

Inch Cape Offshore Wind Farm

New Energy for Scotland

Offshore Environmental Statement:

VOLUME 2A

**Appendix 6A: Export Cable Feasibility
Study**



Report

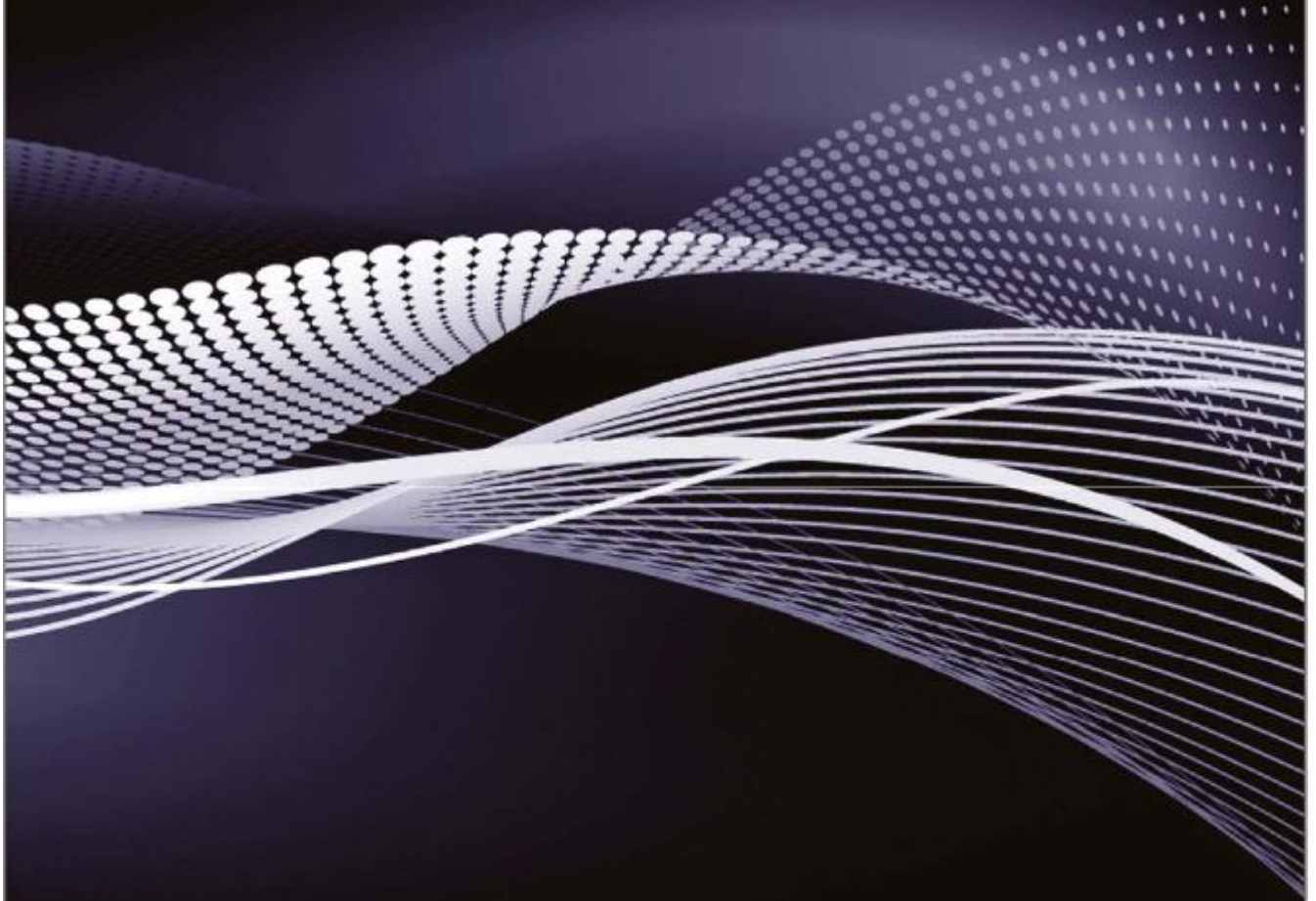
Experience that Delivers



Prepared for: Inch Cape Offshore Limited

Appendix 6A: Export Cable Feasibility Study

April 2012





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INTRODUCTION

6A.1.1 Objectives

The objective of this desktop route selection study is to develop, evaluate, compare, and rank cable route options from the offshore substation to the planned onshore connection point at Cockenzie, taking into consideration all aspects of routing issues including seabed/ground conditions, engineering constraints, third party interactions, environmental and physical constraints, and restricted/prohibited zones. Additional ranking criteria for the routes comprise socio-economic considerations, risk, and through-life cost (costs have been removed from this report as confidential).

This report is comprised of the following:

- Establishment of data requirements
- Generation of a comprehensive GIS geo-database and associated constraint maps;
- Study of the bathymetry and slopes;
- Proposal and appraisal of potential landfalls;
- Incorporation of results from the HAZID Workshop;
- Incorporation of results from the Design Review.
- Development of cable routes options through a comprehensive desktop route selection process;
- Development of through-life cost estimates; and
- Comparison and ranking of route options in terms of complexity, risks and costs.

6A.1.2 Definitions and Abbreviations

For the purposes of this document, the following definitions, abbreviations and acronyms have been used:

BGS	British Geological Survey
CLV	Cable Lay Vessel
CPT	Cone Penetration Testing
FPSO	Floating Production Storage and Offloading
HDD	Horizontal Directional Drilling
ICOL	Inch Cape Offshore Limited
KP	Kilometre Post
MBL	Minimum Breaking Load
MOD	Ministry Of Defence
MPSV	Multi-Purpose Supply Vessel
NNR	National Nature Reserve

OSP	Offshore Substation Platform
ROV	Remotely Operated Vehicle
RYA	Royal Yachting Association
SAC	Special Areas of Conservation
SPA	Special Protection Areas
SSSI	Site of Special Scientific Interest
UKHO	United Kingdom Hydrographic Office
UTM	Universal Transverse Mercator
WGS	World Geodetic System
WTG	Wind Turbine Generator

