EIRGRID / RTE

CELTIC INTERCONNECTOR - MARINE CONSULTANCY & ENGINEERING SERVICES

ROUTE INVESTIGATION REPORT

Report Reference: P1812_R3426_REV3_Route Investigation Report

Issued: January 2015

Intertek
Exchange House
Liphook
Hants GU30 7DW
United Kingdom

Tel: +44 (0) 1428 727800
Fax: +44 (0) 1428 727122

E-mail: energy.water.info@intertek.com
Web Site: www.intertek.com

SUMMARY

Intertek Energy & Water Consultancy Services ('Intertek') has been commissioned by EirGrid and RTE to undertake a cable route investigation for the potential HVDC Celtic Interconnector cable between Ireland and France. The objective of the study is to propose an optimised marine route deemed technically feasible and economically appropriate, for further seabed survey.

Intertek conducted an initial desktop study using a geographical information system (GIS) to map and assess constraints between the potential French and Irish landfalls. Six viable route options were identified based on an initial assessment of:

- The shortest feasible marine route.
- Environmental and engineering constraints.
- The feasibility of securing consent.

To facilitate assessment of the route options, nominal points were chosen offshore of the landfall area options creating 6 main Trunk routes and individual Branches to each landfall option.

The route options were then further assessed and ranked based on environmental, technical, third-party and commercial constraints. Of the six routes identified, two were initially recommended for further investigation as follows:

- **Route 1:** Ballinwilling Strand (Cork Coast, Ireland) to Mogueriec (Côte des Légendes, France), with routing **inside** UK Territorial Waters.
- **Route 2:** Ballinwilling Strand (Cork Coast, Ireland) to Mogueriec (Côte des Légendes, France), with routing **outside** UK Territorial Waters.

These routes are considered the favoured marine route options due to a combination of the level and type of constraints present along their routes and commercial factors such as their overall length. Route 1 is the shortest route (468.8km) and the second least constrained route and Route 2 is the third shortest route (486.6km) and the least constrained route overall. Intertek would advise that, although marginally greater in length, Route 2 (the least constrained option) is recommended over Route 1. In addition to having greater constraints, Route 1 passes through UK territorial waters which would commit the project to the undefined annual cost of a lease from The Crown Estate. It is further recommended that Route 2 be taken forward for the marine survey.

There are a number of recommendations made within this document that should be considered in the final engineering solution for a successful installation. The recommendations from this report should also be considered, along with the Landfall Report (Intertek Ref: P1812_R3400_Rev1), when scoping the marine survey solution.

Upon completion of the 2014-15 marine survey, it is recommended that:

- this Route Report be updated and the least constrained route option(s) refined; and
- a full cable risk assessment and burial study be undertaken to inform the cable installation and burial protection requirements of the project.

CONTENTS

1 INTRODUCTION AND METHODOLOGY 1

1.1 BACKGROUND INFORMATION 1
1.2 PROJECT DESCRIPTION 1
1.3 STUDY OBJECTIVES 2
1.4 STUDY AREA 2
1.5 METHODOLOGY 4

2 REVIEW OF KEY CONSTRAINTS 15

2.1 TECHNICAL CONSTRAINTS 15
2.2 PERMITTING / CONSENTING 16
2.3 BIOLOGICAL ENVIRONMENT 17
2.4 THIRD PARTY CONSTRAINTS 19
2.5 COMMERCIAL CONSIDERATIONS 23

3 OVERVIEW OF TRUNK CONSTRAINTS 26

3.1 RANKING OF CONSTRAINTS 26

4 OVERVIEW OF LANDFALL AREA CONSTRAINTS 30

4.1 CORK COAST LANDFALL AREA 30
4.2 WATERFORD/WEXFORD LANDFALL AREA 33
4.3 CÔTE DES LÉGENDES LANDFALL AREA 38

5 ROUTE RANKING CONCLUSIONS 41

5.1 TECHNICAL AND ENVIRONMENTAL CONSTRAINTS 41
5.2 COMMERCIAL CONSTRAINTS 42

6 CABLE ROUTE RECOMMENDATIONS 44

6.1 OFFSHORE ROUTE 44
6.2 COMMERCIAL CONSIDERATIONS - ROUTES 1 AND 2 45
6.3 CONCLUSION 46
6.4 LANDING OPTIONS 47

7 REFERENCES 48

APPENDIX A CABLE ENGINEERING A-1

APPENDIX B MARINE NATURE CONSERVATION SITES B-1

APPENDIX C PROTECTED SITES C-1

APPENDIX D OVERVIEWS OF ROUTE OPTIONS AND CONSTRAINTS D-1

APPENDIX E RPLS E-1

TABLES

Table 1-1: Key Constraints 4
Table 1-2: Data Sources 10
Table 2-1: Typical Installation Methods for Different Types of Substrate in Submarine Power Cable Installation and Protection 24
Table 3-1: Trunk Constraints Overview 29
Table 4-1: Distance of Branch from Protected Site 31
Table 4-2: Distance of Branch from Protected Site 35
Table 4-3: Distance of Branch from Protected Site 39
Table 5-1: Complete Route Options 41
Table 5-2: Route Constraints Ranking 41
Table 5-3: Route Commercial Ranking 43
Table 6-1: Cable Installation Components – Typical Budget Estimates (as at 2014) 45
Table A-7-1: Two cable corridor swathe A-4
Table A-7-2: Four cable corridor swathe A-5
Table A-7-3: Cable burial methods A-11

FIGURES

Figure 1-1: Study Area for Route Investigation 3
Figure 1-2: Trunk Routes 1 & 2 5
Figure 1-3: Trunk Routes 3 & 4 6
Figure 1-4: Trunk Routes 5 & 6 6
Figure 1-5: Cork Coast Branches and Landfalls 8
Figure 1-6: Waterford/Wexford Branches and Landfalls 8
Figure 1-7: Côte des Légendes Branches and Landfalls 9
Figure 1-8: Environmental and Technical Risk Ranking Matrix 12
Figure 1-9: Example Risk Ranking Matrix (Inch Beach Branch) 14
Figure 2-1: Commercial Fishing Grounds 22

1 INTRODUCTION AND METHODOLOGY

1.1 BACKGROUND INFORMATION

EirGrid and RTE are investigating the feasibility of installing a power cable interconnector between Ireland and France. The project proposes to include 2 No. High Voltage Direct Current (HVDC) converter stations, a 700+MW HVDC submarine interconnector between the converter stations and onshore lines/cables as appropriate.

Intertek have been appointed by EirGrid and RTE to provide a range of marine consultancy and engineering services related to the Celtic Interconnector Project (Ref EirGrid contract ENQEIR369 and Rte contract No. XC513T4010).

This report focuses primarily on the cable route options for the marine element of the interconnector cable. A list of further reports undertaken by Intertek and others, relevant to this Report are provided below:

- Intertek, June 2014 - Land Report (Ref: P1812_R3400_Rev1).
- Intertek, June 2014 - Land and Marine Consultant Workshop, Ireland (P1812 _XNov29_Rev1).
- Intertek, June 2014 - Land and Marine Consultant Workshop, France (P1812_YJan01_Rev1).
- ESBI, February 2014 (Ireland – France Interconnector - Feasibility Study - Converter Station Site & Route Selection in Ireland, Report No. PE424-F0000-R000-024-000).
- C&S Conseils, January 2014 – RTE Ouest, Projet de Liaison Celtic Interconnector – Partie Terrestre Française, Etude de Contexte.
- RSK, September 2013 - Consents Required for HVDC Interconnector and Associated Infrastructure in Ireland, UK and France (Ref: Briefing note P80502).

1.2 PROJECT DESCRIPTION

The total marine cable between Ireland and France proposes to be approximately 500km long. Cable specifications have not been determined at the time of writing but it is anticipated that the cable would be a HVDC system consisting of two cables which would be bundled for installation and laid in a single trench.

The cable would be installed using either a single vessel, simultaneously laying and burying the cable bundle, or by two vessels, one laying and the following vessel carrying out the burial work. The burial depth at any given location would depend on the hazard profile, but it is likely that the cables will be buried to 2m in non-cohesive sediments and less in areas of more cohesive, solid sediments. The variation in sediment across the region may require a range of burial techniques e.g. ploughing, jetting and/or rock cutting/trenching. This will be assessed after completion of the marine survey.

1.3 STUDY OBJECTIVES

The route feasibility study for the Celtic Interconnector is an initial desk-top analysis of environmental, technical, third-party and economic factors which influence marine cable installation and operation. The objective of the study is to propose an optimised route deemed technically feasible and economically appropriate, for further seabed survey.

The study involved:

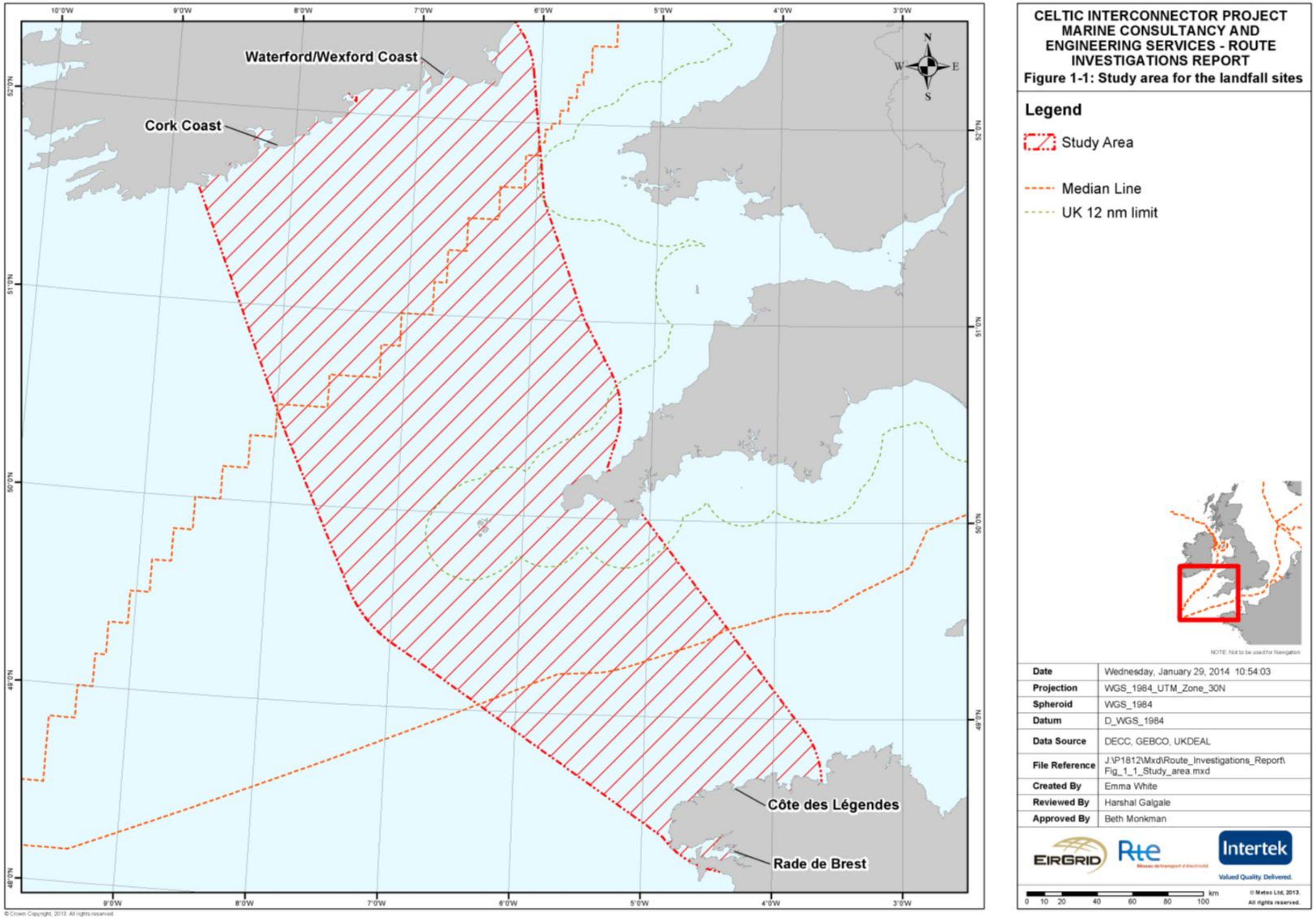
- Identifying a number of offshore routes that merit further analysis.
- Identifying and appraising offshore infrastructure, conditions and constraints that may prohibit, restrict or enhance the route development.
- Incorporating the potential landfalls sites that have been identified as feasible by the land consultants (ESBI, Ireland and C&S Conseils, France).
- Developing preliminary subsea cable route alignments taking into consideration: the shortest reasonable route; marine environmental constraints; engineering constraints; and the feasibility of securing consent.
- Comparatively ranking and comparing preliminary subsea cable routes and landfall sites with the objective of clearly identifying a least constrained option.
- Recommending the least constrained route option(s) to be further investigated through a marine survey campaign.

1.4 STUDY AREA

Landfall feasibility studies were commissioned in Ireland and France to identify landfall site options for the marine cable. In Ireland ten landfall sites were proposed for consideration. These fall into two regions: five in County Cork near the Knockraha substation and five in County Waterford and County Wexford near the Great Island substation. In France six sites were proposed: five located in a region on the north coast of Brittany (referred to as Côte des Légendes) and one located within the port of Brest (referred to as Rade de Brest) - both of these areas are proposed to link to the La Martyre substation.

The study area is a corridor that extends between Ireland and France including a 50km buffer either side of the potential landfall options, see **Figure 1-1**.

Figure 1-1: Study Area for Route Investigation



1.5 METHODOLOGY

1.5.1 Route Identification

Selection of initial route options for interconnector studies is an iterative process, typically commencing with a 'straight line' from landfall to landfall (i.e. the shortest route) followed by re-routing around key technical and environmental constraints listed in **Table 1-1** below.

Table 1-1: Key Constraints

Criterion	Factors to be considered
Development of the shortest route possible to minimise cable length and hence cable manufacturing and installation costs	Achieving optimal balance between a straight line from A to B and a route avoiding existing infrastructure, topographic features and geological features.
Avoidance of areas that would present insurmountable technical difficulties for installation and/or maintenance of cable burial depths	Route length in intertidal areas minimised. Route length in water depths of less than 10m minimised. Crossing of sand banks minimised. Crossing of bedrock outcrops minimised.
Identify suitable landfall locations	Obstruction free inshore approaches. Beach sediment suitable for cable burial. Access to beach for installation plant. Location adjacent to open land for land cable routing.
Avoidance of areas with a prior use, where there is increased risk of damage to cable	Anchorage areas, dredging areas, disposal areas, munitions areas to be avoided
Avoidance of areas of existing and proposed seabed development	Oil and gas infrastructure, port developments, dredged channels and existing windfarms to be avoided. Consideration given as to whether to avoid proposed windfarms.
Avoidance of wrecks	Wrecks avoided by 100m
Bundle with existing infrastructure	250m separation from existing cables and 500m separation from existing pipelines where possible. Pipelines and cables to be crossed at right angles.
Avoidance of areas with pre-existing environmental designations	Avoid or minimise crossing of protected sites e.g., SACs, SPAs, Ramsar Sites, Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR).

