite. The impacts of such a risk are outlined in ES Chapter 23 Onshore Ecology (Document Reference: 3.1.25, [**APP-037**]).

99. The following risks with the potential to impact other stakeholders have been identified in Table 4-1.

Table 4-1 High level risk assessment

Risk	Potential Impacts	Risk Before Mitigation	Control Measures / Mitigations	Risk After Mitigation
Failure of HDD technique	Damage, work delays, economic impact on the project	Medium	Geotechnical investigation carried to confirm the expected ground conditions, with further geotechnical investigations to be undertaken in nearshore region. 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 selecting contractors with good internal processes to prevent/minimise any issues. Appropriate construction monitoring including use of specialist advisors in both the current planning phase and future construction phases.	Low

Risk	Potential Impacts	Risk Before Mitigation	Control Measures / Mitigations	Risk After Mitigation
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	Medium	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 selecting contractors with good internal processes to prevent issues. Appropriate risk and emergency management procedures.	Low
HDD entry compound susceptible to surface water and ground water flooding	Flooding of HDD compound resulting in damage, work delays and having economic impact	High	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	Low

Risk	Potential Impacts	Risk Before Mitigation	Control Measures / Mitigations	Risk After Mitigation
			groundwater bearing strata to serve as protection from groundwater flooding. Robust contractor selection process selecting contractors with good internal processes to prevent issues. Further details are set out in the OCoCP (Document Reference: 7.13). Appropriate risk and emergency management procedures.	
Breakout of drilling fluid to the surface during pilot drilling	Potential impacts to local environment (e.g. SSSI, watercourses – see Section 4.2.2 below), delay to programme, economic impact	Medium	See section 4.2.	Medium (offshore end) Low (onshore end)
Risk of affecting structural integrity of sea defences	Subsidence / settlement of seawall leading to structural integrity issues Potential increased flooding risks to local areas	Medium	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. 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,	Low

Risk	Potential Impacts	Risk Before Mitigation	Control Measures / Mitigations	Risk After Mitigation
			fluid returns and volumes) etc to be applied in line with breakout prevention when drilling below the seawall.	

4.2 Risk of Bentonite Breakout, Mitigation and Clean-up (Contingency Plan)

4.2.1 Risk of a breakout

100. Based on previous experience, breakout will most likely occur when the drill profile is in close proximity to the surface, generally in the first 30m or so, until it reaches optimum drill depth within the ground strata. Bentonite breakout also occurs where the strata the drill is passing through has a high permeability (e.g. peat) or voids (e.g. chalk).

4.2.2 Sensitive receptors

101. In the event of a breakout, key consideration is given to the following sensitive environmental receptors:

Holland Haven Marshes SSSI

102. The SSSI is designated for the following aquatic features:

- Its ditch network which, the citation states, represents an outstanding example of a freshwater to brackish water transition intimated by the aquatic plant communities, and which include a number of nationally and locally scarce species; and
- Aquatic and terrestrial invertebrates associated with these habitats.

103. These features are potentially sensitive to releases of bentonite into the watercourse in the event of a breakout. A detailed impact assessment of the effect of breakout upon these features is provided in ES Chapter 23 Onshore Ecology (Document Reference: 3.1.25, [**APP-037**]).

Watercourses

104. Main rivers and ordinary watercourses located along the onshore cable route, their water quality and the aquatic ecology they support are sensitive to releases of bentonite into the watercourse in the event of a breakout. A detailed impact assessment of the effect of breakout upon these features is provided in ES Chapter 21 Water Resources and Flood Risk (Document Reference: 3.1.23, [**APP-035**]).

4.2.3 Mitigation

105. To mitigate the risk of bentonite breakouts, work has been carried out up front to minimise the risk of breakouts occurring. For the landfall, a proposed (conceptual) HDD alignment been developed, and overlain on results from ground investigations carried out by Five Estuaries at the landfall location. This has been used to understand the ground conditions for the proposed drills. This will be updated during detailed design post-consent.

106. For longer and more complex HDDs, such as the landfall and crossing main watercourses etc, hydrofracture modelling will be undertaken by a specialist HDD contractor for the proposed HDD alignment options. Initial modelling has been carried out for the landfall, and it 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. Calculations for other onshore HDDs will be carried out during detailed design.

107. For shorter and less complex onshore HDDs, typical designs and risk assessments will take place. This will then be applied to each specific HDD as needed.

108. To ensure that any release is minimised, a competent contractor will be selected through a thorough selection process. Mitigation techniques to understand when a bentonite release is occurring so that the minimum amount of fluid is released, will be included within the requirements. These could include:

- Proper drilling procedure including removal of cuttings to minimise drill pressure to minimise the amount of bentonite required.
- Constant monitoring of mud levels in the tanks to identify falling fluid levels greater than expected.
- Constant monitoring of downhole pressure and any sudden loss of pressure treated as a hydrofracture.
- Regular walkovers of the drill to see if there are any visible leaks of drill fluid.