Summary

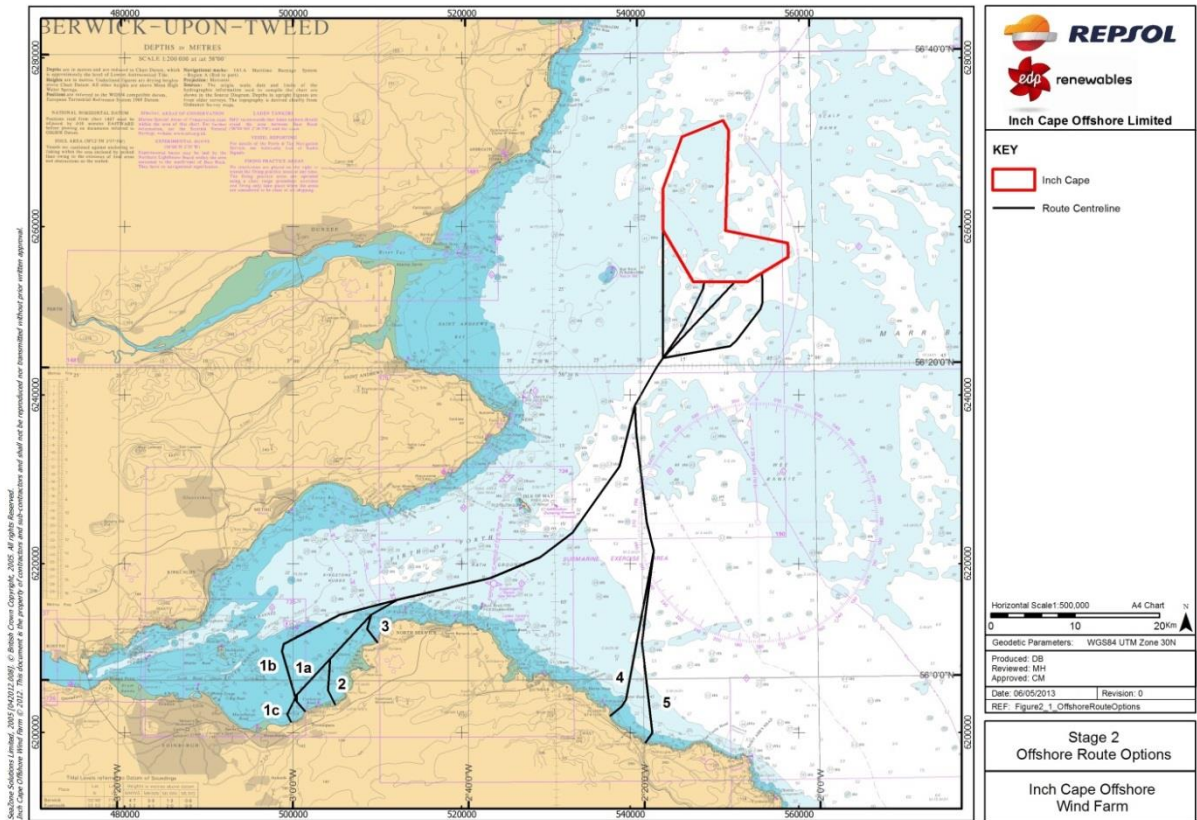
6A.1.3 Routes Summary

As a result of the desktop routing process, seven routes to shore have been considered and all are considered feasible. Two routes (1a Cockenzie & 2 Seton Sands) offer the most attractive routes when considering all relevant criteria including cost and distance from landfall to the onshore grid connection point and environmental factors. The availability of onshore land/wayleaves has not been considered in this report. All of the routes considered are shown in Figure 6A.1 and their lengths are summarised in Table 6A.1.

Table 6A.1 Approximate Route Lengths

	1a	1b	1c	2	3	4	5
	Cockenzie	Cockenzie	Prestonpans	Seton Sands	Gullane	Thornton loch	Pease Bay
Offshore Route Length	75.5km	79.8km	81.1km	72.9km	64.0km	55.0km	57.6km
Straight Line Onshore Length – Landfall to Connection Point	0.6km	0.6km	2.6km	3.1km	11.5km	35.6km	39.9km

Figure 6A.1 Offshore Route Options



Since the location of the offshore substation platforms are not yet known, a number of potential route deviations are shown that meet the Development Area boundary at other points. All of these route deviations are feasible and may be required individually or in combination depending on final offshore substation locations and the number of export cables.

6A.1.4 Routing Process Summary and Conclusions

A geophysical database and associated constraint maps were generated to inform the desktop route selection process.

From eight initial offshore route options considered during screening, six offshore route options were developed on the basis of six landfall locations which were chosen after a comprehensive landfall review. Further to the review of those four routes, two routes were retained (1a & 2), with their respective landfalls located in Cockenzie and Seaton Sands.

The offshore starting point of all routes was assumed to be located on the boundary of the Inch Cape development area, to the south of its centroid. The ultimate end point of the routes was set at Cockenzie Sub Station to connect to the national grid although onshore routes are not considered in detail in this review.

The proposed offshore routes respect all routing constraints and the respective centrelines of these routes are within a 1km-wide corridor (based on a maximum of 6 export cables) containing no obstructions.

Data Sources

6A.1.5 General

The principal source of information used for this concept routing study is the chart data listed in *Section 6A.1.6* below. All data were compiled into a GIS database used for the initial screening process and for the detailed route selection process.

The information gathered during landfall site visits is included in this report.

6A.1.6 Data Source List

The following datasets provided by ICOL have been used in this concept routing study:

- SeaZone data;
- Gridded bathymetry data;
- Chartered basemap;
- BGS data – seabed sediments;
- Physical and third party data (wrecks, oil & gas infrastructures, cables and pipes, geology, tides and currents);
- Environmental data (e.g. protected areas, fauna & flora, navigation, yachting);
- Onshore environmental data provided by ICOL;
- Technical data provided by ICOL (site boundary, other wind farm boundaries).
- Additionally, the following data sources were used:
 - Google aerial imagery;
 - Bing aerial imagery;
 - Site visit of preferred landfall locations.

6A.1.7 Grid and Coordinate System

The internal project GIS database was developed in the Universal Transverse Mercator coordinate system, within zone 30N. The datum system used is WGS 84. Coordinates are given in Eastings and Northings in metres.

6A.1.8 Kilometre Point Definition

Positions along the cable are identified by their Kilometre Point (KP) which is defined as the length of cable measured from the southern boundary of the Development Area towards shore.

6A.1.9 Key Locations

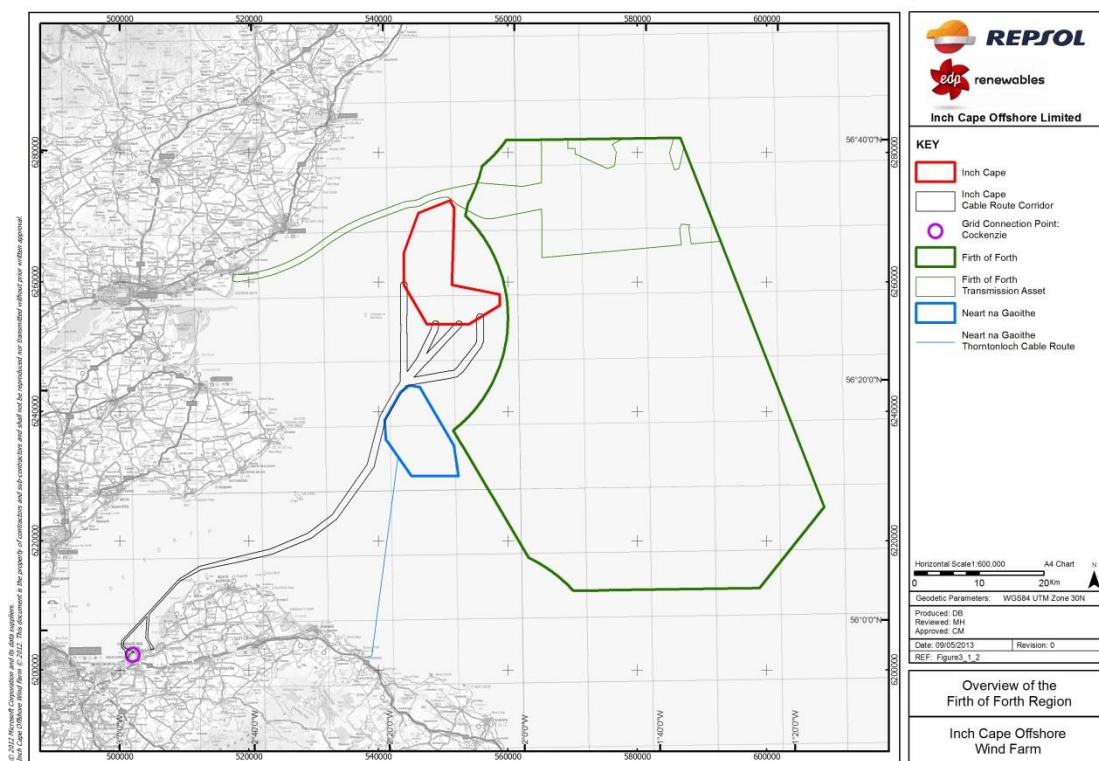
An overview of the Firth of Forth area is shown in Figure 6A2. The location of the principal wind farm offshore substation where the export cables start has not been finalised at this stage, hence the proposed export cable routes start on the southern boundary of the Development Area. It should be noted that the relocation of this starting point to adapt to the final location of the substation would not have a significant impact on the conclusions of this study.