Appendix D provides examples of constraints considered during initial routing

On this basis, 6 route corridors for the route "Trunk" were identified providing options routing from the Cork or Waterford/Wexford coasts to the Côte des Légendes or the Rade de Brest coasts - see Figure 1-2, Figure 1-3 and Figure 1-4.

The options are as follows:

- Route 1: Cork Coast to Côte des Légendes inside UK Territorial Waters (TWs).
- Route 2: Cork Coast to Côte des Légendes outside UK TWs.
- Route 3: Waterford/Wexford Coast to Côte des Légendes inside UK TWs.
- Route 4: Waterford/Wexford Coast to Côte des Légendes outside UK TWs.
- Route 5: Cork Coast to Rade de Brest outside UK TWs.
- Route 6: Waterford/Wexford Coast to Rade de Brest inside UK TWs.

Two further routes:

- Cork Coast to Rade de Brest inside UK TWs, and,
- Waterford/Wexford Coast to Rade de Brest outside UK TWs

were discounted due to the significant increase in cable route length, and hence cost, making these options unviable.

Figure 1-2: Trunk Routes 1 & 2

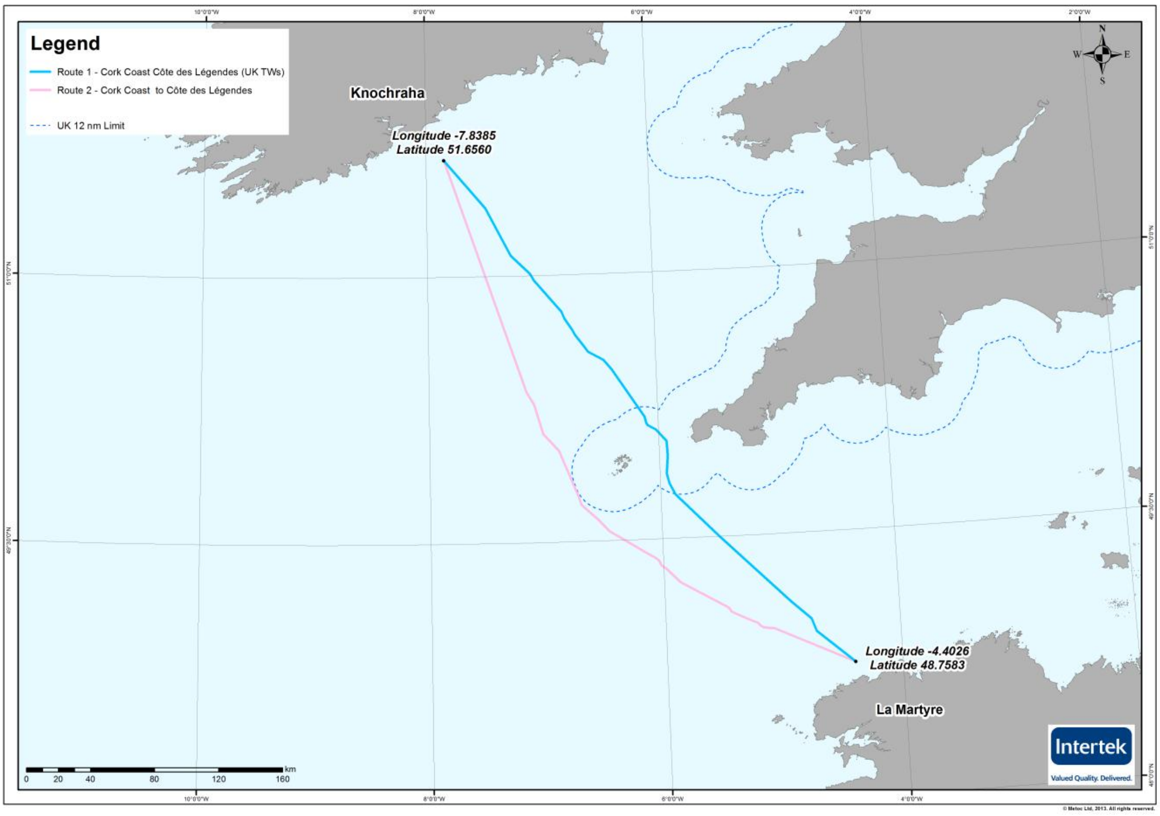


Figure 1-3: Trunk Routes 3 & 4

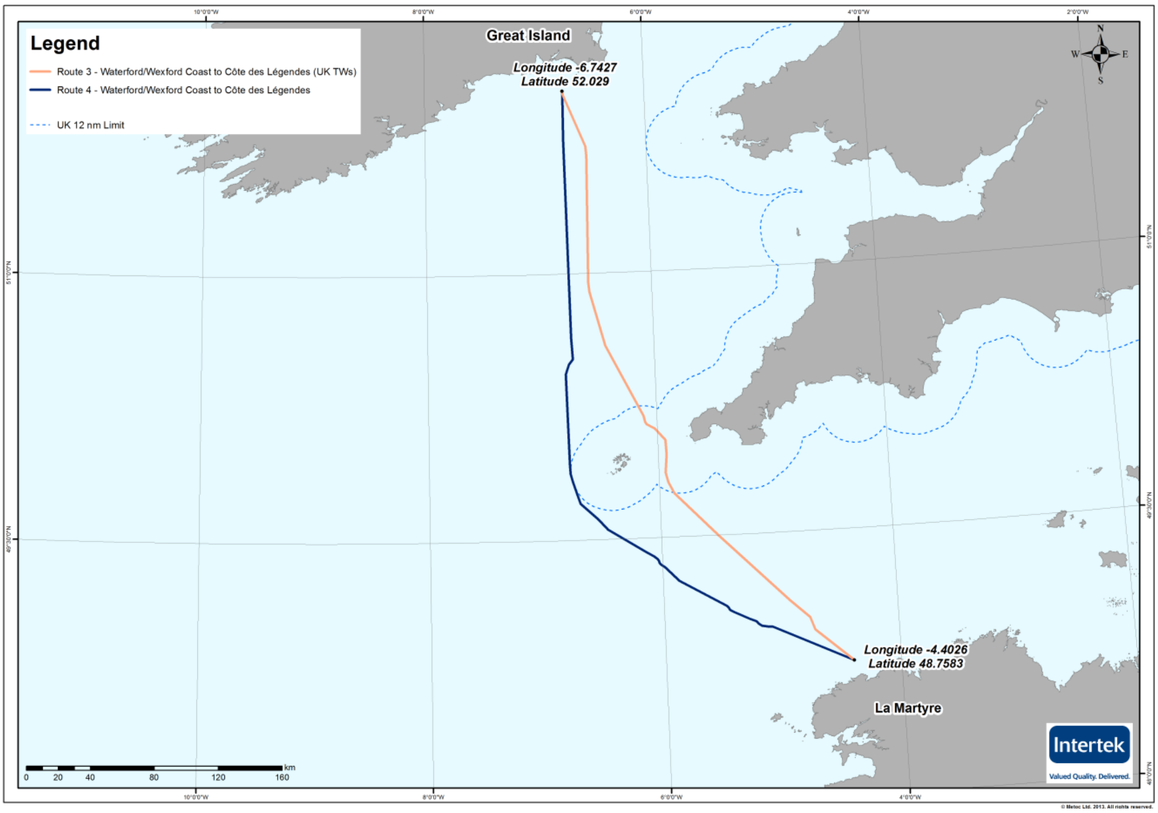
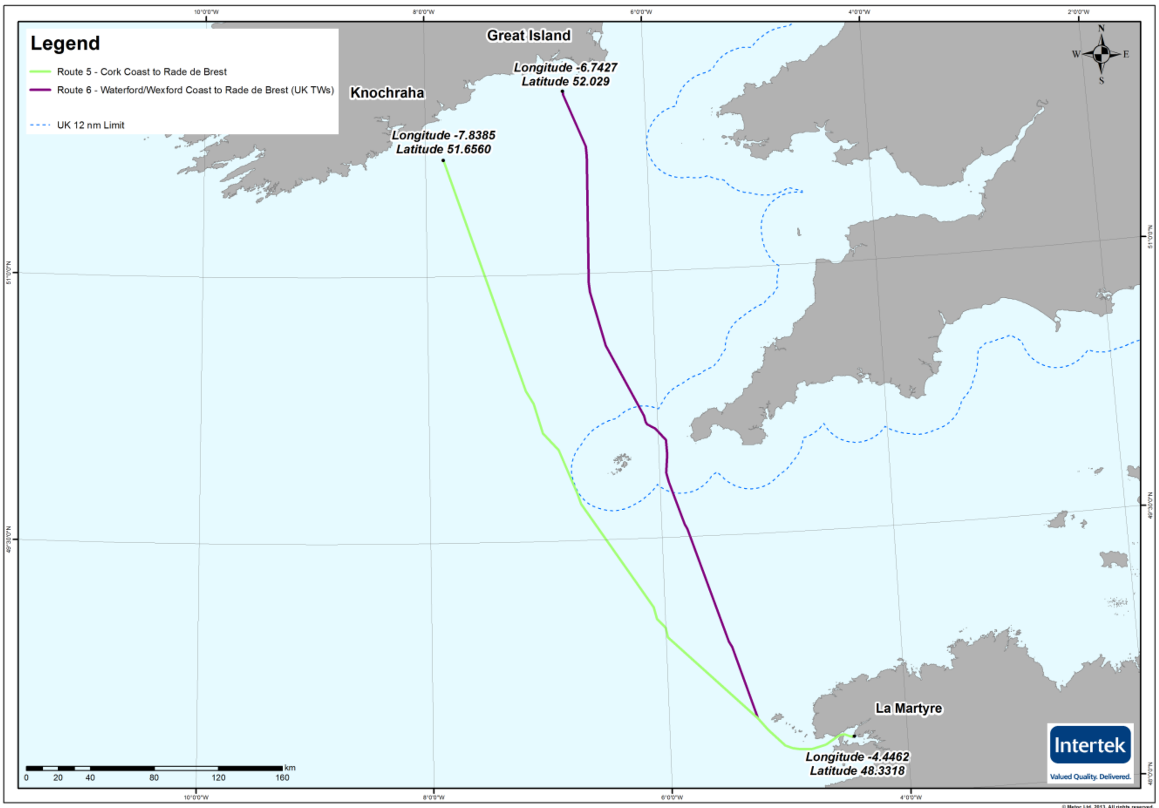


Figure 1-4: Trunk Routes 5 & 6



Landfall sites had not been selected at the time of writing this report. Therefore, the Trunks and "Branches" to each landfall option were separated to facilitate evaluation of the Trunk routing options separately from the inshore routing to specific landfalls.

To establish the limits of the main Trunks, a nominal point offshore of each of the landfall areas, Cork Coast and Waterford/Wexford in Ireland and Côte des Légendes in France was chosen as follows:

- Cork Coast Point = 51°39'21.9"N, 7°50'18.42"W.
- Waterford/Wexford Coast Point = 52°1'45.084"N, 6°44'33.797"W.
- Côte des Légendes Point = 48°45'30.124"N, 4°24'9.437"W.

(Please note: Co-ordinates are given in WGS1984)

The inshore routes of the Branches were then created from the corresponding points above to each landfall option as follows:

- Cork Coast Point to Inch Beach.
- Cork Coast Point to Ballycroneen Beach.
- Cork Coast Point to Ballinwilling Strand.
- Cork Coast Point to Redbarn Beach.
- Cork Coast Point to Claycastle Beach.
- Waterford/Wexford Point to Rathmoylen Cove.
- Waterford/Wexford Point to Baginbun Beach.
- Waterford/Wexford Point to Newtown Beach.
- Waterford/Wexford Point to Bannow Beach.
- Waterford/Wexford Point to Cullenstown Beach.
- Côte des Légendes Point to Mogueriec.
- Côte des Légendes Point to Kerfissien
- Côte des Légendes Point to Poulfoen.
- Côte des Légendes Point to Pontusval.
- Côte des Légendes Point to Dibbennou.

Figures 1-5 to 1-7 illustrate the inshore route Branches to each landfall option.