109. The final HDD Method Statement and Contingency Plan will include the number of walkovers, proposed route(s) taken and the number of operatives involved.

110. Any alternative measures proposed by the contractor will need to provide equal or better mitigation to minimise a release.

111. 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.

112. 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.

113. No works vehicles will access the SSSI, including in the event of breakout unless discussed and agreed with Natural England in advance.

4.2.4 Site Reporting

114. If a large bentonite breakout, or a breakout in a potentially sensitive area occurs, drilling operations will be stopped and the NFOW 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:

  - Reports of the drilling activities will be kept by the contractor. Any potential breakouts shall be contained within these reports.

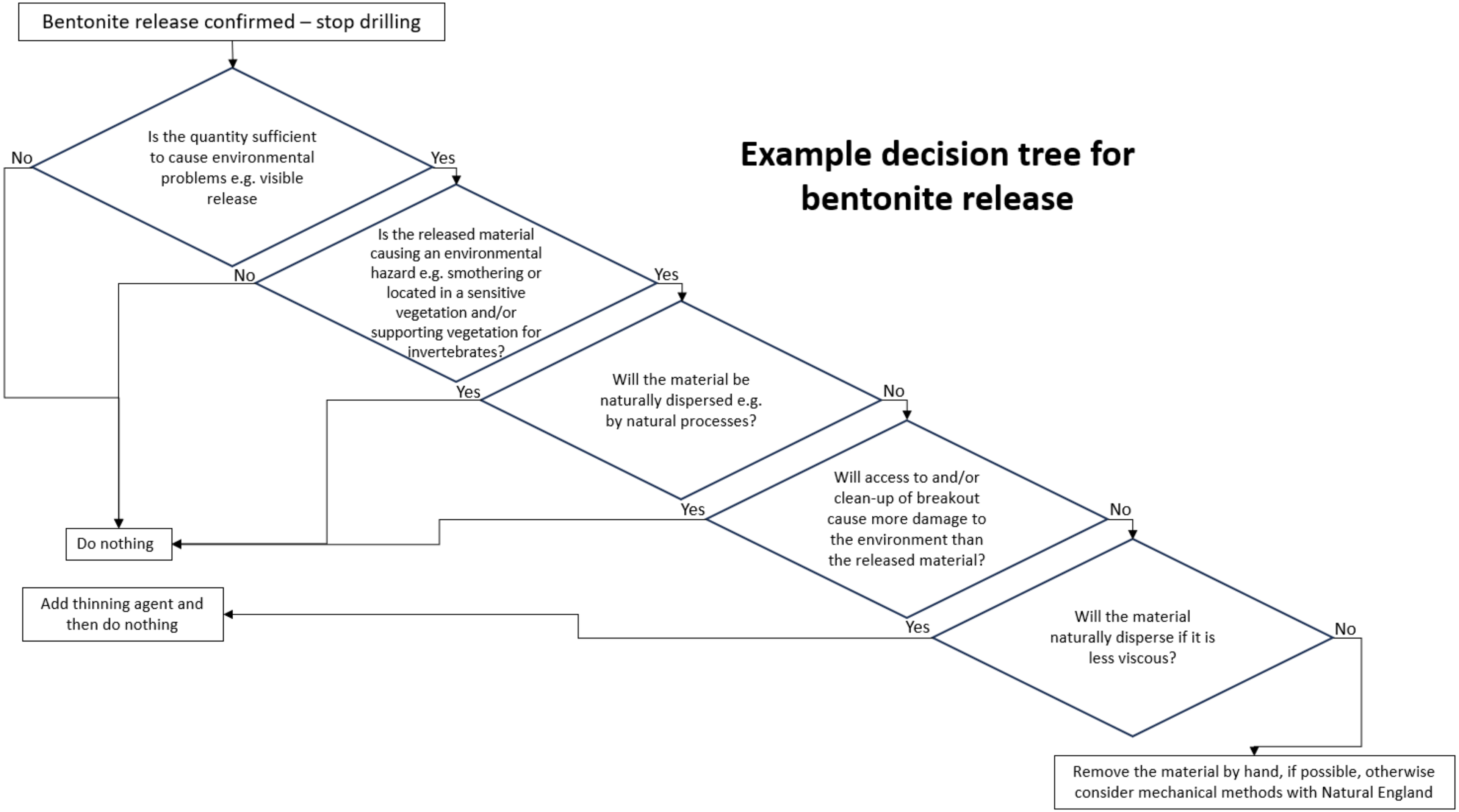
4.2.5 Clean-up

115. The drilling contractor shall develop and produce a detailed HDD Method Statement and Contingency Plan, which will be based on the plan outlined in this document, and which is secured by DCO Requirement. Depending on complexity, a specific drill plan may be generated for the more complex drills, but for shorter less complex drills a generic plan will be applied to a crossing. The contingency plan is based on good practice and will generally follow the below methodology.