The coordinates of the export cable endpoints are listed in Table 6A.2.

Table 6A.2 Export Cable Endpoints Location

Location	Easting [m]	Northing [m]
Export cable start point (on the Inch Cape wind farm boundary)	548797	6253427
Cockenzie Substation	501781	6202505

Figure 6A.2 Overview of the Firth of Forth Area



The onshore connection point is at Cockenzie substation as shown in Figure 6A.3.

Figure 6A.3 Connection Point at the Cockenzie



6A.1.10 Electrical Infrastructure

The electrical infrastructure of the wind farm is yet to be finalised. However, for the purpose of this study, it has been assumed that a maximum of six export cables would be required.

Offshore Routing Considerations

6A.1.11 Methodology

At a high level, offshore cable routing is a minimisation exercise to find the shortest route from the offshore substation to the landfall site under constraints dictated by engineering, physical and environmental limitations, and third parties. All constraints are associated with a “weight” and are input into the GIS database. A global weighted constraints map is then created for a multi-criteria evaluation to find the optimum route outside of the no-go areas. Multi-criteria evaluation is a process comprising automated tools as well as appraisal by engineers with specialist expertise in different fields (e.g. power cables, cable laying, ploughing, landfall installation). This high level approach was adopted to identify a cable corridor that could then be confirmed by surveyed since it is not practical to survey very large areas of seabed.

The constraints effectively define the envelope which will guarantee the long term integrity of the cable as well as its safe installation. The main sets of constraints which have been used in this study are presented in the following sections. Other parameters taken into account by the multi-criteria evaluation are as follows:

- Cable stability;
- Cable protection;
- Cable separation requirements;
- Ability to utilise existing cable lay construction methods;
- Minimisation of seabed pre-lay intervention requirements;
- Minimisation of seabed and cable post-lay intervention requirements;
- Minimisation of the number of cable and pipeline crossings;
- Minimisation of the environmental impact;
- Minimisation of interference of all types.

A comparison matrix showing all the route options can be found in Annex 1.

It should be noted that the chosen routes described in Section 6A.5 are shown on the figures of this section to illustrate the application of routing methodology in respect of the constraints.

6A.1.12 Route Length

The offshore route length minimisation exercise described above is bound by the route end points, namely the location of the offshore substation and the landfall. When comparing routes to different landfalls, the overall route length from the offshore substation to the onshore connection point has been taken into account. In some situations it can be preferable to increase the offshore route length to decrease the onshore route length, depending on onshore routing constraints which can be complex regarding land/right of way negotiations.

6A.1.13 Engineering Constraints

6A.1.13.1 Bathymetry and Slopes

Figure 6A.4 shows the bathymetry in the area of interest for cable installation sourced from the United Kingdom Hydrographic Office (UKHO). Its mesh size is adequate for this study, but a detailed survey of the final corridor will be required for detailed routing. The maximum local slope over the whole area has been derived from the UKHO data and is shown in Figure 6A.5. The Inch Cape Wind Farm site boundary defines a region characterised by very gentle slopes generally below 1 degree.

Away from the coast, outside of the firth, the seabed in the area of interest for cable installation features gentle relief at water depths varying generally between 50 and 60m. Such water depth is not considered to be a problem for the installation of large power cables of typical design for such application. Supposing that HVAC cables are installed, each carrying 225MW at 220kV, the cable weight in water is likely to be in the vicinity of 85 kg per metre. At 60 m water depth, the maximum tension in the cable due to its own weight during installation is estimated at approximately 6.2 tonnes which is comfortably

below the typical maximum allowable tension of such cable. This will have to be confirmed once the electrical infrastructure and the cable type have been finalised. The transmission properties of the cables are unlikely to be affected by pressure at such depth.

Despite the variation in water depth, the slopes are generally gentle at less 1 degree and rarely exceed 3 degrees, which will not restrict the use of any typical equipment for offshore cable installation, including ploughs in particular.

Close to the coast, the nearshore approach is characterised by very gentle slopes, and water depths below 10 m extending to more than 1 km from the coast. Floating the cable ashore over such distance is possible in suitable weather conditions. However, in more adverse weather conditions, a shallow draft Cable Lay Vessel (CLV) may be required to come closer to the coast to reduce cable stress.

Generally speaking, it is preferable for routes to traverse areas with a smooth seabed and benign gradients. In locally steeper slopes, cable laying should be conducted at 90° to the direction of the greatest slope to avoid asymmetrical loads on the plough which would destabilise it. The maximum slope angle in which a cable can be safely ploughed is typically in the vicinity of 10 degrees depending on the plough and the experience of the cable installer. At high angles, cable plough operations become unstable: the plough tends to come out of the ground or bury itself in, or can topple over. Slope reversals can cause the tension at the back of the plough to unbury the cable in the downward slope as the plough is going uphill. Moreover, the sediment in high slopes is more likely to move and possibly lead to the cable becoming unstable or becoming exposed. On the basis of the available bathymetric data, the cable is not expected to encounter such steep slopes. However, it should be noted that the relatively low resolution of the bathymetric data used smoothes contours; hence higher slopes are expected to be found locally along the cable routes. A detailed seabed survey of the corridors is needed to confirm this.