Figure 1-5: Cork Coast Branches and Landfalls

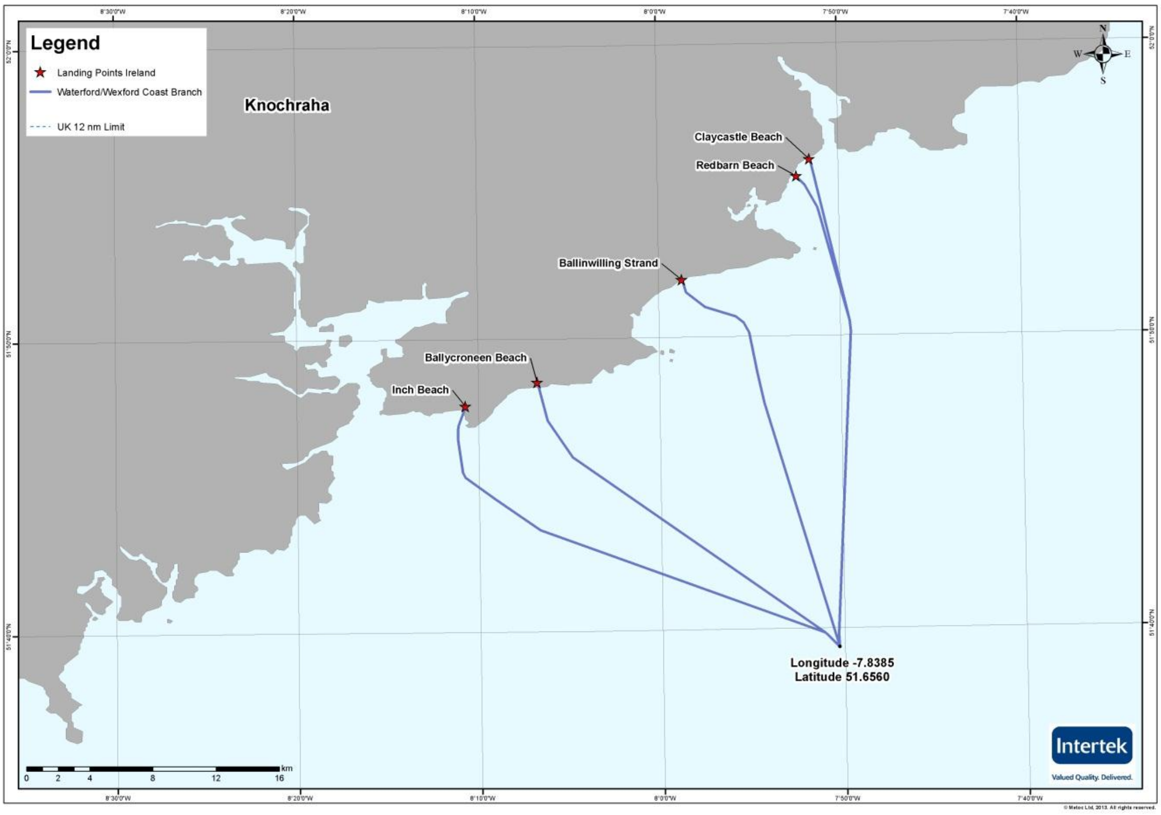


Figure 1-6: Waterford/Wexford Branches and Landfalls

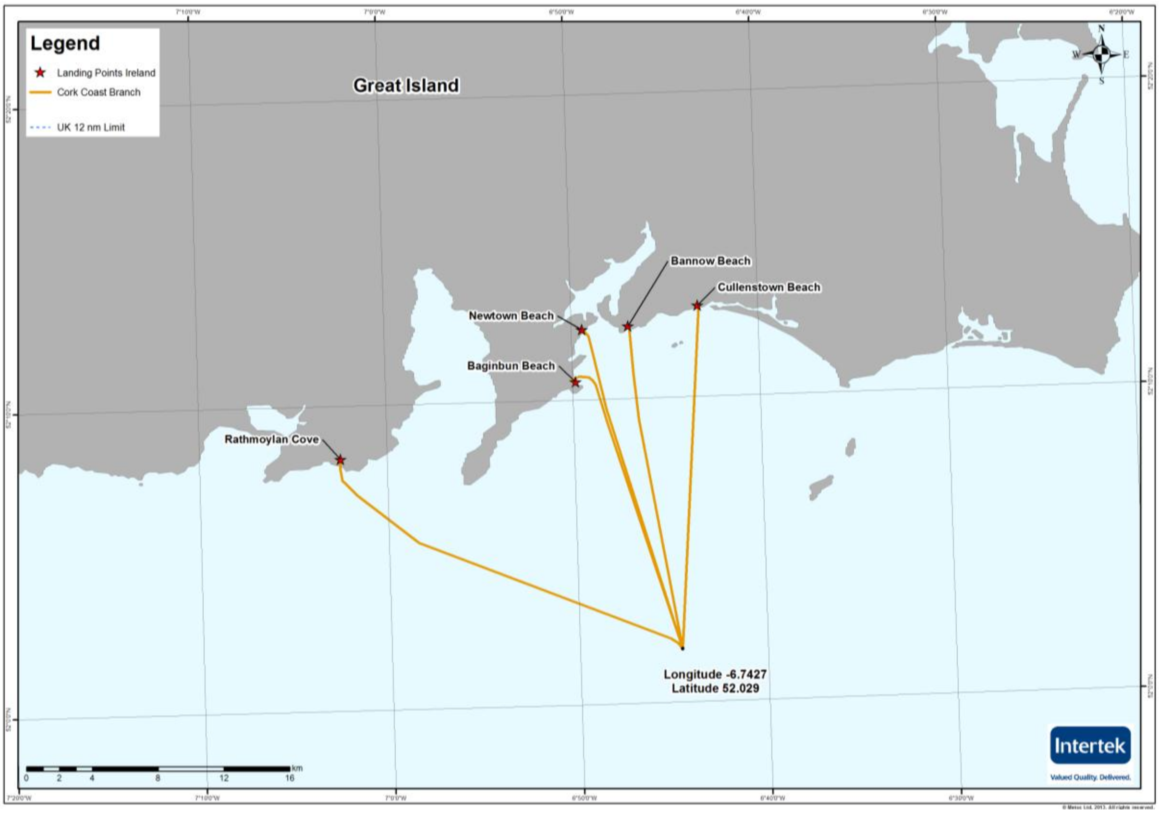
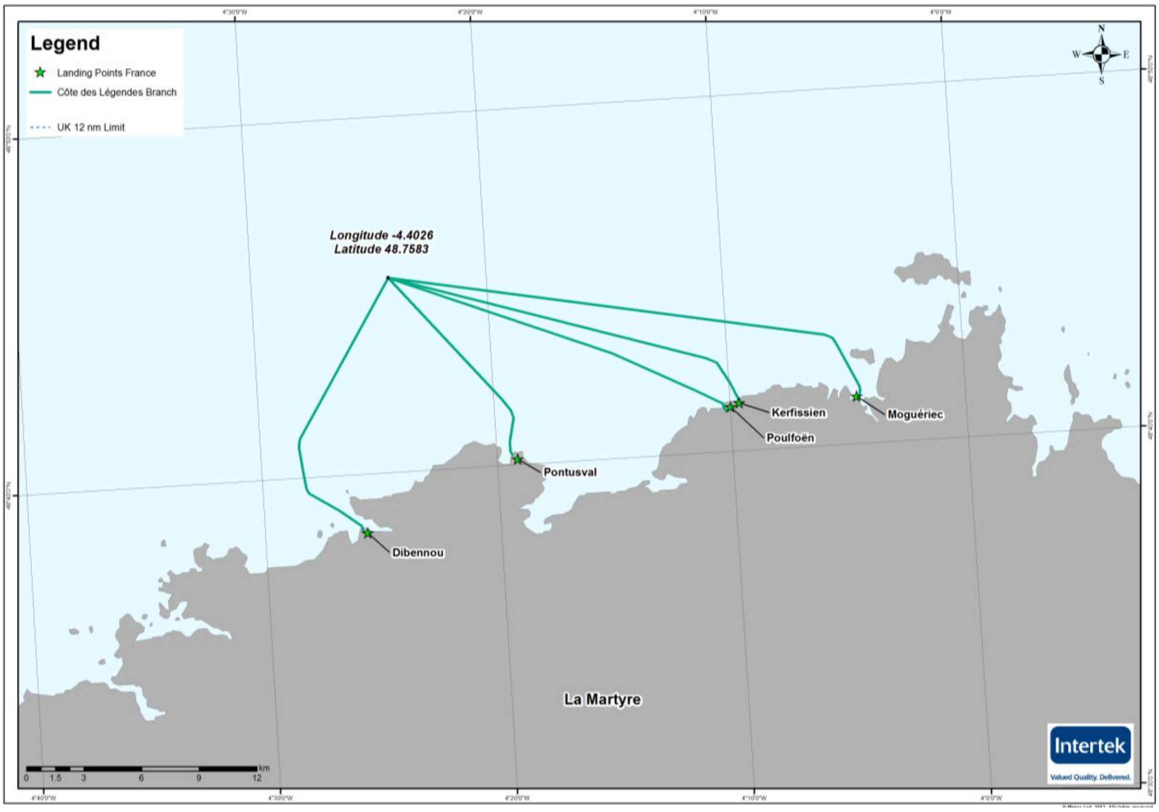


Figure 1-7: Côte des Légendes Branches and Landfalls



In order to enable the marine route options to be described and constraints accurately noted along the length of each route option, a KP (Kilometre Point) system has been used. This describes the distance along each route in KP, commencing at the common offshore points (i.e. a point 125 km further offshore of this point along the route is described as KP125).

A table of the route directions for KP numbering is available in the Ranking Matrix spread sheet (“Celtic Interconnector - Route Investigation Report - Route Ranking Matrix.FINAL.xls”).

1.5.2 Route Ranking

Using a geographical information system (GIS), constraints were mapped from a wide range of data sources, see Table 1-2 below. Any constraints of a technical, consenting/permitting or third party nature, considered likely to have an impact on the cable survey and/or installation, were identified for each cable route option and the risk evaluated as per Figure 1-8.

It should be noted that this study has focused on issues that are material to the feasibility of the cable routes and has made use of publicly available data sources. For certain constraints (e.g., fishing, spawning grounds for sensitive species of fish such as herring, and military activities) accurate data and information can only be obtained through consultation and detailed research and assessment.

Table 1-2: Data Sources

Source	Data Provider	Data description
Admiralty charts 2675-0, 1123-0, 1121-0, 2655-0, 1410-0, 1178-0, 2565-0, 777-0, 1149-0, 7401-0, 7401-1, 7399-0, 2740-0, 1765-0, 2046-1, 2046-2, 2046-3, 2046-4, 2046-0, 2071-0	UKHO and SHOM admiralty charts provided by SeaZone and FindMaps.	Navigational information, pipelines, cables,
SeaZone Hydrospatial Base and Hydrospatial One Marine Themes	SeaZone; http://www.seazone.com/data/hs/One /1/2013/4	Bathymetry & Elevation Natural & Physical Features Structures & Obstructions Socio Economic & Marine Use Conservation and Environment Climate & Oceanography
Seabed Sediments charts Seabed Geology charts	British Geological Society (BGS) charts	Geology and seabed sediments
Disposal sites	Centre for Environment, Fisheries and Aquaculture Science (CEFAS)	Geographical data on disposal sites
UK Military Practice areas	Practice and Exercise Areas (PEXA)	UK Military Practice areas
Protected Areas Special Protection Areas (SPA) Special areas of Conservation (SAC) Potential Annex I Habitats	Joint Nature Conservation Committee (JNCC)	Protected habitats in the marine environment
Special Protection Areas (SPA) Special areas of Conservation (SAC) Nature Parks	National Parks & Wildlife Service (NPWS)	Irish Environmental Protected Areas
Marine Conservation Zones (MCZs)	Natural England	UK Environmental designations
Aggregate extraction areas Offshore wind development areas	The Crown Estate	Geographical information on aggregate extraction and offshore wind development
Subsea telecoms and electricity cables	Kingfisher Information Services Offshore Renewables and Cable Awareness (KIS-ORCA)	Geographical data existing cables and offshore renewables
Oil and Gas pipelines Platforms Subsea infrastructure Surface infrastructure Wells	UK DEAL	Oil and Gas subsurface infrastructure
Seabed Habitats	Marine European Seabed Habitats	Seabed type information
UK 12 nm limit UK Median Line limit	UK Hydrographic Office (UKHO) digital data	Navigational information

The process to identify the least constrained routes was as follows:

Step 1: Identification of the risk profile along each trunk and branch. This involved the following stages:

a) Identify key constraints which will influence decisions. The constraints considered included:

- Water depth (bathymetry).
- Geology/Seabed Sediment.
- Disposal sites and munitions disposal.
- Cables (Power & Telecommunication).
- Oil and gas infrastructure.
- Protected sites and potentially protected sites.
- Protected species.
- Shipping and navigation.
- Military exercise areas.
- Fishing.
- Ports.
- Recreational Use.
- Wrecks.

(For examples of routing in consideration of the above constraints please see Appendix D.)

b) Determine level of environmental and technical impact and likelihood of impact occurring and assign risk level.

Scoring of the constraints was based on Intertek experience and the risk assessment matrix presented in Figure 1-8.

Figure 1-8: Environmental and Technical Risk Ranking Matrix

Environmental constraints	Technical Feasibility			
	Resolution of the issue (meeting acceptable safety standards) has potential for cost or schedule impacts as identified below, or no contingency measures identified which give an acceptable outcome if a risk materialises:			
	Definition	**Indicative Cost to resolve (€M)**	**Schedule delay (months)**	
Uncontrolled widespread and sustained environmental impact affecting a significant ecosystem to such an extent as to threaten its ability to recover. Highly unlikely to be acceptable to consenting authorities.	Intolerable – beyond organisations ability to manage. Beyond the capability of current known installation vessels/spreads.	> 90	>24	**Very High [5]**
Localised or short term environmental impact causing severe local ecosystem damage or significantly affecting a regional ecosystem. May be acceptable but likely to cause significant consenting delay.	Severe – potential showstoper (could be managed outside normal organizational framework. Would require substantial vessel/spread modifications of enhancements – severely restricts choice. Would require re-routing.	≥ 30 - 90	12 to 24	**High [4]**
Limited impact with localised effect on ecosystems and insufficient to threaten their long term recovery. May be acceptable with appropriate mitigation	Moderate – potential showstopper (can be managed with normal resources) e.g. major restriction to choice of vessel/spread or may require re-routing.	≥ 15 - 30	6 to 12	**Medium [3]**
Impact with measurable, but no lasting effect. Likely to be acceptable	Material Impact – readily manageable e.g. slight restriction to choice of vessel/spread	1 - 15	3 to 6	**Low [2]**
Impact with no measurable effect. No consenting risk.	No issues e.g. no restriction on choice of vessel/spread	≤ 1	<3	**Very Low [1]**

Key:

- Extremely challenging
- Challenging
- Acceptable risk

Impact

5-1	5-2	5-3	5-4	5-5
4-1	4-2	4-3	4-4	4-5
3-1	3-2	3-3	3-4	3-5
2-1	2-2	2-3	2-4	2-5
1-1	1-2	1-3	1-4	1-5

Likelihood

Very Low [1]	Low [2]	Medium [3]	High [4]	Very High [5]
Very unlikely to happen (<5%)	Less likely (≥5% to 25%)	Likely (>25% to 60%)	More likely than not (>60% to 80%)	Very likely - expected to occur (>80%)

Step 2: Ranking of Branch and Trunk options.

For all Trunk and Branch options constraints were identified and ranked as ‘extremely challenging’, ‘challenging’, ‘acceptable’ or ‘no risk’ (see risk matrix above). Where sections of the Trunk or Branch had more than one constraint the highest risk rank was applied to that section.

The total length of each risk rank along each Branch was calculated and the Branch ranked according to the length of extremely challenging and challenging risks. The Branch with the lowest length of extremely challenging/challenging risk was assigned the highest rank (1).

Step 3: Combining the Branch ranking with the landfall ranking.

The Branches for each landfall area (Cork Coast, Waterford/Wexford and Côte des Légendes) were then combined with the findings from the Land Report (Ref: P1812_R3400_REV1) and assessed to establish the least constrained Branch option for each landfall area.

Step 4: Overall route ranking (constraints).

These least constrained Branches were then combined with the Trunk options to rank each route option, landfall to landfall.

An example ranking matrix for the Branch to Inch Beach in Cork is provided in Figure 1-9 below.

Step 5: Route ranking (commercial).

As a high level constraint, route length has a straight forward impact on route options. Each route (Trunk combined with least constrained Branch) was ranked according to length. The shortest route being assigned the highest rank (1).

Step 6: Identification of least constrained commercially viable route.

The specific details of the route ranking exercise including assessment of each trunk and branch are contained within a separate spreadsheet (“Celtic Interconnector - Route Investigation Report - Route Ranking Matrix.FINAL.xls”).

For the purpose of simplicity, the rest of this report provides a general discussion around the constraints within the study area, the key constraints along the trunks and the key constraints within the landfall area (which include the landfall sites and branches).