116. Any breakouts will be investigated to determine if clean-up is required, and where considered necessary, ensure the most appropriate method of clean-up is selected. This will be based upon the location of the breakout and the quantity of material released. 'Manual clean-up' refers to clean-up by hand, where an individual operative or operatives use handheld tools (e.g. a ~~space~~ spade and wheelbarrow or bucket) to remove the material.

117. In some cases, it may be more harmful to clean up a small release than it would be to leave it in situ. This is particularly true where mechanical equipment is needed as the movement of the machinery could cause more damage to the environment than the bentonite itself. A decision tree shown in Figure 4-1 shows the indicative process to assess whether removal of the released material is the best option. This is in discussion with Natural England for further updates.

Figure 4-1 Indicative decision tree for Bentonite clean up



4.2.5.1 *Bentonite Breakout Materials*

118. Where bentonite is released in sensitive areas, materials shall be readily available on site to clear up the release. The drilling contractor onsite will typically have available the below:

- Silt fencing
- Mobile suction pump, or similar
- Sedimats or similar
- Teram or similar
- Straw bales or similar
- Timber stakes or similar
- Sand bags or similar
- Small tools for erecting temporary bunds

119. It is recognised that the containment options are likely to have an impact in their own right, therefore, the Project's Environmental Clerk of Works (EnvCoW) will give careful consideration to the potential negative impacts, including sediment compaction, extension of impact, damage to vegetation and site interest features, before deploying them, and adopt further mitigation measures to lessen the impacts where possible, e.g. minimising the time in-situ.

120. Some of the above may be erected prior to drilling to pre-emptively mitigate any releases from entry pits, particularly where interaction with environmentally designated areas may occur. For example, bunding and/or silt fencing may be erected around the entry pit to prevent release entering SSSI areas at the landfall, if the relief of the land means a flow path could exist. The exact requirements will be developed during detailed design, where the final location of the entry pit is selected. Entry pits, and where appropriate exit pits, will be located >30m away from Holland Haven Marshes SSSI.

4.2.5.2 *Sequence*

121. In the event of a rare failure in the trenchless construction method being employed, public access may need to be restricted to enable the Applicant to implement mitigation; however, any restriction would be limited to the area affected and would removed as soon as practicable

122. A typical clean up sequence for smaller breakouts is:

    - Once the breakout location has been identified the priority is personal safety and then containment.
    - The drilling activity will be immediately stopped to stop further fluids migrating to surface (immediate).
    - Locate the breakout (typically 15 minutes to half an hour).

- Assess the release and understand the impacts caused and the wider situation (e.g. tides) to understand whether intervention to clean up is needed.
- If manual/mechanical intervention is not required, leave the bentonite to disperse naturally (or use thinner if needed).
- Contain the spill by using materials to prevent it flowing further from the location of the breakout (typically half an hour – dependent on the size of the leak). Options to contain the spill will be detailed in the final HDD Method Statement and Contingency Plan and will be site specific to ensure that no detrimental compaction and/or vegetation trampling occurs, which may affect the recovery of sensitive environmental receptors.
- If manual/mechanical intervention is required, cover the fluid in a thickening compound to make it more viscous so it can be removed (typically 15 minutes). Once the bentonite has been thickened, all thickened bentonite and any thickening compound will be removed. The use of manual/mechanical methods, if required, will be discussed and agreed in advance with Natural England.
- All of the drilling fluid at surface level can and will be removed back to the drilling compound (typically an hour), including any thickening compound.

123. Smaller breakouts can be cleaned up in a couple of hours.

124. In the event that a larger spill occurs, a typical clean up sequence is as follows:

- The drilling activity will be immediately stopped to stop further fluids migrating to surface (immediate).
- Locate the break out (typically 15 minutes to half an hour)
- Containment is by the use of silt fencing and straw bales (typically 30 minutes to an hour, depending on volumes)
- Due to larger volumes, a mechanical method e.g. suction pump would be needed to remove the quantities of mud (can take a number of hours – dependent on volume).
- Remaining deposits would be cleaned and removed from site by hand (typically an hour).

125. Clean up of larger volumes can generally take a day to carry out. This may require large machinery and access to the sites will be required.

126. 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.

127. 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

128. 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, Natural England Site Officer, MMO etc), and this information will be disseminated to the site teams.
129. 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.

4.4 Summary of requirements on contractor

130. In the event of a release, drilling will stop immediately and the appropriate response measures taken.
131. In line with section 4.2.3, the contractor will be expected to put in place mitigation to ensure the works can be undertaken minimising the potential impact on the environment. These measures could include the following, or alternatives which will provide an equal or better mitigation to minimise a release:
    - Ensure proper procedures and process in place
    - Monitor the mud tank levels to ensure they are not falling too quickly
    - Monitor bentonite pressures during the drill
    - Regular walkovers of the drill to see if there are any visible leaks of drill fluid, particularly across the SSSI.

HARNESSING THE POWER OF NORTH SEA WIND

North Falls Offshore Wind Farm Limited

A joint venture company owned equally by SSE Renewables and RWE.

To contact please email contact@northfallsoffshore.com