Figure 6A.4 Bathymetry in the Firth of Forth

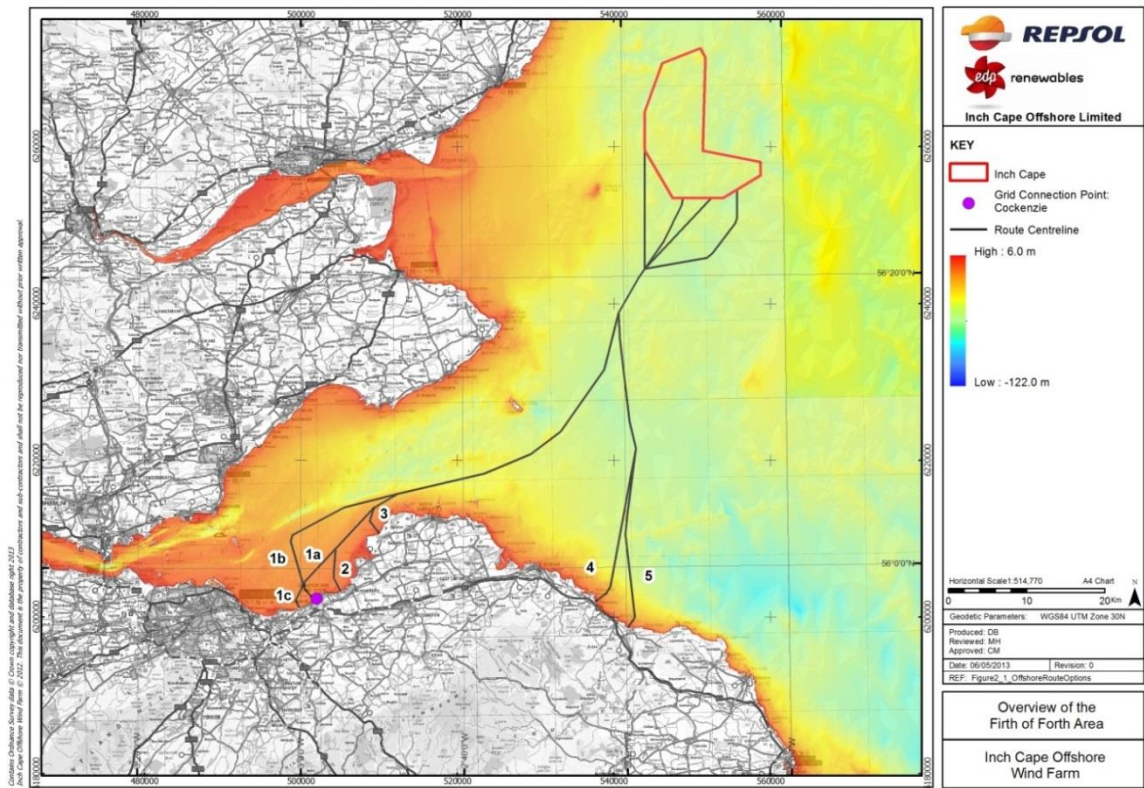
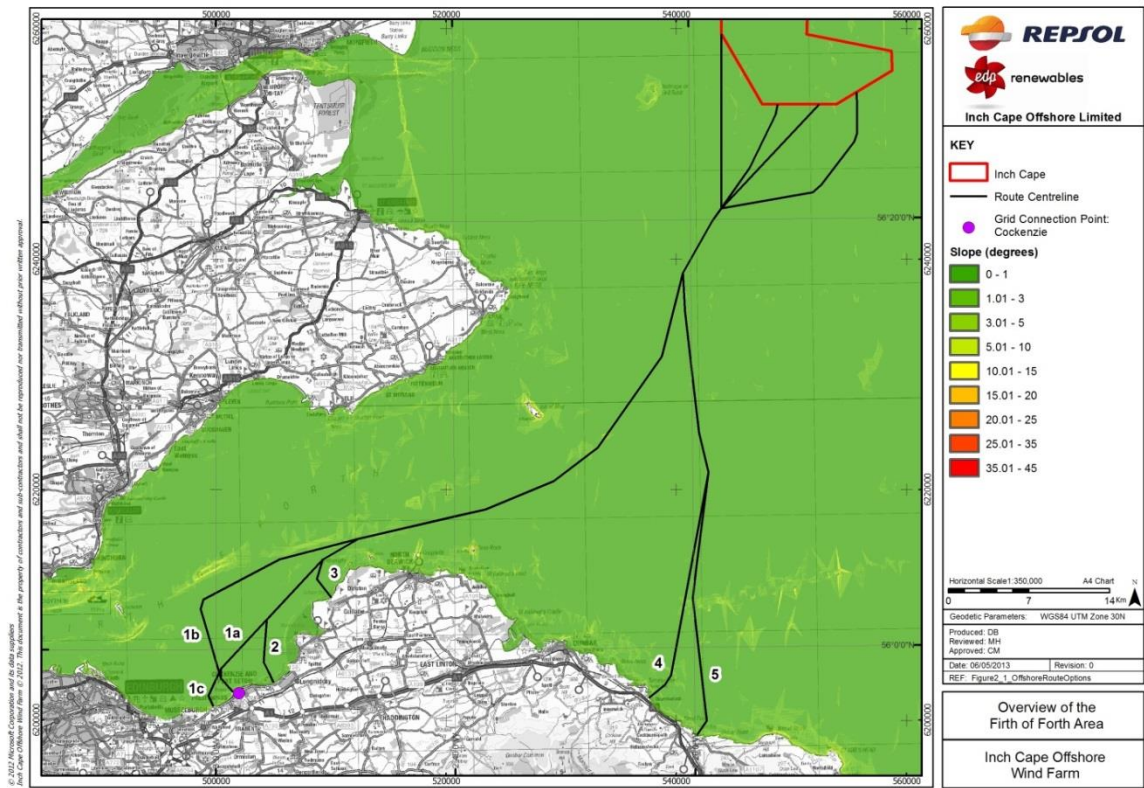


Figure 6A.5 Seabed Slopes in the Firth of Forth (Degrees from Horizontal)



6A.1.13.2 Geology

For stability and protection purposes, it is envisaged that the cable will be buried where possible. The required burial depth will be defined at a later phase in the project, but a depth circa two metres is likely to be recommended for protection. The top layer of seabed sediments is therefore critical to the design and installation of the cables.

The type and shear strength of the top soil will determine the suitability of different burial techniques, and in particular ploughing which is the preferred burial method for such application. The type and strength of the soil also affects the stability of the cable in slopes. Areas with mobile sediments (e.g. sand waves) are avoided to mitigate the risk on cable stability and unburial over time. In shallow waters, the potential for soil liquefaction should also be examined when more information on sediments is available.

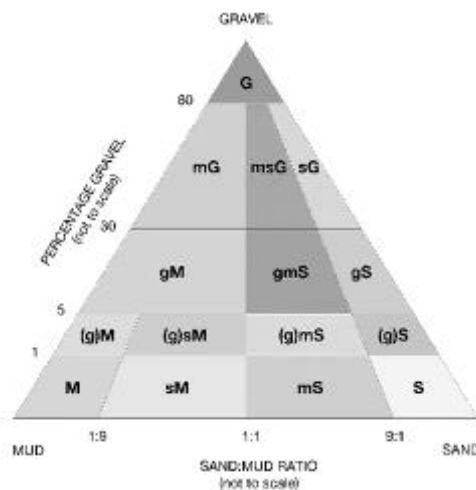
Determination of the shear strength of the soil will require surveying using intrusive techniques such as Cone Penetration Testing (CPT) or coring. The topsoil sediment type is estimated from BGS charts but its depth is unknown. Again, surveying will be necessary to determine this depth, either through intrusive techniques (e.g. CPT), with a sub-bottom profiler (sparker / boomer), or a combination of the two. Areas which are not suitable for ploughing may require extra cable protection such as rock placement.

Table 6A.3 shows the seabed sediment types found in the Firth of Forth using the project classification system, together with the modified Folk equivalent classification used by BGS illustrated in Figure 6A.6.

Table 6A.3 Classification of Seabed Materials

Classification in supplied GIS data	Description	Folk classification (Ref. 1)
MUD	Mud	M
SDMD	Sandy mud	sM
-	Slightly gravelly mud	(g)M
-	Slightly gravelly sandy mud	(g)sM
GVMD	Gravelly mud	gM
SND	Sand	S
MUSD	Muddy sand	mS
SGSA	Slightly gravelly sand	(g)S
SGMS	Slightly gravelly muddy sand	(g)mS
GMSD	Gravelly muddy sand	gmS
GVSD	Gravelly sand	gS
GV	Gravel	G
MDGV	Muddy gravel	mG
MSGR	Muddy sandy gravel	msG
SDGV	Sandy gravel	sG
ROCK	Undifferentiated bedrock lithology	-

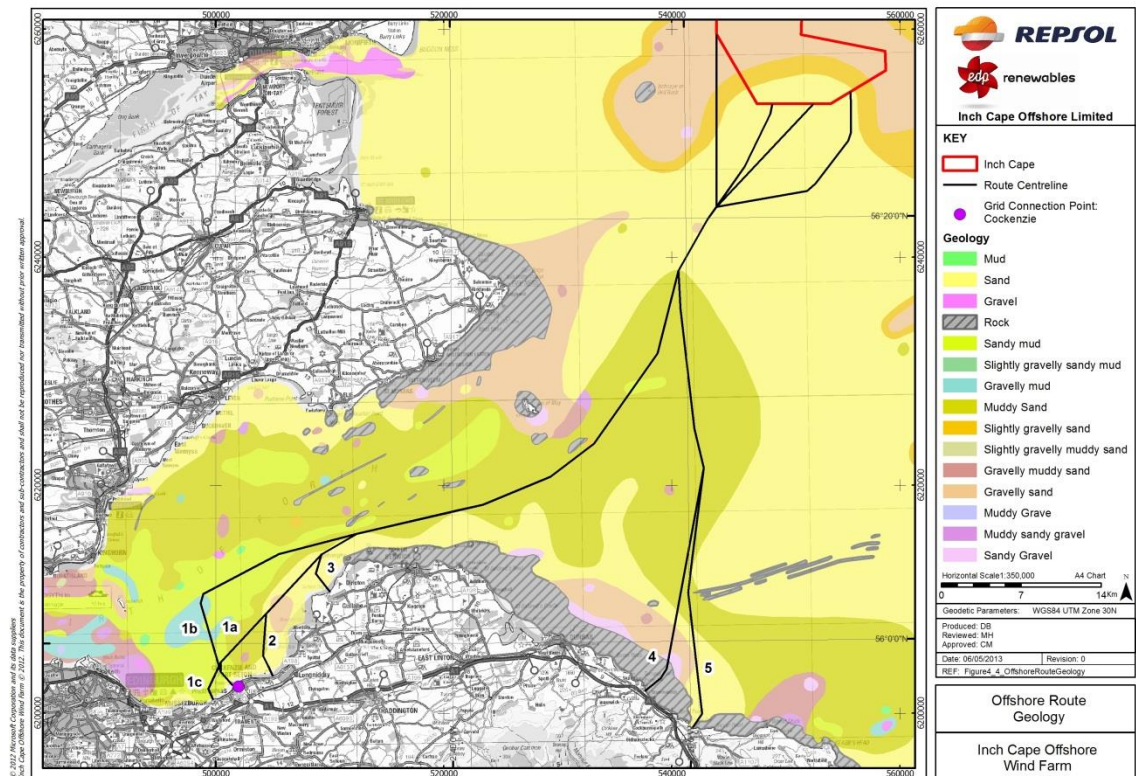
Figure 6A.6 Modified Folk Triangle Classification Used by BGS