Figure 1-9: Example Risk Ranking Matrix (Inch Beach Branch)

		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	km	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Technical	Cable and Pipeline Crossings	3-4: Kinsale Gas Pipeline in close proximity KP 0-2																														
	Bathymetry	2-5: Water depth 0-20m KP 0-4																														
	Seabed Sediment		4-4: Bedrock																													
Permitting / Consenting	Spawning Herring	1-5: Route passes through possible herring spawning ground. A herring spawning survey may need to be conducted to determine the value of the sediments and micro routing may be necessary to avoid sensitive areas. The JNCC will need to be consulted.																														
	Wreck (within 1km)		1-2: Wreck approx800m																													
Third Party	Dredging & Disposal							3-2: Disposal area in close proximity KP 6-9																								
	Harbour Areas	2-4: Cork Harbour Area KP 0-7.5																														

Risk	Length Km
Extremely Challenging	6
Challenging	4
Acceptable	21
No Risk	0
Total length	31

Risk	Extremely Challenging	Challenging	Acceptable	No risk
% of total branch length	18%	15%	68%	0%

2 REVIEW OF KEY CONSTRAINTS

This section provides a high-level review of the various constraints to cable installation and operation within the study area. Overview images of the constraints present within the study area are within **Appendix D**.

2.1 TECHNICAL CONSTRAINTS

2.1.1 Water Depths below 20m

Landing a cable through intertidal areas is typically the most challenging aspect of a cable installation as it represents the interface between land and vessel based operations. Both land and marine operations need to be coordinated and the handling of the cable, from the vessel on which it is being held to shore, managed. The tidal regime of the area may also severely constrain the time available for installation operations.

If a route contains areas in shallow water then larger main installation spreads may be unable to operate. In addition, in the event of any weather and/or swell, a vessel's operational range can be significantly reduced.

In cases where the shallow water section of cable is too long to be installed from the main cable installation vessel an additional shallow draft cable handling vessel would be required. Additional lengths of cable would also need to be cut and re-joined at the point of interchange between the two installation vessels in this scenario. A water depth of 15m is used as an average cut-off for a typical large cable handling vessel. However the 15m water depth contours are not consistently identified within the bathymetry data at every landfall. Intertek have therefore conservatively used the 20m contour at this preliminary stage of the project.

All of the marine route options are constrained for some distance by shallow waters at the landfalls.

2.1.2 Seabed Sediments

Determining the thickness of the sands and gravels is fundamental to planning the installation and burial methods. A review of the geological data from the study area provided a good baseline understanding of the anticipated sediment type ahead of conducting the full route surveys. However, this is purely an indicative preliminary appraisal.

Final burial methodology can only be developed following a thorough burial assessment study (BAS) which will include a review of all constraints, including morphology, slope angles and an appropriate assessment of scour potential. This work will primarily be informed through the geophysical and geotechnical survey work. A full cable risk assessment is recommended, to calculate burial depths, once the geotechnical survey results are available.

For the majority of the cable route options, the seabeds comprise of predominantly sands or gravelly sands with a varying mud component. The seabed topography of the study area appears to also be largely benign, with no notable extensive or extreme slopes. The areas of greatest concern occur along the Irish coast, the Côte des Légendes and the outer entrance to the

Rade de Brest and areas south of Île d'Ouessant and Île de Molène where surface expressions of bedrock present the greatest obstacle to cable installation and long term cable integrity.

2.1.2.1 Bedrock At or Near the Surface

All route options cross areas identified as bedrock outcropping at or near the surface. These areas of bedrock either run parallel to the Irish and French coasts or are on the inshore approaches to the landfalls. Although it is not possible to avoid these areas completely, the cable route options have been designed to cross areas at the narrowest point. The relatively low-resolution geological data available for this desk-top study does indicate that there is a high chance of encountering sub-cropping bedrock in both the Irish and French landfall areas. A marine survey campaign will be necessary to provide additional clarity on seabed characteristics.

Depending on the nature of the bedrock it may be possible to bury the cable. Additional cable protection may be required if burial is not possible. It should be noted that rock or concrete mattress placement do not provide as good protection to the cable as burial. They can also incur greater environmental impacts compared to burial due to smothering of benthic species and causing a surface obstruction to mobile fishing gear.

2.1.3 Existing Infrastructure

There are numerous cables transecting the Celtic Sea and due to the orientation of these cables it is not possible to avoid many of them. However, suitable separation distances and optimised crossing angles were taken into consideration during the initial routing exercise.

In line with common practice, sections of Out-of-Service cables will be required to be cleared from the area prior to installation, to prevent any interference of these cables with the installation activities. For further information on Route Clearance techniques see **Appendix A**.

The existing In-Service cables usually require a break in burial technique and additional cable protection to avoid abrasion, corrosion, interferences and thermal effects which may be experienced by some cables.

Cable routing would typically be optimised following marine survey to ensure the cable is not in close proximity to any key cable bodies such as repeaters. Each crossing will have to be analysed individually and the protection requirements agreed with the crossed party well in advance of the installation.

All of the route options cross in the region of 20 In-Service cables. Hence, this constraint is not a key differentiator between route options.

2.2 PERMITTING / CONSENTING

The cable routes cross a maximum of three national jurisdictions: Ireland, UK and France. The consents required in each of the jurisdictions, at all stages of the project (baseline surveys, installation and operation), are highlighted in an independent consent report (RSK, 2013).

As a general 'rule of thumb' it can be assumed that routes which pass within or are in close proximity to sensitive National and International conservation/ heritage areas, are likely to require full consideration during assessment.

Furthermore, routes which pass through the UK waters within 12nm of land will require a marine licence from UK MMO, unlike routes which pass outside this area i.e. through Irish and French waters only.

2.3 BIOLOGICAL ENVIRONMENT

2.3.1 National and International Legislation for Marine Conservation

Within each administrative area (Ireland, UK and France) national and international conservation designations may apply. Sites of nature conservation are designated to protect them from development and other activities that may affect their biodiversity interest. Key legislation for protecting marine sites of nature conservation interest that apply to all three nations are summarised in **Appendix C**.

2.3.2 Protected Sites

There are a wide range of national and international statutory designations that vary in their level of importance and protection. Designated sites across the routes include:

Special Protection Areas (SPA)

A SPA is a strictly protected site of international conservation importance for rare and vulnerable birds as listed on Annex I of the EC Directive 2009/147/EC (Birds Directive) on the conservation of wild birds (codified version), and for regularly occurring migratory species. The Directive provides a framework for the conservation and management of, and human interactions with wild birds in Europe, protecting birds through the establishment of a network of SPAs comprising all the most suitable territories for these species.

Special Areas of Conservation (SAC)

SACs are areas of land or water of international conservation importance designated under the EC Habitats Directive (92/43/EEC) and relate to habitat or species types which are listed for protection under Annexes I and II of the Directive. Designations under The Habitats Directive aim to maintain or restore natural habitats and wild species listed on the Annexes to the Directive at a favourable conservation status.

Sites of Community Importance (SCI)

These are areas that have been adopted by the European Commission as Special Areas of Conservation, but not yet formally designated by the government of each country.

Sites of Special Scientific Interest (SSSI)

A SSSI is an area of land or water notified under the UK Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000). SSSIs provide legal protection for areas of special interest by reason of their flora, fauna, or geological features. All SSSIs noted for their important bird assemblages are also designated as Ramsar sites in England.

Natural Heritage Areas (NHA)

Natural Heritage Areas are notified under the the Wildlife (Amendment) Act 2000. These are deemed to be areas of special interest, containing important wildlife habitat and often rare or threatened species. They may also be selected on the basis of their geology or geomorphology.

Ramsar Sites

Ramsar sites are wetlands of international importance, designated under the Ramsar Convention of Wetlands, and protected as European sites (as set out in The Conservation of Habitats and Species Regulations 2010).

Marine Conservation Zones (MCZ)

Marine Conservation Zones are designated in the UK under the Marine and Coastal Access Act, 2009 to protect areas that are important to conserve the diversity of nationally rare or threatened and representative habitats and support functioning communities of species. An aim of MCZs is to complement existing marine protected areas such as SACs and SPAs.

The protected sites encountered across the routes, their descriptions and features of conservation interest are included in Appendix C and discussed in more detail in Section 3. Five of the six potential trunk routes pass through at least one currently designated marine protected area. All branches and landfall are within 5km of at least one protected area.

Routing through a protected area is feasible in certain cases, although any project will have to demonstrate that it will not adversely and significantly affect the integrity of the designated features. All activities which may be deemed to impact a European protected area will be subject to screening for possible negative significant effects. It is not expected that full appropriate assessment would be required in most instances as it is hoped that any potential adverse effects can be avoided or mitigated for in the design process. In the unlikely case that the impact is significant or unavoidable, the application would be subject to an appropriate assessment, which would add time to the consenting process. Seasonal restrictions on installation works and the installation methodology employed may also be stipulated, so as to protect sensitive species -- such as marine mammals and nesting, breeding or over wintering birds.

Protected sites within the vicinity of the cable routes which have been proposed, but are not yet officially designated, are considered (for the purposes of routing studies) as if they were fully designated. Potential designations within the study area include recommended Marine Conservation Zones (rMCZ), Potential Annex I Habitat (PAIH) and Proposed Natural Heritage Areas (pNHA). Further information on these proposed designations is provided within **Appendix C**.

Espaces Remarquables

Areas protected as an Espace Remarquable, constitute outstanding areas of natural and cultural heritage on the coast, worthy of conservation for their biological or ecological interest. An Espace Remarquable is intended to protect an area which:

- Has a species or habitat quoted on “article R.146-1 du code de l’urbanisme”.
- Has a specific area or landscape, necessary for keeping biological balance or with an ecologic interest.

Such areas may include dunes, saltmarsh, beaches, coastal heathland, estuaries, coral reefs, tidal flats, lagoons, cliffs, coastal woodlands and uninhabited islands. They also encompass geological formations and environments harbouring concentrations of animal or plant species of conservation interest (under Article 4 of Law No. 76-629 of 10 July 1976 and rest areas, nesting and feeding grounds for birds designated by the European Directive No. 79- 409 of 2 April 1979 on the conservation of wild birds).

Development is possible within an area of an Espace Remarquable providing the location and appearance of the development does not; alter the character of the site; compromise the architectural and landscape quality; affect the quality of the environment and species. Electricity cables are able to be routed through such sites under the condition that they are buried and connect to a renewable source. However, transformer or interconnectors are not currently permitted through such areas.

2.3.3 Herring/Sand Eel Spawning Grounds

All routes in the approach to the Irish coast pass through regions defined by the CEFAS as areas where herring and/or Sand Eel spawn (lay their eggs) or where juveniles will be present. The eggs and juveniles of fish species are susceptible to disturbance from cable installation operations. CEFAS may hold more detailed information on the actual location of herring spawning in these areas, and are also likely to require that sections of the chosen route that pass through herring spawning zones should be surveyed to assess the potential for herring spawning.

Re-routing during route optimisation and/or seasonal restrictions during installation may also apply. It is important to note that fish spawning and nursery grounds are dynamic features which are influenced by a range of factors. This means their location can vary from one season to the next.

2.4 Third Party Constraints

2.4.1 Port Authorities

2.4.1.1 Irish Ports

The Inch Beach and Rathmoylen Cove Branches enter waters under the jurisdiction of the Cork and Waterford Port Authorities respectively. Cork Harbour is a key sea port on the south coast of Ireland and is one of only two Irish ports that can service all modes of shipping. Waterford harbour is another busy port on the south coast of Ireland and is the only Irish port to currently have planning permission secured for further extensions. The Cork Port's authority extends out to Ballycroneen East, 500m west of the Ballycroneen landfall option with 7.5km of the Inch Beach landfall Branch falling within the port's limits. The Waterford port's authority reaches roughly 2km south of Hook Head with 5.5km of the Rathmoylen Cove landfall Branch falling within the port's limits. Cable installation in these areas is expected to be more challenging given the high density of shipping.

As none of the Irish Branch routes fall within the main port area they are at a lower risk of causing significant impact to the port and therefore should be less likely to be subject to opposition from the relevant Port Authorities. However permission will be required from the Authorities to install a cable in their waters. Consultation should be undertaken to determine if they have any objections or restrictions in terms of safety of navigation.

2.4.1.2 French Ports

None of the landfalls in the Côte des Légendes area fall within any port authority areas. The route to Porz Meur through the Rade de Brest, although avoiding the Brest harbour limits, falls within unavoidable restricted areas for 39km of the cable route from the landfall. Restrictions apply to anchoring, fishing and disposal; there are also compulsory waiting areas for certain types of vessels. It is likely that obtaining permission for cable installation in these restricted areas will be challenging.

It is important to note that port authorities may also be concerned with potential compass deviation effects of the magnetic fields generated by the cables. Conditions may be imposed with regard to the maximum compass deviation they will allow in their areas of jurisdiction.

2.4.2 Military Practise and Exercise Areas

All potential marine routes pass through Irish, UK and French Military practise and exercise areas. Experience of similar projects has shown that if cable installation does not conflict with their use of the area, nor has implications on safeguarding, they are unlikely to object to the project. However, consultation will be necessary to determine the specific use of the area and whether there are any objections.

Another consideration within this category is that of minefields. Though not common within the study area, there is a dis-used minefield near to the Dibbenou landfall. This is likely to have been installed during World War II and although now disused remains a charted danger area for any subsurface activities.

2.4.3 Shipping

A specialist Shipping Report was undertaken as part of the constraints investigation of the study area by Anatec Limited, the findings of which have been incorporated into this report.

Shipping lanes are present in the study area and all route options cross Traffic Separation Schemes. However, these are not deemed to be significantly busy or restricted spatially, therefore installation operations are unlikely to experience an increased level of risk providing the use of Guard vessels is undertaken during marine operations.

Another shipping risk is where routing falls in close proximity to anchorages where in an anchor is deployed directly onto the cable or dragged into it, either by negligence or as the result of an emergency situation. Contact with an anchor is very often disastrous for submarine cable as the kinetic energy of a moving anchor may be extremely high. Also the power of large vessels' windlasses will often be great enough to lift and damage a cable should it become hooked.

2.4.4 Dredging and Disposal

Dredging areas to maintain ports or to extract aggregates represent a physical risk to a cable route however the current planned route do not cross or come into close proximity to any known dredging areas.