The Firth of Forth region is shown in Figure 6A.7. A wide range of topsoil sediments is present in the area of interest between the development area and the coast, south of the wind farm development zone. The cable routes will predominantly encounter sand (SND) and muddy sand (MUSD). Assuming that the top sediment layer has a depth of at least two to three metres, a range of burial methods is possible, including ploughing which is typically preferred to minimise disturbance to the environment. Close to the coast, the

cable will also have to traverse a section of surface rock. Ploughing may still be possible in sufficiently weak rock but the use of mechanical trencher or alternative means of protection (e.g. rock placement) may be required.

Figure 6A.7 Seabed Geology in the Firth of Forth



6A.1.13.3 Turns and Lay Radii

The number of turn points in the offshore route is minimised to simplify the installation and minimise the risk of ploughing operations.

Although the minimum allowable bending radius of power cables under tension is typically of the order of a few metres, it is desirable to observe a minimum lay radius to suit the plough limitations and to avoid the unburial of the cable behind the apex of a turn due to tension in the cable behind the plough. In this study, a minimum lay radius of 1 km was used.

6A.1.13.4 Landfall Approach

To minimise the complexity of cable installation at the landfall, the angle of the cable at shore approach is chosen to find a compromise between the following parameters:

- Minimisation of the shore pull length across the landing area to minimise the maximum pull load on the cable;
- Minimisation of the distance between the cable landing point and the 10 m water depth isoline to allow the CLV to come as close as possible to shore and minimise the length of nearshore trenching required;
- Maximise the distance from the coast of the first turn to simplify marine operations nearshore;

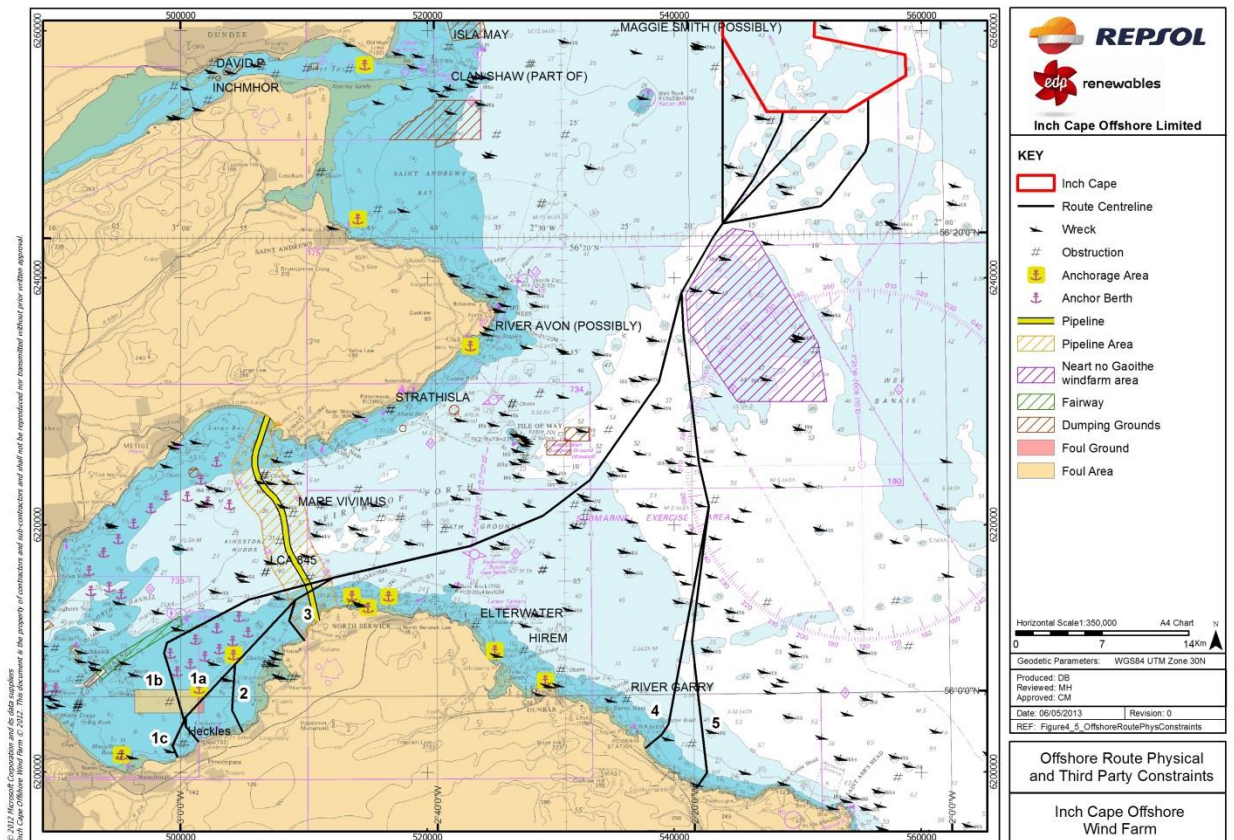
- Be as parallel as possible to nearshore wave effects to ease installation and minimise the loads on any exposed part of the cable.

6A.1.14 Physical and Third Party Constraints

6A.1.14.1 General

One of the key constraints of offshore routing in highly developed / utilised areas is to minimise interference of the cable with obstacles and hazards, such as those which exist in parts of the Firth of Forth area (see Figure 6A.8). The offshore route completely avoids obstacles which cannot be crossed (see Section 6A 1.14.1) and is optimised to minimise the number of obstacle crossings which require special works (pre or post-lay), such as crossing pipelines and other cables. A minimum safe distance is observed around obstacles which may increase the risk to cable integrity in their vicinity (e.g. dropped objects at offshore platforms), or which may be sensitive (e.g. other cables / pipelines).

Figure 6A.8 Physical and Third Party Constraints in the Firth of Forth



6A.1.14.2 Obstructions

Obstructions which cannot be crossed are avoided altogether with a minimum clearance of 100 m for disused / natural obstacles and 500 m for offshore structures in operation. Numerous obstacles are found in the Firth of Forth as shown in Figure 6A.8. Such obstacles include:

- Wrecks;
- Subsea structures;
- Wellheads (active or not);
- Platforms and FPSOs;
- Rock outcrops;
- Foul ground;
- Coastal structures (buildings, pontoons, harbours).

6A.1.14.3 Crossings

Some obstacles can / must be crossed but extra works (pre or post-lay) are required, which is non-desirable to minimise cost, risk, and potential conflicts with the owners. The following structures which may require crossing works are found in the Firth of Forth:

- Telecoms cables;
- Pipelines;
- Power cables (planned route);

Furthermore, areas envisaged for future developments (e.g. other wind farm sites such as Neart na Gaoithe) have been avoided to safeguard the cable and avoid potential future conflicts. In particular, pinch points (e.g. landfalls or corridors between sensitive areas) should not be sterilised by the installation of the cable.

6A.1.14.4 Hazards

Other features which can be crossed but are avoided to minimise the risk to the cable due to dropped objects are:

- Navigation routes;
- Yachting routes near ports;
- Anchoring areas.

Also, the length of cable traversing harbour authority areas is minimised to avoid potential conflicts arising from the hindrance to port access caused by the CLV, which must stay stationary close to the coast potentially for days during landfall installation.

6A.1.14.5 Other Development Areas

The Neart na Gaoithe wind farm development area south of the Inch Cape Wind Farm is avoided altogether to reduce conflict with third parties. This decision has not increased the length of required offshore cable length significantly.

6A.1.15 Environmental and Seabed Use Constraints

6A.1.15.1 General

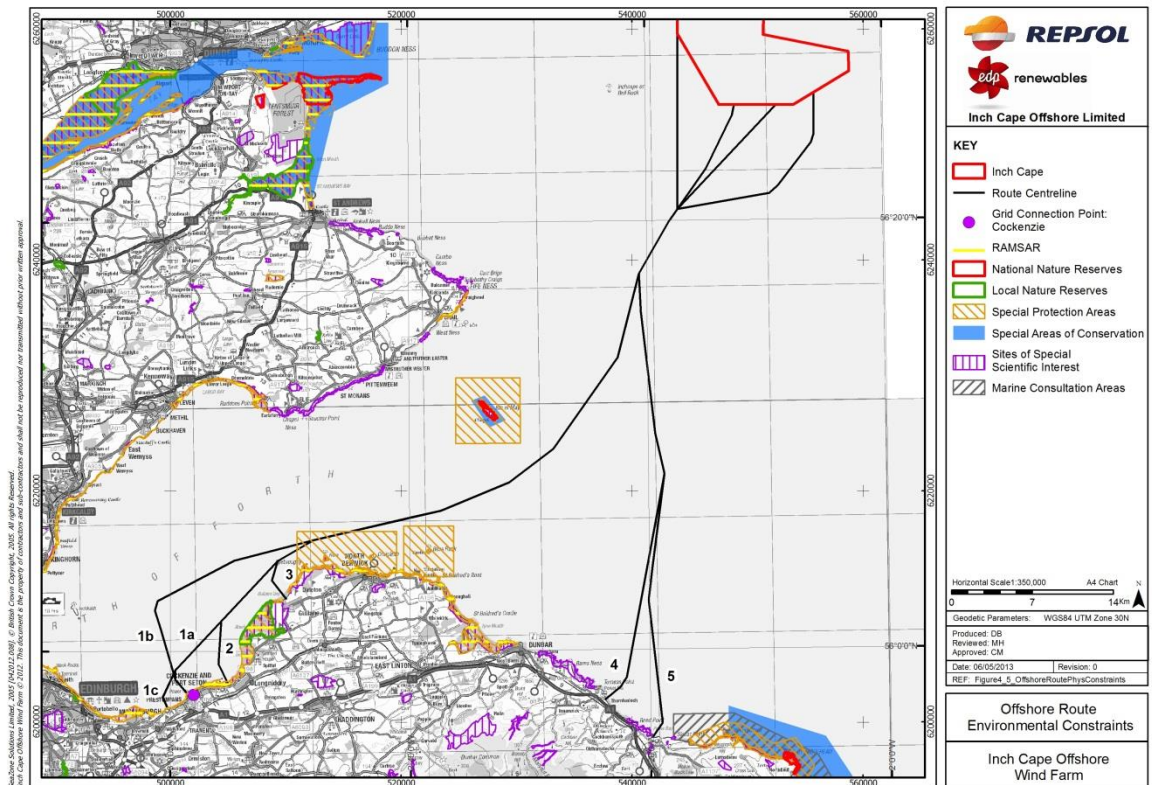
Routing through environmentally sensitive areas may be a barrier to environmental consenting and has therefore been avoided (see Figure 6A.9). Seabed zones which are exploited by human activities increase the risk to the cable during operation and can be the source of conflicts during installation of the cable; they have therefore been avoided wherever possible.

6A.1.15.2 Protected Areas

The protected areas in and around the Firth of Forth (see Figure 6A.9) and include the following types of sites:

- Wetlands conservation (RAMSAR);
- National Nature Reserves (NNR);
- Local Nature Reserves (LNR);
- Special Protection Areas (SPA);
- Special Areas of Conservation (SAC);
- Sites of Special Scientific Interest (SSSI);
- Marine Consultation Areas.

Figure 6A.9 Environmental Constraints in the Firth of Forth



6A.1.16 Seabed Use

The available dataset specifies that most of the area is classified as a “Military Practice and Exercise Areas”. This will require investigation during detailed design to ascertain whether special protection to the cable will be required locally or globally.

6A.1.17 Fishing

Minimising the interference of the cables (and their installation) with known fishing grounds is an important consideration due to mutual risk of damage during the operational phase. Bottom-towed objects (fishing gear and dragged anchors) may pose a risk to vessels and cables, particularly if the desired burial depth is not achieved consistently along the cable route.

Offshore Cable Route Options

6A.1.18 Methodology

The starting point of the offshore cable routing is to choose suitable landfall locations to be used as endpoints for the offshore routing which are effectively separate exercises (refer to Appendix 6B regarding landfall selection). The intrinsic suitability for cable landing of the potential landfall locations is taken into account, as well as the intention to propose a variety of routing options to retain flexibility in route selection.

The initial screening identified six landfalls suitable for cable routing. A multi-criteria evaluation was then undertaken of potential offshore corridors and at landfall locations to produce conceptual routes. The methodology used in the multi-criteria evaluation is described in Section 6A.4.1.

All routes are considered feasible and concept solutions for design and installation exist at all points of the proposed routes using proven designs and construction methods.

6A.1.19 Offshore Routes

The offshore cable route options are shown in Figure 6A.1. Their length is presented in Table 6A.1. These routes satisfy all known routing constraints and have been engineered to meet operational and construction requirements.

The offshore route options are briefly presented in the following sections, with an emphasis on notable differences compared to the other route options.

6A.1.19.1 Cockenzie Route (1a) – 75.5km and (1b) – 79.8km

Two offshore routes with a landfall in Cockenzie have been assessed in this study. Common features are summarised in this section followed by unique features of each.

- Common Features

Starting at the Development Area boundary, routes 1a and 1b first go south to avoid a protected area and a region of high density of wrecks, then heads south-east into the Firth of Forth towards landfall at Cockenzie.

A high number of wrecks are present in the vicinity of the route, but the 1km-wide corridor is free of wrecks. A major pipeline traversing the Firth of Forth must be crossed and a Crossing Agreement will be required. The route runs parallel to navigation lines but adequate protection should ensure the cable is not at undue risk.

These routes have the advantage of a short onshore route as the landfall is located very close to the planned onshore connection point.

- Cockerzie Route (1a) – 75.5km

Route 1a to Cockerzie has a 8km-long section that runs parallel to the coast in shallow water (in circa 5-10m water depth) to the south of an anchoring area off the coast of Longniddry and a large area of anchoring berths, both shown on admiralty charts. Shallow water installation techniques will be required. Potential disruption to or risk from the anchoring berths / area (temporary and permanent) may arise and would have to be mitigated.

This route traverses an area categorised as “foul ground” and traverses the edge of a “foul area” and both would require further investigation and/or survey to identify the nature of the seabed disturbance.