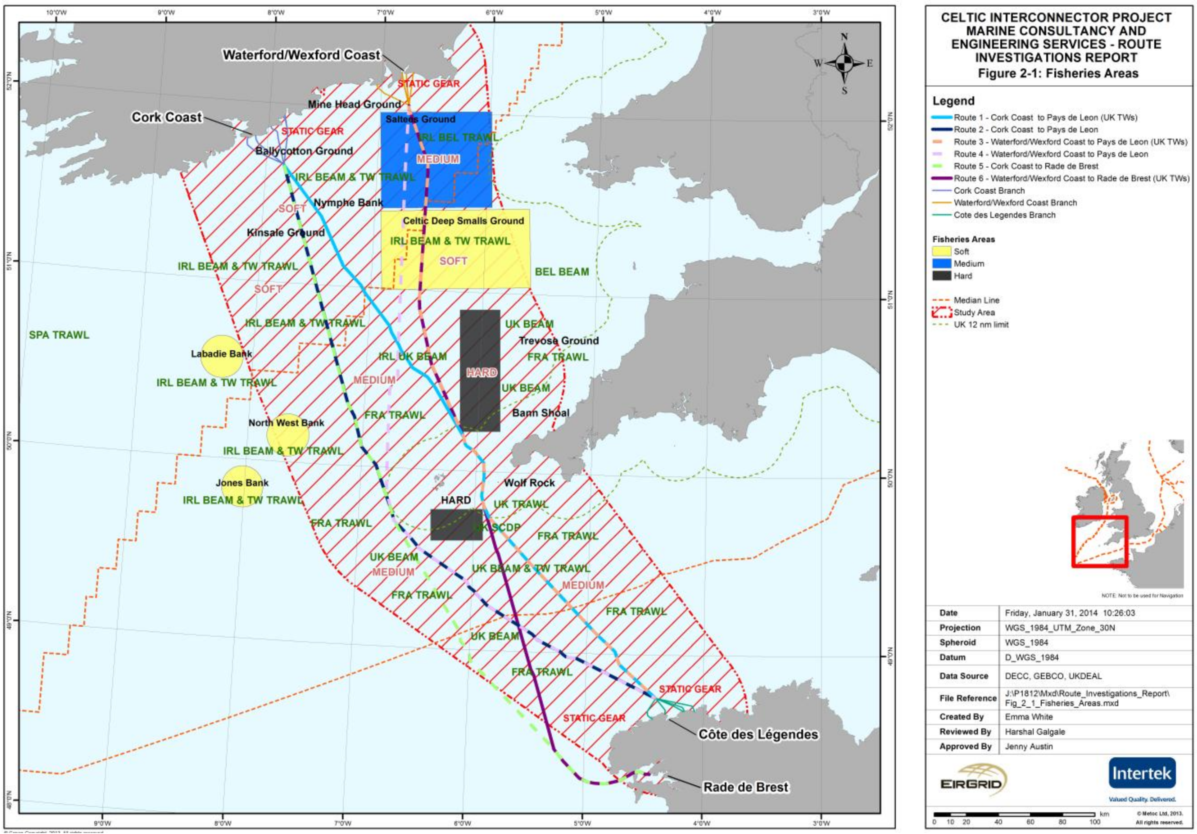
There are some disposal areas within the study area near to Cork Harbour, the approaches to the Rade de Brest and within Brest Harbour. These areas pose a risk to cables via dropped objects or through unstable substrate, for example where addition of dredged material causes slumping of the substrate.

2.4.5 Commercial Fisheries

A specialist Fishing Report was undertaken as part of the constraints investigation of the study area, the findings of which have been incorporated into this report.

There are some important commercial fishing areas in the Celtic Sea including the Saltees Ground, the Celtic Deep and the area north west of Bann Shoal (Figure 2-1).

Figure 2-1: Commercial Fishing Grounds



The Saltees Ground is a medium to hard stony ground where Irish, Belgian and UK beam trawlers operate together with Irish, French and UK demersal otterboard trawlers. The Celtic Deep Small Ground is dominated by a large fleet of twin-rigged French, Irish and UK twin rig trawlers - this area is intensively fished for prawns throughout the year. Due to the nature of the seabed in the Saltees Grounds (hard, stony ground) there may be areas where sufficient burial may not be achievable which presents a risk to the long-term integrity of the cable. In comparison the soft ground of the Celtic Smalls Ground, is likely to achieve sufficient burial depth for optimal cable protection. Therefore although the Celtic Small Ground area has a much higher density of fishing activity, given that the type of fishing, (i.e. Prawn fishing which is not designed to deeply penetrate the seabed) and higher chance of achieving sufficient burial, the risk to the cable is reduced.

The areas of notable risk to a submarine cable have been identified as the area northwest of Bann Shoal and an area south of the Isle of Scilly. These areas are subject to fishing from Irish, UK and Belgian beam trawlers operating with stone mat gear over the areas of hard ground. Due to the nature of the seabed there are concerns over the likelihood of achieving target burial in these areas and although additional protection methods can be utilised these do not provide the same level of protection to the cable as burial. Therefore the effects of the stone mat gear are of considerable concern to the long-term integrity of the cable.

Static gear fishing is carried out in the inshore waters off southern Ireland and France and around the UK coast. This mostly involves potting for lobster on the hard, rocky grounds and potting for crab on the more sandy ground and for prawns on the muddy, clay grounds out and along the coast to around 6nm offshore. These activities will usually only pose a constraint upon survey and installation operations and not to the integrity of the cable once installed as these fishing mechanisms do not penetrate the sea bed. Most ports and small harbours along the Southern Irish coast have some level of commercial fishing operations based there.

2.5 COMMERCIAL CONSIDERATIONS

2.5.1 Route Length

It is clear that all aspects of cable production, marine survey and cable installation and protection will increase in cost with any increase in route length.

Based on the current assessment, the variation in option lengths are in the region of 40km, with Trunks 1 and 3, which fall inside UK territorial waters (TWs), being the shortest options, and Trunk 6 the longest.

However, there are many factors which, at this stage of the project, cannot be included in this initial route investigation that have the potential to significantly affect this constraint. For example, until geophysical & geotechnical seabed survey information is available, the detailed routing cannot be finalised, and it is unclear whether significant deviations from the initial proposals will be required.

2.5.2 UK Territorial Waters

The alignments which route inside of the Isles of Scilly would require a licence from the Crown Estate. The Crown Estate, in its role as landowner, grants licences for the right to install cables on Crown Estate property. Until application is made to the Crown Estate for the licence for installation, a precise annual cost is not known. However, based on "The Crown Estate's Head of Terms for Submarine Telecommunications Cables – Standard Licence (with effect from 1st January 2010)" the indicative annual cost of the licence would be in the region of £140K, excluding UK VAT.

Trunks 1, 3 and 6 are options that take routes inside the UK TWs and therefore will be subject to the additional consenting process and the related licence fees.

2.5.3 Sediment Type & Installation Tool

Data on sediment type is limited at this stage of the project, and is largely restricted to very low-resolution public domain British Geological Survey (BGS) charts. These depict the Quaternary seabed sediment distributions in the area of study (Quaternary sediments being those deposited since the onset of Northern Hemisphere glaciation approximately 2.6 million years ago). This mapping is largely founded on widely spaced boreholes, and in the offshore environment is generally regarded as indicative only.

With the limited information currently available for the study area, it is not possible to make accurate assumptions on cable installation tool usage and likely percentages of post-lay protection. Furthermore, none of the data available is of an adequate resolution to make a detailed determination of the comparative risks associated with alternative route options.

Whilst there are indications of potential seabed variability, this is not adequate information on which to base a comparison of commercial implications associated with a cable installation campaign. Therefore, until results of detailed corridor surveys are available, the only clearly defined variable that can be compared between possible routes is their length.

During the installation phase of the project, cable burial and protection can be provided by a number of alternative methodologies and technologies. Those likely to be considered when a detailed evaluation of the seabed has been undertaken, and an installation methodology finalised, are itemised for information purposes in Table 2.1 below.

Table 2-1: Typical Installation Methods for Different Types of Substrate in Submarine Power Cable Installation and Protection

Tool	Suitable For	Notes
Ploughs	Soft Sediments Firm Sediments	Cannot be used in fluid mud conditions. Sediment strength will affect speed of operation. This is the most favourable tool for post-glacial boulder clay conditions. Can be used for simultaneous lay and protection, or in a post-lay cable protection scenario.
Jetting Tools	Soft Sediments Not effective in stiff clays	Not normally used in fluid mud conditions. Softer sediments may temporarily increase turbidity. Operational methodologies are tracked/skids and free-flying.
Mechanical Trenchers	Firm seabed and weak rock	Tend to be utilised for short sections of a route only due their very slow progress rates. Can be chain or wheel cutters. In some instances, potential progress uncertainty makes this option less favourable than post lay protection by rock dumping.
Rock Placement	Rock/Hard substrate Crossing transitions	Design of rock berm depends on several conditions. May have to be used in conjunction with trenching if initial protection deemed insufficient.
Concrete Mattress Placement	Cable/Pipe crossings. Short areas of difficult trenching	Can be used for sections of cable protection where trenching is deemed impossible or ineffective. Certain vulnerability to snagging on fishing gear.
Cast Iron Cable Shells	Short sections of seabed where trenching is difficult or impossible and rock/mattress placement is not an option.	Some basic protection afforded to surface laid cables.
Landfall Construction - Horizontal Directional Drilling (HDD)	Various conditions	Used when open-cut trenching is not practical, or when construction impact is to be minimized.
Landfall Construction – Open Cut Trench	Various conditions	Trench opened through intertidal zone and up to Transition Joint Pit (TJP) location. Traditional method, often substituted by HDD in more recent projects where construction impact is of concern.

2.5.4 Vessel Hire & Rates

The cost of vessel hire will depend on vessel availability, market conditions and the timing of the work to be completed. The cost will also vary depending on the technical capabilities of the ship and the requirements for the work. Vessels are typically charged at a rate per day and do not include the following:

- Weather downtime
- Maintenance downtime
- Mobilisation
- Demobilisation

A greater understanding of these elements of the commercial package will be developed at the pre-installation phase of the project when the installation design is defined and the projected installation date is proposed.

3 OVERVIEW OF TRUNK CONSTRAINTS

This section provides an overview of the key technical, environmental and third party constraints for each trunk 1-6 along with their risk classification. A summary overview is present in Table 3-1.

Detailed ranking matrices for each trunk are contained in a separate spreadsheet ("Celtic Interconnector - Route Investigation Report - Route Ranking Matrix.FINAL.xls").

3.1 RANKING OF CONSTRAINTS

Bathymetry/Areas of <20m Water Depth have been classed as 'Challenging' constraints due to extensive areas of shallow water resulting in the requirement for a shallow water barge and a cable joint.

In-Service cable crossings have been classed as 'Challenging' constraints due to the associated requirements for cable crossing agreements, potential additional protection and post installation burial.

Out-of-Service cable crossings have been classed as 'Acceptable Risks' for the associated route clearance requirement.

Seabed Sediments are ranked as follows:

- Sand based Sediments – 'No Risk'.[1]
- Gravel based Sediments – 'Acceptable Risk'.
- Clay based Sediments – 'Challenging'.
- Surface Expressions of Bedrock - 'Extremely Challenging'.

These classifications reflect the likelihood of achieving sufficient burial, the potential requirement for additional protection method and the probability of cable integrity.

Spawning Herring/Sand Eel Areas

Where the route passes through, or in close proximity to, potential herring spawning areas, this has been classified as an 'acceptable risk'. Should the selected route pass through such areas, the potential for spawning should be assessed at the survey stage and the cable re- routed to avoid these areas if necessary. Seasonal restrictions on installation activities may apply should the route pass in close proximity to these areas.

[1] The presence of sand based sediments could present a risk of mobile sandwaves in the region, which could pose a threat to the cable integrity. At this time the desktop data available does not provide the level of detail required to identify the presence of sandwaves. Therefore the assessment of risk is purely in relation to the anticipated plough progress through the sediment types. Avoidance of mobile sandwaves will be a consideration during and following the marine survey.

Wrecks

Where cable trunks passed in close proximity to wrecks this has been classified as an 'acceptable risk'. This is due to the fact that wrecks are usually avoidable as part of the micro-routing exercise performed post-survey.

Protected Sites

The level of risk associated with protected sites depends on its proximity to the potential cable route and the nature of its designation. Only sites within the range of impact of the cable and with features with the potential to be impacted were considered. All such sites were classed as 'challenging constraints'.

A summary table of the protected sites in the study area, including proposed sites, is contained in Appendix C.

Potential Annex I Habitat (PAIH)

Areas identified as PAIH for rocky reef are classified as an 'Acceptable risk'. Benthic and habitat surveys will be required to indicate whether protected habitats are present within these areas.

Traffic Separation Schemes constitute 'Challenging' constraints as co-ordination with the relevant authorities would be required for survey and installation activities.

Military Practice Areas are generally considered 'Acceptable Risks, as mentioned in Section 2.4.2, with appropriate consultation with the relevant authorities, this is unlikely to pose a significant risk to the project. However the area within the Rade de Brest identified as a French Military "Firing Danger Area", is considered a 'Challenging' constraint as a result of the likelihood that live ammunition would be used within this area.

Fishing Area constraints associated with fishing activity are classed as follows;

- Routes passing through both the Saltees Ground, identified as an area which is popular for multiple forms of fishing activity over medium to hard stony ground, and the Celtic Deep Smalls Ground which has a high density of prawn fishing activity over soft ground are considered to pose a 'Challenging risk' to a cable route. In the case of the Saltees Grounds this is due to the nature of the seabed as there may be areas where sufficient burial may not have been achievable. The Celtic Smalls Ground, although having a higher density of fishing activity, given the soft ground, where the cable is likely to achieve sufficient burial depth for optimal protection, and the type of fishing, i.e. Prawn fishing equipment is not designed to deeply penetrate the seabed results in this area also being considered a Challenging risk.
- Routes passing through or in close proximity to the areas north west of Bann Shoal and south east of the Isle of Scilly where whitefish trawling over hard ground results in an increased risk to the cable safety are identified as 'Extremely Challenging' areas.

Dumping/Disposal Areas present 'Extremely Challenging' constraints. Dumping areas include those used for dredged materials and have historically been used for munitions dumping and waste disposal. Although crossing these areas has been avoided, passing within 1km proximity of these areas presents an obvious risk to any subsurface activities in the case of explosives disposal areas. Dumping areas also pose an Extremely Challenging risk to the cable mainly post-installation through impact from a large dumped object or from a potentially unstable substrate.

Anchorages are also considered 'Extremely Challenging' given the possible costs associated system down-time and cable repair operations resulting from external aggression to a cable. Although crossing these areas has been avoided it was not possible in some cases to give more than 500m clearance. Given this extremely close proximity the likelihood of a stray or dragged anchor hit could be very high. In the approaches to Rade de Brest there is a waiting area for vessels laden with hydrocarbons or other dangerous substances, therefore there is likely to be a higher than average density of vessels within this area. It is not considered practical to avoid this area given its size however, the risk of a vessel having to deploy its anchor within this area would only occur in case of emergency, therefore the risk to the route across this area is considered 'Challenging'.

Restricted Areas have been classed as 'Challenging'. Within Brest Harbour there are large, unavoidable areas that restrict vessels from fishing, anchoring and disposal of any form. The impact from this may be that a more highly specified vessel may be required for survey and installation to ensure there would be no need for use of anchors during operations. Also it is highly possible, given the current restrictions, that subsurface operations such as would be required for cable installation would not be granted consent from the relevant authorities.