- Cockerzie Route (1b) – 79.8km

Route 1b to Cockerzie passes close to the north of a large area of anchoring berths. The route remains in deeper water until turning south to approach the landfall. Potential disruption to or risk from the anchoring berths / area (temporary and permanent) may arise. This route is 4.3km longer than 1a and will therefore have a higher cost and overall impact. The route crosses a wide area of gravelly mud as it turns toward the shore that may increase the risk with certain installation methods.

The route runs parallel to navigation lines and whilst adequate protection should ensure the cable is not at undue risk there is a greater exposure than for route 1a which is why route 1a is preferred.

This route passes through the middle of the area categorised as “foul ground” (see above) and may require further investigation and/or survey to identify the nature of the seabed disturbance.

6A.1.19.2 Prestonpans Route (1c) – 81.1km

Route 1c follows the same path as Routes 1a but would continue offshore to land at Prestonpans, to the west of Cockerzie and Seton Sands. A relatively short onshore route to the connection point would therefore be required.

Route 1c has the same features as 1a until it diverges in a westerly direction. It then continues in shallow water until turning to the landfall. This route is 5.6km longer than 1a and will therefore have a higher cost and overall impact offshore and a longer route onshore than 1a.

6A.1.19.3 Seton Sands Route (2) – 72.9km

Route 2 to Seton Sands follows the same path initially as Routes 1a and 1c but lands in Seton Sands to the east of Cockerzie. A relatively short onward onshore route to the connection point is therefore required.

Starting at the wind farm array, route 2 first goes south to avoid a protected area and a region of high density of wrecks, and then heads south-east into the firth towards its landfall in Seton Sands.

A high number of wrecks are present in the vicinity of the route, but its 1km-wide corridor is free of wrecks. A major pipeline traversing the Firth of Forth has to be crossed and a

Crossing Agreement will be required. The route runs parallel to navigation lines but adequate protection would ensure the cable is not at undue risk.

Route 2 to Seton Sands runs parallel to the coast in the vicinity of an anchoring area similar to Route 1a. In addition to the requirement for shallow water installation (in circa 5-10m water depth), potential disruption to the anchoring area (temporary and permanent) may arise.

6A.1.19.4 Gullane Route (3) – 64.0km

Route 3 to Gullane initially follows the same path as routes 1a and 1b and 2 but lands in Gullane to the east of Prestonpans, Cockenzie and Seton Sands. A longer onward onshore route to the connection point is therefore required.

A high number of wrecks are present in the vicinity of the route than...., but its 1km-wide corridor is free of wrecks. A major pipeline traversing the Firth of Forth has to be crossed and a Crossing Agreement will be required. The route runs parallel to navigation lines but adequate protection would ensure the cable is not at undue risk.

6A.1.19.5 Thorntonloch Route (4) – 55.0km

From the Inch Cape Development Area, Route 4 heads south towards its landfall in Thorntonloch and avoids the Neart na Gaoithe wind farm development area and the numerous wrecks in the area.

Compared to the other offshore routes, Thorntonloch is the shortest but it also comes with a much longer onshore section.

A high number of wrecks are present in the vicinity of the route, but its 1km-wide corridor is free of wrecks. A 60m-long section of the route is categorised as “foul area” in the nearshore; further investigation and/or surveyed to identify the nature of the seabed disturbance would be required.

A major drawback of this route is a 3.5km-long section of cable which traverses a rocky seabed. A number of adequate protection techniques exist, but they all come at a higher cost and risk than ploughing. Protection by rock placement has been assumed for the purpose of the cost analysis. Risks may arise through proximity to export cables from the Neart na Gaoithe offshore wind farm during construction and/or operation.

6A.1.19.6 Pease Bay Route (5) – 57.6km

From the Inch Cape development area, Route 5 heads south towards its landfall in Pease Bay and avoids the Neart na Gaoithe wind farm development area and the numerous wrecks in the area.

Compared to the route to Thorntonloch, the route to Pease Bay is longer by 2.6km. The associated onshore route is the longest of all options.

A high number of wrecks are present in the vicinity of the route than other options, but its 1km-wide corridor is free of wrecks. Risks may arise through proximity to export cables from the Neart na Gaoithe offshore wind farm during construction and/or operation.

6A.1.19.7 Offshore Routes Comparison

A comparison matrix of the offshore route options is included in Annex 1.



All offshore routes are considered technically viable; hence it is recommended that they are differentiated in terms of cost, installation risk with regard to the offshore / onshore route length ratio, and other material factors.

6A.1.20 Consenting Parameters

The results of this study will be used to define the consenting parameters to be included in the Design Envelope. The following parameters can be used regarding the export cable:

- Footprint:

The offshore route length is up to 84km;

- Installation technique:

It is expected the export cable will be ploughed over its whole length except nearshore and close to the offshore substation platform;

Nearshore and at the offshore substation platform, the cable may be buried by jetting;

The temporary increase in suspended sediments (plumes), the extent of sediment deposition, and the release of contaminants bound in seabed sediments due to cable installation are expected to be minimal overall, as ploughing causes minimal disturbance to the seabed and jetting may be used only over short lengths.

- Protection:

Nearshore and at the offshore substation, the cable may be protected by rock placement or matting;

Protection of the cable is not expected to impact fishing activities.

- Crossings:

The export cable may have to cross a pipeline.

References

1. Robert L. Folk, The Distinction between Grain Size and Mineral Composition in Sedimentary-Rock Nomenclature, The Journal of Geology, Vol. 62, pp 344–359, Jul 1954



Annex 1
ROUTE OPTIONS COMPARISON MATRIX



Inch Cape Concept
Engineering Cable Routing
Comparison Matrix

Issue level	Colour key	Description
Negligible or N/A		Unlikely to occur / insignificant impact
Minor		Potential impact, no mitigation required
Moderate		Significant issue requiring mitigation
Major		Critical issue requiring mitigation

Routes						
Cockenzie (1a)	Cockenzie (1b)	Prestonpans (1c)	Seton Sands (2)	Gullane (3)	Thorntonloch (4)	Pease Bay (5)

OFFSHORE							
Engineering							
Number of cables [-] - AC option		Up to 6	Up to 6	Up to 6	Up to 6	Up to 6	Up to 6
Number of cables [-] - DC option		2	2	2	2	2	2
Offshore cable length [km]		75.5	79.8	81.1	73	64	57.6
Subsea cable joints per cable (indicative c. 40km of bundle on largest cable vessel)		1 for AC / 0 for DC	1 for AC / 0 for DC	1 for AC / 0 for DC	1 for AC / 0 for DC	1 for AC / 0 for DC	1 for AC / 0 for DC
Geophysical constraints to cable laying and burial	General bathymetry (average water depth)	37.7	38.2	37.7	39.4	42.8	49.1
	Maximum water depth [m]	57.0	57.0	57.0	57.0	57.0	58.1
	General seabed slopes (average slope - degrees)	0.3	0.3	0.3	0.2	0.3	0.3
	Maximum slope (degrees)	3.1	3.1	3.1	3.1	2.2	3.5
Seabed geology / cable protection	Suitability to cable burial	Combinations of sand, mud and gravel	Combinations of sand, mud and gravel	Combinations of sand, mud and gravel	Combinations of sand, mud and gravel	Combinations of sand, mud and gravel. Rock for 3.5km at landfall approach	Combinations of sand, mud and gravel