Table 3-1: Trunk Constraints Overview

	Constraint														
Trunk	Shallow Water (km)	In-Service Cable Crossings	Out-of-Service Cable Crossings	Seabed Sediment s (km)	Spawning Herring (km)	Spawning Sand Eel (km)	Wrecks / Wreck Clusters	Portected Sites (km)	PAIH (km)	Traffic Separatio n Schemes (km)	Military Practice Areas (km)	Fishing Areas (km)	Dumping / Disposal Grounds (km)	Anchorag es (km)	Restricted Areas (km)
1	Included in Branch Assessment	19	17	219 196.6	17		9	32	96	26	198	32			
2	Included in Branch Assessment	19	22	200 233.4	17		10		11 6	19	198				
3	Included in Branch Assessment	19	17	327 97.6	9	98	16	61	97	26	201	123 35			
4	Included in Branch Assessment	18	22	262 199.2	11		15	48	11 5	29	161	120			
5	2.2	19	24 +32km section	238.3 226 15	17		16	67	12 3	84	186 42		6	6 11	38
6	2.2	20	20 +32km section	392.9 82 15	9	97	18	127	83	68	193 42	123 41	6	6 11	38

4 OVERVIEW OF LANDFALL AREA CONSTRAINTS

4.1 CORK COAST LANDFALL AREA

4.1.1 Technical

The Cork Coast landfall area has relatively few technical constraints, there are no existing cables within the area and only one pipeline (Kinsale Gas export pipeline) to the west of the planned Inch Beach route. Despite the planned route not currently crossing this pipeline the cable would be in very close proximity at the landfall if this option was chosen and therefore this proximity to the pipeline is considered to be a Challenging constraint as agreement would still need to be made with the pipeline's owners.

Lengths of shallow water (<20m WD) vary across the landfalls, Inch Beach, Ballycroneen Beach and Ballinwilling Strand all have bathymetry suitable for installation directly from the main installation vessel whereas Redbarn Beach and Claycastle Beach exhibit bathymetry that is likely to result in a separate shallow water barge being required for the shallow water installation.

Finally the seabed sediment is fairly uniform across the landfall area with an Extremely Challenging band of bedrock present that is roughly 8-10km in width. However optimised routes across this band were possible at all landfalls. For example this could be potentially limited to 2km at the Ballinwilling Strand landfall and ~5km at the Inch Beach and Ballycroneen Beach landfalls. The Redbarn Beach and Claycastle Beach options however would be at risk for lengths of 8km.

4.1.2 Environmental

The Cork Coast landfall areas have relatively few environmental constraints. Branches 1 and 2 are the least environmentally constrained. All branches fall within a potential herring spawning area, which may result in a seasonal restriction to installation activities. The protected sites in close proximity to the Cork branches 3 – 5 are summarised below and listed in **Table 4-1**.

- **Inch Beach Branch 1** has one wreck within 1km of the route and does not pass within 5km of any protected areas.
- **Ballycroneen Beach Branch 2** has no wrecks or protected sites within 5km.
- **Ballinwilling Beach Branch 3** is within 5km of three protected areas: Ballycotton Bay SPA and Ramsar Site and Ballycotton, Ballynamona,and Shanagarry pNHA.
- **Redbarn Beach Branch 4** is within 5km of five protected areas: Ballymacoda Bay SPA and Ramsar Site, Ballymacoda (Clonpriest and Phillmore) SAC, Capel Island and Knockadoon Head pNHA and Ballyvergan Marsh pNHA.
- **Claycastle Beach Branch 5** is within 5km of ten protected areas: Blackwater River cSAC, Blackwater Estuary SPA and Ramsar Site, Ballymacoda Bay SPA and Ramsar Site, Ballymacoda (Clonpriest and Phillmore) SAC, Blackwater River and Blackwater Estuary pNHA Capel Island and Knockadoon Head pNHA and Ballyvergan Marsh pNHA.

Table 4-1: Distance of Branch from Protected Site

Site Name	Designation	Feature of conservation interest	Branches within 5km
Blackwater River	SAC	**Annex I habitats that are a primary reason for selection of this site:** Estuaries Mudflats and sandflats not covered by seawater at low tide Perennial vegetation of stony banks Salicornia and other annuals colonizing mud and sand Atlantic salt meadows (Glauco-Puccinellietalia maritimae) Otter (Lutra lutra) Mediterranean salt meadows (Juncetalia maritimi) Killarney fern (Trichomanes speciosum) Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation Old sessile oak woods with Ilex and Blechnum in British Isles Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) Taxus baccata woods of the British Isles **Annex II species that are a primary reason for selection of this site**: Freshwater pearl mussel (Margaritifera margaritifera), White-clawed crayfish (Austropotamobius pallipes), Sea lamprey (Petromyzon marinus), Brook lamprey (Lampetra planeri), River lamprey (Lampetra fluviatilis), Allis shad (Alosa alosa), Twaite shad (Alosa fallax fallax), Salmon (Salmo salar)	Claycastle Beach (5)
Blackwater Estuary	SPA and Ramsar site	**Supporting important winter populations of Annex II listed species:** Black-tailed Godwit (*Limosa limosa*) Curlew (*Numenius arquata*) **Supporting nationally important wintering populations of 6 bird species:** Wigeon (Anas penelope), Golden Plover (*Pluvialis apricaria*), Lapwing (*Vanellus vanellus*), Dunlin (*Calidris alpina*), Bar-tailed Godwit (*Limosa lapponica*), Redshank (*Tringa totanus*) **Internationally important wetland of conservation importance for overwintering bird species**	Claycastle Beach (5)
Blackwater River and Estuary	pNHA	Riparian vegetation, marshes and reedbeds and dry woodlands and nationally important wintering bird species.	Redbarn Beach (4) and Claycastle Beach (5)
Ballymacoda Bay	SPA and Ramsar site	**Supporting important European populations of Annex II listed species:** Black-tailed Godwit (*Limosa limosa*) **Regularly supporting at least 20,000 waterfowl:** Overwinter, the area regularly supports 22,000 individual waterfowl.	Redbarn Beach (4) and Claycastle Beach (5)

Site Name	Designation	Feature of conservation interest	Branches within 5km
		Supporting nationally important wintering populations of 15 bird species **Internationally important wetland**	
Ballycotton Bay	SPA and Ramsar Site	**Supporting European important populations of Annex II listed species:** Bar-tailed Godwit (*Limosa lapponica*) Golden Plover (*Pluvialis apricaria*) **Supporting nationally important wintering populations of 9 bird species:** Teal (Anas crecca), Ringed Plover (Charadrius hiaticula), Golden Plover (Pluvialis apricaria), Grey Plover (Pluvialis squatarola), Lapwing (*Vanellus vanellus*), Black-tailed Godwit (Limosa limosa), Bar-tailed Godwit (Limosa lapponica), Curlew (Numenius arquata), Turnstone (Arenaria interpres), Common Gull (Larus canus) and Lesser Black-backed Gull (Larus fuscus). **Internationally important wetland.**	Ballinwilling Beach (3)
Ballymacoda (Clonpriest and Phillmore)	SAC	Estuaries Mudflats and sandflats not covered by seawater at low tide Salicornia and other annuals colonizing mud and sand Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	Redbarn Beach (4) and Claycastle Beach (5)
Ballycotton, Ballynamona and Shanagarry	pNHA- 0076	Coastal vegetation and bird species	Ballinwilling Beach (3)
Capel Island and Knockadoon Head	pNHA- 0083	Coastal vegetated cliffs. Capel Island is important for nesting Cormorants, gulls, fulmar and black guillemot	Redbarn Beach (4) and Claycastle Beach (5)
Ballyvergan Marsh	pNHA-0078	Coastal sand & clay cliffs and fresh water marsh Supports a diversity of bird species including Annex I Species - Hen Harrier Important as a pre-migration stop-over point for various passerine species on their way to wintering grounds further south and as a breeding site for Reed Warbler.	Redbarn Beach (4) and Claycastle Beach (5)

4.1.3 Third Party

The third party constraints within the Cork Coast area are limited to a recreational vessels anchorage in close proximity to the Redbarn and Claycastle landfalls. However it is unlikely that anchors use by vessels of this size would be capable of penetrating the substrate to a level considered dangerous to the cable, therefore this is considered an ‘Acceptable risk’.

There is a disposal area in proximity to the Inch Beach landfall which represents a ‘Challenging risk’ to the cable in this area. Given that there is sufficient unconstrained space in this region it should be possible to minimise risk to the cable from this area as micro-routing post-survey. The Inch Beach landfall also falls within the Cork Port Authority area and therefore consent from the port authority would be required for installation.

In summary the results of the constraints study of the Cork Coast branches combined with the results from the Intertek Landfall Report are as follows:

Branch	Extremley Challenging	Challenging	Acceptable	No risk	Branch Ranking	Landfall Ranking	Overall Ranking
Inch Beach	18%	15%	68%	0%	3	2	3
Ballycroneen Beach	19%	4%	77%	0%	1	3	2
Ballinwilling Stand	8%	15%	77%	0%	1	1	1
Redbarn Beach	26%	23%	51%	0%	4	4	4
Claycastle Beach	26%	22%	52%	0%	5	5	5

4.2 WATERFORD/WEXFORD LANDFALL AREA

4.2.1 Technical

The Waterford/Wexford Coast landfall area also has relatively few technical constraints; there are no In-Service cables and just one Out-of-Service cable near to the trunk common point.

Lengths of shallow water (<20m WD) are more consistent in this area compared to the Cork Coast area with all of the Waterford/Wexford landfalls having roughly 4-6km of shallow water. This bathymetry means that dependant on the survey findings these landfalls may require a shallow draft vessel for installation and be subject to an additional cable joint.

Finally the seabed sediment is fairly uniform across the landfall area with an Extremely Challenging band of bedrock present that is roughly 8-10km in width. However optimised routes across this band were possible at all landfalls. Therefore the highest level on exposure relates to the Rathmoylen Cove branch at 4km. All of the other Waterford/Wexford Coast branches have been able to find much shorter routes across the exposed bedrock with lengths ranging between 1.5-0.5km.

4.2.2 Environmental

The Waterford/Wexford branches are within a potential herring spawning area, which may result in a seasonal restriction to installation activities.

All branches with the exception of branch 4 currently cross a protected site. The protected sites in close proximity to the Waterford/Wexford branches are summarised below and listed in Table 4-2.

- **Rathmoylen Branch 1** crosses Hook Head cSAC for approximately 17km and is within 5km of two other protected areas: Dunmore East Cliffs pNHA and Hook Head pNHA. There are three wrecks within 1km of this branch.

- **Baginbun Beach Branch 2** crosses Hook Head cSAC for approximately 8.5km and is within 5km of four other protected areas: Bannow Bay SPA and Ramsar Site, Bannow Bay cSAC, Bannow Bay pNHA.
- **Newtown Beach Branch 3** crosses Bannow Bay cSAC, Bannow Bay pNHA, Bannow Bay SPA and Ramsar Site for approximately 2.5km, and Hook Head cSAC for approximately 8km. There is one other protected area within 5km of this branch: Keeragh Islands SPA.
- **Bannow Beach Branch 4** does not cross any protected sites. The branch is within 5km of eight protected areas: Hook Head cSAC, Bannow Bay SPA, Keeragh Island SPA, Saltee Island SPA and Ramsar Site, Saltee Island cSAC, Ballyteige Burrow cSAC and Ballyteige Burrow SPA. There is one wreck within 1km of the branch.
- **Cullenstown Beach Branch 5** crosses Ballyteige Burrow SAC, Ballyteige Burrow SPA for approximately 700m. The branch is within 5km of four other protected sites: Keeragh Island SPA, Saltee Island SPA and Ramsar Site and Saltee Island cSAC.

The Waterford/Wexford landfall areas are in close proximity to European designated sites, however, routing through a protected area is feasible in certain cases. The project will have to demonstrate that it will not affect the integrity of the designated features. All activities within a European protected area, which may affect the conservation objectives of that site, will be subject to an Appropriate Assessment which will add time to the consent process. Seasonal and installation methodology restrictions on construction activities may also be applied to protect sensitive species, such as nesting, breeding or over wintering birds.

Table 4-2: Distance of Branch from Protected Site

Site Name	Designation	Feature of conservation interest	Branches within 5km
Hook Head	cSAC	**Annex I habitats that are a primary reason for selection of this site:** ▪ Reef ▪ Large shallow inlets and bays ▪ Vegetated sea cliffs of the Atlantic and Baltic coasts	Rathmoylen Beach (1) intersects for 17km; Baginbun Beach (2) intersects for 8.5km; Newtown Beach (3) intersects for 8km; Bannow Beach (4)
Saltee Island	cSAC	**Annex I habitats that are a primary reason for selection of this site:** ▪ Reef ▪ Mudflats and sandflats not covered by seawater at low tide ▪ Large shallow inlets and bays ▪ Vegetated sea cliffs of the Atlantic and Baltic coasts ▪ Submerged or partly submerged sea caves **Annex II species that are a primary reason for selection of this site:** Grey seal (Halichoerus grypus)	Cullenstown Beach (5) intersected for 700m
Ballyteige Burrow	cSAC	**Annex I habitats that are a primary reason for selection of this site:** ▪ Estuaries ▪ Mudflats and sandflats not covered by seawater at low tide ▪ Coastal lagoons ▪ Annual vegetation of drift lines ▪ Perennial vegetation of stony banks ▪ Salicornia and other annuals colonizing mud and sand ▪ Spartina swards (Spartinion maritimae) ▪ Atlantic salt meadows (Glauco-Puccinellietalia maritimae) ▪ Mediterranean salt meadows (Juncetalia maritimi) ▪ Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi) ▪ Embryonic shifting dunes ▪ Shifting dunes along the shoreline with Ammophila arenaria (white dunes) ▪ Fixed coastal dunes with herbaceous vegetation (grey dunes)	Bannow Beach (4); Cullenstown Beach (5) intersected for 700m
Ballyteige Burrow	SPA	**SPA Species:** Light-bellied Brent Goose Shelduck	Bannow Beach (4); Cullenstown

Site Name	Designation	Feature of conservation interest	Branches within 5km
		Golden Plover Grey Plover Lapwing Black-tailed Godwit Bar-tailed Godwit	Beach (5)
Saltee Island	SPA and Ramsar Site	**Annex II species that are a primary reason for selection of this site:** Fulmar (*Fulmarus glacialis*), Gannet (*Morus bassanus*), Cormorant (*Phalacrocorax carbo*), Shag (*Phalacrocorax aristotelis*), Lesser Black-backed Gull (*Larus fuscus*), Herring Gull (*Larus argentatus*), Kittiwake (*Rissa tridactyla*).Guillemot (*Uria aalge*) Razorbill (*Alca torda*) and Puffin (*Fratercula arctica*) **Internationally important wetland**	Cullenstown Beach (5)
Keeragh Islands	SPA and Ramsar Site	**Annex II species that are a primary reason for selection of this site:** Breeding Cormorant (*Phalacrocorax carbo*) **Internationally important wetland**	Newtown Beach (3); Bannow Beach (4); Cullenstown Beach (5)
Bannow Bay	SPA and Ramsar Site	**Annex II species that are a primary reason for selection of this site:** Light-bellied Brent Goose (*Branta bernicla hrota*), Shelduck (*Tadorna tadorna*), Pintail (*Anas acuta*), Oystercatcher (*Haematopus ostralegus*), Golden Plover (*Pluvialis apricaria*), Grey Plover (*Pluvialis squatarola*), Lapwing (*Vanellus vanellus*), Knot (*Calidris canutus*), Dunlin (*Calidris alpina*), Black-tailed Godwit (*Limosa limosa*), Bar-tailed Godwit (*Limosa lapponica*), Curlew (*Numenius arquata*) and Redshank (*Tringa totanus*). **Internationally important wetland**	Newtown Beach (3) intersects for 2.5km; Bannow Beach (4)
Bannow Bay	SAC	Estuaries, Mudflats and sandflats not covered by seawater at low tide, Annual vegetation of drift lines, Perennial vegetation of stony banks, Salicornia and other annuals colonizing mud and sand, Spartina swards (Spartinion maritimae), Atlantic salt meadows (Glauco-Puccinellietalia maritimae), Mediterranean salt meadows (Juncetalia maritimi), Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi), Embryonic shifting dunes,Shifting dunes along the shoreline with Ammophila arenaria (white dunes) and Fixed coastal dunes with herbaceous vegetation (grey dunes)	Baginbun Beach (2); Newtown Beach (3) intersects for 1.5km;
Dunmore East Cliffs	pNHA	Large kittiwake (gull) colonies on several cliffs, well studied.	Rathmoylen Beach (1)
Hook Head	pNHA	Sea cliff vegetation and bird species	Rathmoylen Beach (1)

4.2.3 Third Party

The singular third party constraint within the Waterford/Wexford Coast area is limited to the Rathmoylen Branch route which falls within Waterford Port Authority area therefore consent from the port authority would be required for installation; this constraint is defined as Challenging.

4.2.4 Summary

In summary the results of the constraints study of the Waterford/Wexford Coast branches combined with the results from the Intertek Landfall Report are as follows;

Branch	Extremley Challenging	Challenging	Acceptable	No risk	Branch Ranking	Landfall Ranking	Overall Ranking
Rathmoylan Cove	22%	78%	0%	0%	3	3	3
Baginburn Beach	3%	97%	0%	0%	3	4	4
Newtown Beach	2%	98%	0%	0%	3	5	5
Bannow Beach	5%	25%	70%	0%	1	2	1
Cullenstown Beach	7%	26%	66%	0%	2	1	1

Bannow Beach and Cullenstown Beach were both ranked top least constrained options; hence the overall length was used as a deciding factor. Therefore Bannow Beach branch at 19.8km, 1km shorter than Cullenstown Beach, was combined with the Trunk options to complete the route options to the Waterford/Wexford Coast.

4.3 CÔTE DES LÉGENDES LANDFALL AREA

4.3.1 Technical

The Côte des Légendes landfall area has relatively few technical constraints, there are no In-Service cables and only two Out-of-Service cable near to the trunk common point which cross the Kerfissien, Poulfoen and Mogueriec Branches. The Pontusval branch crosses one of the Out-of-Service cables and the Dibennou Branch route falls clear of both.

Lengths of shallow water (<20m WD) are mostly in the region of 2-3km in this area with the exception of the Dibbenou Branch having roughly 4-6km of shallow water. This bathymetry meaning that dependant on the survey findings these landfalls may require a shallow draft vessel for installation and be subject to an additional cable joint.

Finally the seabed sediment is fairly uniform across the landfall area with an Extremely Challenging band of bedrock present that is roughly 3-4km in width. However optimised routes across this band were possible at all landfalls of between 2-2.5km.

4.3.2 Environmental

The Côte des Légendes landfall areas have relatively few environmental constraints. The protected sites in close proximity to the Côte des Légendes landfall are summarised below and in Appendix C.

- **Dibbenou Branch 1** crosses the Abers - Côtes des Legendes SCI for approximately 4km. No other protected areas are within 5km of this branch. There are two wrecks within 1km of the route.
- **Poulfoen Branch 2 and Kerfissien Branch 3** are within 5km of two protected area: Anse de Goulven, Dunes de Keremma SCI. Kerfissien also falls within an Espaces Remarquable which imposes certain restriction on construction activities allowed. There are no other protected sites within 5km.
- **Mogueriec Branch 4** is within 5km of one protected area: Baie de Morlaix SPA. There are no other protected sites within 5km of these branches. There is one wreck within 1km of the branch.
- **Pontusval Branch 5 is** within 5km of one protected area: Anse de Goulven, Dunes de Keremma SCI. There are no other protected sites within 5km. There is one wreck within 1km of the branch.

Branch 1 is the most environmentally constrained route. All branches are considered to be minimally environmentally constrained.

Table 4-3: Distance of Branch from Protected Site

Site Name	Designation	Feature of conservation interest	Branches within 5km
Abers - Côtes des Legendes	SCI	**Annex I habitats that are a primary reason for selection of this site:** ▪ Estuaries ▪ Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	Dibbenou (1) intersects for 4km
Anse de Goulven, Dunes de Keremma	SCI	**Annex I habitats that are a primary reason for selection of this site:** ▪ Mudflats and sandflats not covered by seawater at low tide ▪ Annual vegetation of drift lines ▪ Reefs ▪ Vegetated sea cliffs of the Atlantic and Baltic coasts ▪ Salicornia and other annuals colonising mud and sand ▪ Spartina swards (Spartinion maritimae) ▪ Atlantic salt meadows (Glauco-Puccinellietalia maritimae) ▪ Embryonic shifting dunes ▪ Shifting dunes along the shoreline with *Ammophila arenaria* ▪ ("white dunes") ▪ Fixed dunes with herbaceous vegetation ("grey dunes") ▪ Humid dune slacks	Poulfoen (2); Kerfissien (3); Pontusval (5)
Baie de Morlaix	SPA	**Annex I habitats that are a primary reason for selection of this site:** ▪ Mudflats and sandflats not covered by seawater at low tide ▪ Vegetated sea cliffs of the Atlantic and Baltic coasts ▪ Salicornia and other annuals colonising mud and sand ▪ Spartina swards (Spartinion maritimae) ▪ Coastal lagoons ▪ Large shallow inlets and bays ▪ Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	Moguériec (4)

4.3.3 Third Party

The only third party Extremely Challenging risk within the Côte des Légendes area is a dis-used minefield that is unavoidable in the approach to the Dibennou landfall. This covers 6km of the route and presents an obvious risk for any marine activities within this area and especially to those activities which disrupt the seabed.

4.3.4 Summary

In summary the results of the constraints study of the Côte des Légendes branches combined with the results from the Intertek Landfall Report are as follows;

Branch	Extremley Challenging	Challenging	Acceptable	No risk	Branch Ranking	Landfall Ranking	Overall Ranking
Dibbennou	44%	43%	12%	0%	5	3	5
Poulfoen	10%	4%	49%	37%	2	4	3
Kerfissien	10%	5%	30%	55%	2	5	4
Mogureric	7%	4%	40%	49%	1	2	1
Pontusval	22%	9%	44%	26%	4	1	2

5 ROUTE RANKING CONCLUSIONS

5.1 TECHNICAL AND ENVIRONMENTAL CONSTRAINTS

From the constraints assessment exercise it was possible to identify the least constrained Branch and Landfall combination option for each landfall area as follows:

- Cork Coast; Ballinwilling Strand.
- Waterford/Wexford Coast; Bannow Beach.
- Côte des Légendes: Mogueriec.

Having defined the least constrained Branches these were then combined with the Trunk options with the associated least constrained Branches to give a complete route landfall to landfall. A summary of these final route options is given within Table 5-1.

Table 5-1: Complete Route Options

Route	Irish Landfall	French Landfall	Trunk	Length (km)	In-Service Cable Crossings
1	Ballinwilling Strand	Mogueriec	Inside UK Territorial Waters	468.8	19
2	Ballinwilling Strand	Mogueriec	Outside UK Territorial Waters	486.6	19
3	Bannow Beach	Mogueriec	Inside UK Territorial Waters	471.2	19
4	Bannow Beach	Mogueriec	Outside UK Territorial Waters	507.8	18
5	Ballinwilling Strand	Porz Meur	Outside UK Territorial Waters	505.7	19
6	Bannow Beach	Porz Meur	Inside UK Territorial Waters	509.7	20

A summary of the results of the constraints study for each complete route option is shown below in Table 5-2:

Table 5-2: Route Constraints Ranking

Route Number	Extremely Challenging	Challenging	Acceptable	No risk	Constraints rank
1	7.68%	16.68%	64.12%	11.52%	2
2	0.82%	14.02%	63.17%	21.99%	1
3	8.06%	42.28%	43.51%	6.15%	5
4	0.59%	38.44%	40.88%	20.09%	4
5	5.54%	29.46%	57.03%	7.97%	3
6	13.32%	51.80%	31.74%	3.14%	6

The results show a clear differentiation between the constraint levels for each route option. For example, Route 6 has a significantly higher Extremely Challenging or Challenging Constraint level of 65.12% compared to Route 2, the least constrained route, with a total of only 14.84% of Extremely Challenging or Challenging Constraints. Route 2 is notably less constrained than even the second highest ranking route, Route 1, which has 24.36% Extremely Challenging or Challenging Constraints.

One of the key differentiators between the route options is the fishing areas in the east of the study area which mainly affect Routes 1, 3 and 6. Furthermore, routes to Rade de Brest (Routes 5 and 6) are impacted by multiple constraints including extensive area of surface bedrock, multiple anchorage areas and disposal areas including the explosives disposal ground near to the approaches to Rade de Brest.

5.2 COMMERCIAL CONSTRAINTS

We have discussed in Section 2.5 that the currently available information relating to seabed classification and seabed morphology is of a very low resolution and indicative of regional features only.

Whilst this is a perfectly valid and conventional starting point for reconnaissance level route identification and route planning exercise, there is unfortunately a limit to the commercial assumptions for the route options that can be made with this data.

In an ideal situation, in order to further consolidate the findings of the constraints-based route ranking, it would be preferable to incorporate a detailed commercial assessment of the various routes. However, to complete this, a number of clearly defined physical and engineering limits would need to be identified, as discussed below.

As the proposed Celtic Interconnector project advances, the commercial assessment of the individual routes studied within the report can be enhanced beyond a simple comparison of route length. When the cable electrical design is finalised, the cost per km of the manufactured cable will be determined, and the decision to install as a cable bundle or separately will also have a large impact on the installation costs. The costs associated with both these factors vary with route length, but there are other route-specific variables that will only become clear when associated detailed survey work has been undertaken.

Subsequent to completion of the geophysical and geotechnical surveys, and the ultimate landfall selections in both Ireland and France, micro-routing of the cable within the survey corridor can be undertaken, a burial assessment completed, and the installation and protection design finalised. With this information, it will be possible to provide a greater resolution to installation costs and those associated with landfall construction, cable trenching and other possible protection requirements, such as rock dumping. Thus, refinement of the commercial constraints will be a progressive process.

However, it is also highly probable that a commitment to a preferred route will have already been made prior to the full suite of information becoming available.

In the meantime, for the purpose of incorporating a simple commercial comparison into this initial assessment, the route options were ranked in terms of additional length from the shortest route option, the shortest length being ranked 1 – see Table 5-3. The additional route length provides a direct indication of the additional costs per km of cable. An indicative figure for 1km of route is €1.25M.

Table 5-3: Route Commercial Ranking

Route Number	Total Length (km)	Additional Length from Shortest Option (km)	Commercial rank
1	468.8	0	1
2	486.6	17.8	3
3	471.2	2.4	2
4	507.8	39.0	5
5	505.7	36.9	4
6	509.7	40.9	6

In summary, the two routes to Côte des Légendes from each of the Irish landfall areas (Route 1 & 3) which pass inside the Isle of Scilly are the shortest options and should incur the lowest installation costs on a simple ”rate per km” basis.

6 CABLE ROUTE RECOMMENDATIONS

6.1 OFFSHORE ROUTE

Route 1 (Ballinwilling Strand to Moguericc – inside UK TWs) is the shortest route and the second least constrained route. Route 2 (Ballinwilling Strand to Moguericc – outside UK TWs) is the third shortest route and overall the least constrained route. These routes are therefore considered the favoured marine route options. A brief summary of the six routes is presented below:

Route 1

Route 1 passes within UK Territorial Waters therefore, although shorter than Route 2, this additional international jurisdiction imposes further commercial considerations due to the requirement for a Crown Estate licence. This route also passes through the fishing area north west of the Bann Shoal which is considered an 'Extremely Challenging constraint' due to the risk of cable snagging. Furthermore, Route 1 is in closer proximity to a number of MCZs and passes through areas of Potential Annex I Habitats.

Route 2

Route 2, is between 15.4 and 17.8kms longer than the two shorter routes. However it is considered one of the preferred options due to the very low presence of extremely challenging constraints and the lowest proportion of challenging constraints. The challenging constraints along this route include in-service cable and traffic separation schemes, both of which are common to all routes. The majority of the route has either no constraints or low level constraints considered to be an acceptable risk. The increased confidence in the long-term integrity of the cable (through optimal technical conditions); the minimal environmental constraints; and the reduced disruption to/from third party aspects, potentially outweighs the increased installation cost.

Route 3

Route 3 (Bannow Beach to Moguericc – inside UK TWs), although the second shortest, is the fifth least constrained. Over 50% of the route has Extremely Challenging and Challenging constraints, this potentially outweighs the commercial saving in route length. With roughly 37% of the route falling within Challenging or Extremely Challenging fishing risk areas, the likelihood of a cable routed through these areas experiencing external aggression and the associated cost of system down-time and cable repair, is likely to be significantly higher than the saving made due to the shorter route length. Route 3 also has the additional commercial cost associated with the Crown Estate licence in UK TWs.

Route 4

Route 4 (Bannow Beach to Moguericc – outside UK TWs), is the fourth least constrained and the fifth shortest route, and is therefore a less optimal route given the level of technical, environmental, third party and commercial constraints.

Route 5

Route 5 (Ballinwilling Strand to Porz Meur – outside UK TWs) is the third least constrained and is the fourth shortest route. However, it is important to note that the level of Challenging or Extremely Challenging constraints is more than double that of Route 2. Therefore, when compared to the two highest ranking routes (for both constraints and length), Route 5 is not recommended for further consideration.

Route 6

Route 6 (Bannow Beach to Porz Meur – inside UK TWs), is both the most constrained route and the longest route, and is therefore a less optimal route given the level of technical, environmental, third party and commercial constraints. Route 6 also has the additional commercial cost associated with the Crown Estate licence.

As we have observed in the final route selection ranking matrix (Ref: *Celtic Interconnector_Route Investigation Report_Route Ranking Matrix.Final*), the two routes entitled 1 & 2 have been identified as the most favourable. This is based on technical, environmental and third party constraints, along with route length**.**

Conclusion

Routes 1 and 2 have been highlighted as the preferred route options for survey. This is based on technical, environmental and third party constraints, along with route length (as a high level commercial consideration). Further commercial assessment of the two preferred routes is provided below.

6.2 COMMERCIAL CONSIDERATIONS - ROUTES 1 AND 2

Table 6-1 provides a list of typical costs based on our current understanding of the export cable installation market. Naturally, there can be considerable variation within the individual prices.