		Routes							
		Cockenzie (1a)	Cockenzie (1b)	Prestonpans (1c)	Seton Sands (2)	Gullane (3)	Thorntonloch (4)	Pease Bay (5)	
	Buried cable stability		No issue	No issue	No issue	No issue	No issue	No issue	No issue
	Suitability of alternative protection techniques	Armoring	Feasible	Feasible	Feasible	Feasible	Feasible	Cable stability to be assessed at landfall approach	Feasible
		Ducting	Feasible	Feasible	Feasible	Feasible	Feasible	Not Feasible	Feasible
		Rock placement	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
		Mattressing	Feasible	Feasible	Feasible	Feasible	Feasible	Mattress stability to be assessed at landfall approach	Feasible
	Areas with risk of cable getting exposed (e.g. with mobile sediments)		None identified	None identified	None identified	None identified	None identified	None identified	None identified
	Ease of exposed cable remediation (access / bathymetry / currents)		No issue	No issue	No issue	No issue	No issue	No issue	No issue
Physical obstructions to cable laying	Seabed obstacles	Wrecks	Many wrecks but suitable corridor achieved	Many wrecks but suitable corridor achieved	Many wrecks but suitable corridor achieved	Many wrecks but suitable corridor achieved	Many wrecks but suitable corridor achieved	Many wrecks but suitable corridor achieved	Many wrecks but suitable corridor achieved
		Wellheads	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
		Archaeology	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route



		Routes						
		Cockenzie (1a)	Cockenzie (1b)	Prestonpans (1c)	Seton Sands (2)	Gullane (3)	Thorntonloch (4)	Pease Bay (5)
Third-party platforms / substations		None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
Routing risk due to pinch points		Minor risk due to high number of obstructions and wrecks	Minor risk due to high number of obstructions and wrecks	Minor risk due to high number of obstructions and wrecks	Minor risk due to high number of obstructions and wrecks	Minor risk due to high number of obstructions and wrecks	Minor risk due to high number of obstructions and wrecks	Minor risk due to high number of obstructions and wrecks
Crossings	Cables	Existing	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
		Planned	Route passes close to planned Neart na Gaoithe windfarm area	Route passes close to planned Neart na Gaoithe windfarm area	Route passes close to planned Neart na Gaoithe windfarm area	Route passes close to planned Neart na Gaoithe windfarm area	Route passes close to planned Neart na Gaoithe windfarm area	Route passes close to planned Neart na Gaoithe windfarm area
	Pipelines	1 major pipeline crossed at close to 90 degrees	1 major pipeline crossed at close to 90 degrees	2 major pipelines crossed at close to 90 degrees	1 major pipeline crossed at close to 90 degrees	1 major pipeline crossed at close to 90 degrees	None identified in Seazone data along route	None identified in Seazone data along route
Access for inspection / maintenance / repair	Third-party restrictions	No issue	No issue	No issue	No issue	No issue	No issue	No issue
	Bathymetry	No issue	No issue	No issue	No issue	No issue	No issue	No issue
Health and Safety		No issue	No issue	No issue	No issue	No issue	No issue	No issue
Human Activity								
Risk to cable due to	Trawling	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region



		Routes						
		Cockenzie (1a)	Cockenzie (1b)	Prestonpans (1c)	Seton Sands (2)	Gullane (3)	Thorntonloch (4)	Pease Bay (5)
fishing	Dredge fishing	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region
	Creeling	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region	Some activity in the region
Risk to cable due to dredging (for any other purpose)		None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
Risk to cable due to dropped object	Anchorage areas	8km section in close proximity to anchorage areas	10km section in close proximity to anchorage areas	8km section in close proximity to anchorage areas	3km section in close proximity to anchorage areas	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
	Platforms proximity	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
	Shipping lanes	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
	Navigation / yachting	Route close to navigation lanes in the firth	Route close to navigation lanes in the firth	Route close to navigation lanes in the firth	Route close to navigation lanes in the firth	Route close to navigation lanes in the firth	None identified in Seazone data along route	None identified in Seazone data along route
Risk of conflict with maritime users during construction / maintenance	Shipping	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
	Navigation / yachting	None identified in Seazone data	None identified in Seazone data	None identified in Seazone data	None identified in Seazone data	None identified in Seazone data	None identified in Seazone data	None identified in Seazone data along



		Routes						
		Cockenzie (1a)	Cockenzie (1b)	Prestonpans (1c)	Seton Sands (2)	Gullane (3)	Thorntonloch (4)	Pease Bay (5)
		along route	along route	along route	along route	along route	along route	route
	Fishing (including pelagic fishing)	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
	Risk of conflict with planned wind farm developments	Route passes close to planned Neart na Gaoithe windfarm area	Route passes close to planned Neart na Gaoithe windfarm area	Route passes close to planned Neart na Gaoithe windfarm area	Route passes close to planned Neart na Gaoithe windfarm area	Route passes close to planned Neart na Gaoithe windfarm area	Route passes close to planned Neart na Gaoithe windfarm area	Route passes close to planned Neart na Gaoithe windfarm area
	Risk of conflict with other third-party construction activities	Most of route inside 'Oil and Gas Licence Areas' but no facilities identified in seazone data along route	Most of route inside 'Oil and Gas Licence Areas' but no facilities identified in seazone data along route	Most of route inside 'Oil and Gas Licence Areas' but no facilities identified in seazone data along route	Most of route inside 'Oil and Gas Licence Areas' but no facilities identified in seazone data along route	Most of route inside 'Oil and Gas Licence Areas' but no facilities identified in seazone data along route	Most of route inside 'Oil and Gas Licence Areas' but no facilities identified in seazone data along route	Most of route inside 'Oil and Gas Licence Areas' but no facilities identified in seazone data along route
	Crossing of Ministry Of Defence PEXA	Most of route inside 'UKHO Military Practice and Exercise Areas'. Need to establish MOD use.	Most of route inside 'UKHO Military Practice and Exercise Areas'. Need to establish MOD use.	Most of route inside 'UKHO Military Practice and Exercise Areas'. Need to establish MOD use.	Most of route inside 'UKHO Military Practice and Exercise Areas'. Need to establish MOD use.	Most of route inside 'UKHO Military Practice and Exercise Areas'. Need to establish MOD use.	Most of route inside 'UKHO Military Practice and Exercise Areas'. Need to establish MOD use.	Most of route inside 'UKHO Military Practice and Exercise Areas'. Need to establish MOD use.
	Crossing of marine waste disposal areas	2km section through 'Foul Area' and 'Foul Ground'	2km section through 'Foul Area'	2km section through 'Foul Area' and 'Foul Ground'	None identified in Seazone data along route	None identified in Seazone data along route	60m nearshore section through 'Foul Area'	None identified in Seazone data along route
	Aviation routes	None	None	None	None	None	None	None identified



		Routes						
		Cockenzie (1a)	Cockenzie (1b)	Prestonpans (1c)	Seton Sands (2)	Gullane (3)	Thorntonloch (4)	Pease Bay (5)
		identified in Seazone data along route	identified in Seazone data along route	identified in Seazone data along route	identified in Seazone data along route	identified in Seazone data along route	identified in Seazone data along route	in Seazone data along route
Environment / Seabed Exploitation								
Protected areas	International designated sites (e.g. SPA, SAC, Ramsar)	50m landfall approach section inside RAMSAR, SSSI and SPA site	50m landfall approach section inside RAMSAR, SSSI and SPA site	50m landfall approach section inside RAMSAR, SSSI and SPA site	330m landfall approach section inside RAMSAR, SSSI and SPA site	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
	National designated sites (e.g. SSSI, NNR, MNR)	50m landfall approach section inside RAMSAR, SSSI and SPA site	50m landfall approach section inside RAMSAR, SSSI and SPA site	50m landfall approach section inside RAMSAR, SSSI and SPA site	330m landfall approach section inside RAMSAR, SSSI and SPA site	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
	Seabed / coastal habitats	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
	Marine archaeology and cultural heritage	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route	None identified in Seazone data along route
Onshore Route To Grid Connection	Cost, Complexity, Onshore Impacts, Schedule Uncertainty	Very short route to connection	Very short route to connection	Short route to connection	Short route to connection	Moderate route to connection	Long route to connection	Long route to connection