Table 6-1: Cable Installation Components – Typical Budget Estimates (as at 2014)

Activity	Day Rate, €	Mobilisation, €	Demobilisation, €
		N. Europe	*N. Europe*
Cable Load-out (Barge)	230,000	200,000	200,000
Cable Load-out (Vessel)	230,000	200,000	200,000
Pre-lay Grapnel Run	79,500	115,000	115,000
Offshore Pre-trench Survey	340,000	115,000	115,000
Cable Lay Vessel	340,000	200,000	200,000
Cable Lay Barge	230,000	200,000	200,000
Offshore Post-lay Survey	250,000	115,000	115,000
Substation Pull-in	340,000	115,000	115,000
Trenching Vessel	300,000	250,000	250,000
Rock Placement (per metre)	443	600,000	600,000
Guard Vessels	26,500	10,000	10,000
Barge Support Vessels (Tug)	127,000	95,000	95,000

Activity	Day Rate, €	Mobilisation, €	Demobilisation, €
Open cut trenching works	175,000	250,000	250,000
Cable Pull- in	230,000	5,500	5,500
Remedial Works	130,000	10,000	10,000
Jointing (optional)	170,000	5,500	5,500

As previously stressed, the public domain data on sediments is of insufficient detail to allow accurate assessment of burial techniques and estimation of installation costs with any degree of confidence. However, the present desktop study concludes that the sediment encountered on both trunk routes 1 and 2 are comparable. For example, 55% of Trunk 1 is composed of a gravel based substrate, interspersed with sandy substrates, compared with 54% of gravel substrates on Trunk 2. It is anticipated, therefore, that the same burial technique (plough) is applicable to both routes. With the information available at this stage, Intertek believes that it would not be cost-effective to change tools for relatively short sections of sandy material, where a plough could be used. Also it is worth noting that the installation contractor will usually minimise the number of tools used during installation (to reduce the number of mobilisations).

At the landfalls, the BGS data, although not comprehensive, indicates areas of bedrock on both routes at each end and, therefore, rock placement is likely to be the preferred cable protection choice for both routes.

Given the similarity between routes 1 & 2 in terms of substrate and hence likely cable burial/protection techniques, the only parameter that has an acceptable level of resolution is the route length. Therefore, the most appropriate commercial evaluation at this stage must simply be a relative percentage cost difference based on the comparative route lengths.

In the case of most favourable Routes 1 & 2, for instance, there is an 18km length difference with R1 at 469km and R2 at 487km.

On that basis alone, we can say that a cable system following R2 is likely to be around 4% more expensive to procure and install than a system following R1.

However, it is clear that that the costs associated with the unknown parameters in Table 6-1 will potentially be more significant than this relative difference. That leads to the conclusion that in commercial terms, at this stage of the project, they can be considered comparable.

6.3 CONCLUSION

Routes 1 or 2 are considered the preferred routes for survey. Ultimately, given that Route 2 is the least constrained and that Route 1 passes through UK territorial waters, which would commit the project to the undefined annual cost of a lease from The Crown Estate, Intertek would advise that Route 2 should be taken forward to marine survey.

6.4 LANDING OPTIONS

It is advised that the marine survey tender scope should include more than one branch option. This enables landfall option flexibility to be maintained and allows for redundancy in case of the preferred landfall or nearshore marine route becoming unavailable/unviable due to unforeseen circumstance. The top three least constrained Branches for each landfall area are as follows;

- Cork Coast:
  1) Ballinwilling Strand.
  2) Ballycroneen Beach.
  3) Inch Beach.

- Waterford/Wexford Coast:
  4) Bannow Beach.
  5) Cullenstown Beach.
  6) Rathmoylen Cove.

- Côte des Légendes:
  7) Moguériec.
  8) Pontusval.
  9) Poulfoen.

7 REFERENCES

Intertek, December 2013 - Land Report (Ref: P1812_R3400_RevO), Intertek

Intertek, November 2013 - Land and Marine Consultant Workshop, Ireland (P1812 _XNov29_Rev0)

Intertek, January 2014 - Land and Marine Consultant Workshop, France (P1812_YJan01_RevO)

ESBI, February 2014 (Ireland – France Interconnector - Feasibility Study - Converter Station Site & Route Selection in Ireland, Report No. PE424-F0000-R000-024-000)

C&S Conseils, November 2013 – Projet de Liaison Celtic Interconnector – Partie Terrestre Française, Etude de Contexte.

RSK, September 2013 - Consents Required for HVDC Interconnector and Associated Infrastructure in Ireland, UK and France (Ref: Briefing note P80502)

JNCC (2014), Habitat account – Marine, coastal and halophytic habitats. http://jncc.defra.gov.uk/ProtectedSites/SACselection/habitat.asp?FeatureIntCode=h1170 [Accessed Jan 2014]

Duchas The Heritage Service (2014), Living With Nature – The Designation of Nature Conservation Sites in Ireland

Inventaire National du Patrimone Naturel (INPN) (2014), Abers - Côtes des Legendes. http://inpn.mnhn.fr/site/natura2000/FR5300017

Inventaire National du Patrimone Naturel (INPN) (2014), Anse Goulven, dunes Keremma. http://inpn.mnhn.fr/site/natura2000/FR5300016

Inventaire National du Patrimone Naturel (INPN) (2014), Baie de Morlaix. http://inpn.mnhn.fr/site/natura2000/FR5300015

JNCC (2014), http://jncc.defra.gov.uk/page-162

National Parks and Wildlife Service (2014), Natural heritage Areas (NHA) Site Synopses Archive. http://www.npws.ie/protectedsites/naturalheritageareasnha/

Appendix A Cable Engineering

A.1 Cable Engineering

A.1.1 Introduction

At this initial stage of the project the installation method of bundling or separate installation for the HVDC cables is not confirmed. This will have a large impact on both the handling of the cables and also the burial techniques.

Currently bundled HVDC cables have not been installed by ploughing. Installers are extremely wary of the high risk of damage to one or all of the three cables to be installed - 2 x HVDC conductors & 1 optical fibre cable for “Supervisory Control and Data Acquisition” (SCADA). For a single core submarine cable it is not common to have the optical fibres integrated into the cable.

A recent advent to the European area is the use of a Vertical Injector burial system, a barge with a large jetting tool which is attached to the side of the vessel. This tool has been used successfully on telecom cables in soft sedimentary areas where extreme depth of burial is required (e.g. in harbours) further discussion on this type is provided in Section A.4.

This has led to a general practice of surface lay with post burial jetting equipment. This method carries the risk of not achieving suitable burial depths in areas of little sediment over harder substrates. In such situations, the remedy is to lay concrete mattresses or rock dumping for additional protection. Both of these can incur large costs and have the risk of long term loss of protection due to fishing and seabed sediment mobility, resulting in future re-application of mats or rock.

A.1.2 Pre-Installation Methodology

Survey and Preparation Phase

The first offshore task on a cable project is to conduct surveys to acquire sufficient information to carry out a robust route design. Typically, on many cable projects this has consisted of a single mobilisation with perhaps a smaller vessel being used for the very shallow nearshore areas. However, as the size of the cables increase and the value of the assets grow, the operation becomes more similar to a pipeline project, where a multi-faceted approach to survey is often undertaken. Traditionally, the survey would have been conducted with a broad brush approach, collecting bathymetric data and basic geophysical data with some basic geotechnical sampling to ground-truth the geophysical interpretation.

However, as the awareness of achieving the correct burial criteria for long term asset integrity is growing, it is increasingly common to mobilise a separate vessel to undertake a comprehensive geotechnical testing program. On some occasions, a separate detailed survey is undertaken of critical areas where higher resolution bathymetry is acquired to add greater resolution to the data set.

Following the award of the installation contract, the installation contractor will conduct a pre-installation survey to determine whether the seabed has changed in any way or debris has accumulated on the route since the initial survey. It should be noted that if the contractor identifies conditions or factors in this survey that affect the installation program or their ability to meet the terms of the contract, then claims or variations are likely to be submitted. It is therefore imperative that the most comprehensive data set is acquired at the outset to avoid problems later in the project. Similarly, it is nearly always the case that money spent on a comprehensive survey campaign will be pay dividends in later stages of the project - most importantly with the geotechnical data collection which the burial assessments will be based on.

Installation Phase Planning

At this stage the actual rate of installation is difficult to ascertain. This is a function of a multitude of variables, and until the processes of route selection, soil conditions, burial depth, cable type, single or bundled arrays and choice of vessel are developed enough to finalise a design, and it is not feasible to attempt to estimate installation rates or durations.

In particular, regardless of the choice of cable installation methodology, the overriding factors that will influence the speed of the installation program are the soil conditions, choice of trenching tool and the weather encountered during the installation operation.

Suffice to say that when a design is finalised, the installation contractors will conduct their own studies to fully detail the planning utilising various combinations of their own equipment.

Route Clearance

Prior to offshore cable installation the contractor will undertake a PLGR (Pre Lay Grapnel Run) operation to ensure that all obstacles are removed from the path of the planned cable.

A grapnel (often on wheels), such as the one shown in Figure A-1, is towed along the seabed along the route to try to snag undetected objects. This is primarily to ensure that objects and debris do not interfere with the trenching equipment.

Figure A-1: Wheeled grapnel aboard a cable ship

A.2 Corridor Widths

The issue of the required corridor width will ultimately reflect the method of bundling or separate HVDC conductor installation. The corridor width should allow for:

- Clearance for installation.
- Long term operation and maintenance capability.
- Potential of third parties requiring the seabed adjacent to them.

The process itself depends on the depth of water, number of cables and is scalable in its application.

For two cables that need to be installed (but not bundled) there needs to be sufficient space between them to allow for plough or other burial tool over run, in shallow waters the ability for barges to dry out without being on top of the cable, and during repairs for the repair bight to be laid out.

This has given a general shallow water minimum spacing (in up to 50 m water depths) of 50m between two cables.

If there are additional cables, the adjacent spacing will be much greater and allows for the following:

- Placement of anchors.
- Final bights from repairs or installation requirements.
- If necessary separate seabed ownership/jurisdiction.

This spacing is generally 200m and allows for the above scenarios. If the seabed is extremely soft in nature, to ensure a safe placement of anchors this spacing may be widened.

For Celtic Interconnector, the corridor would be assumed as either a bundled two corridor swathe or in the case of unbundled, a four cable corridor swathe (the SCADA is assumed to be installed with one of each pair of conductors).

Thus for a two and four cables cable swathe in less than 50m water depth, with 250m outer protection areas the corridors required are outlined in Tables A-1 and A-2:

Table A-7-1: Two cable corridor swathe

Item	Width (m)
Outer protection area	250
Cable 1	
Between Cables	50
Cable 2	
Outer protection area	250
Total	**550**

Table A-7-2: Four cable corridor swathe

Item	Width (m)
Outer protection area	250
Cable 1	
Between Cables	50
Cable 2	
Spacing for Maintenance and anchors	200
Cable 3	
Between Cables	50
Cable 4	
Outer protection area	250
Total	**800**

A.3 Installation Methodology

Landfall Installation

A.3.1 Selection criteria

An optimal landfall site is characterised by a wide, gently sloping sandy beach area in front of low lying land. This, coupled with good access, a suitable lay-down area and no environmental restrictions (e.g. presence of protected sites or species which could result in consenting risk, seasonal restrictions, or installation methodology restrictions) could provide a perfect cable landfall.

However, due to the environmental, technical and financial limitations, it is preferable to identify landfalls sites which represent a balance between technically feasible and environmentally acceptable landfall techniques.

A.3.2 Cable landfall works

The transition joint pit (TJP) houses and provides protection to the marine/land cable joint. It is typically constructed of concrete approximately 6m x 2m x 3m. The optimum position for the TJP is likely to be on the beach above the high water mark, where the exit for the cable is positioned at the target burial depth. There are a number of factors which could cause the relocation of the TJP away from an optimum location, for example Horizontal Directional Drilling (HDD) techniques may be required to avoid impacts on environmentally sensitive areas or sea defences.

The cable must be protected along the whole length of its route from the beach, through the intertidal zone and seawards along the seabed. There are a number of methods of providing this protection but the most effective is usually burial. This provides adequate protection from external hazards and removes any danger to the public.

In the intertidal area, excavators are generally employed to dig a trench for cable burial between the TJP and a position where marine burial tools will become effective. It should be noted that burial tools such as ploughs can often be pulled up the beach at high water, as shown in Figure A-2, closer to the joint pit, reducing the area where excavators are required. Trenches can either be dug prior to the cable being pulled ashore, or the trench is excavated once the cable has been pulled ashore. Trench widths are likely to be approximately 1m and depths are dependent on the contractual requirements for burial.

If HDD is required, heavy plant access must be available to both the entrance and exit points of the bore hole for the HDD rig. The HDD exit point can be designed to be either above or below the low water mark. Diver intervention will be required should the exit point be below low water. A conduit is usually installed inside the bore hole to prevent collapse and allow the cable to be pulled through.

Figure A-2: Cable plough on beach

An HVDC HDD pull in is generally recommended to be no longer that 1,000m and this is ultimately dependent on the cable design and if it is able to withstand the expected pulling forces during the operations.

A.3.3 Required lay-down areas & timescales

A typical compound size for an HDD operation is 3,000m^2. This will house the required equipment and allow the drilling of a number of bores. Timescales will be dependent on the lengths of the bores and the soil conditions.

A typical compound size for a beach pull and joint area is around 2,000m^2 to 3,000m^2. This will accommodate the joint pits as well as the additional equipment such as cable haulers, excavators, portacabins and other ancillary equipment. A beach pull operation can take up to 3 days, dependent on tides and working limitations.

Landing

In principle there are two methodologies available to land an HVDC cable:

- Direct from the main cable installation vessel (ship or barge).
- Using a barge to install a separate nearshore/shore end cable section.

The direct method is preferable as no cable joint is required between the separate shore end and the main cable section.

The maximum direct pull in length for an HVDC cable is in the order of 1,000-1,500m. This distance is a factor of the weight of the cable and the maximum tension that can be applied during the pulling operations.

Therefore the method of landing the cable, direct shore end operation or separate shore end operation, will be determined by the distance between the cable haul in position and the position offshore where the cable vessel can safely set up - usually at water depths > 10m.

If the distance is greater than 1,500m then the use of one of the following is considered:

- An interim support vessel during the pull.
- A separate shore end/nearshore barge.
- The use of a barge for the whole operation.

In the case of landings where the cable is to be landed via a HDD duct, the pull in length may be further limited by the friction generated within the duct, but it is possible to inject lubricants into the duct to specifically reduce friction during the pull.

In addition to the HDD length the direction of the HDD in relation to the sitting of the installation vessel may hinder the options and further determine the installation strategy, for example the use of additional vessels to carry out the cable landings.

Separate Shore-end or Nearshore Installation

In the case of a separate shore end installation, the sequence of events to land the cable is similar the those for a direct landfall from a single installation vessel, however, in this case the operation is carried out by a shallow draft barge, which can operate in water depths of less than 5m and if the vessel operators permit, can be grounded between tides when necessary. The barge will land the cable and proceed to lay the cable out to a point where the main lay vessel can gain access. Figure A-3 shows a barge laying the cable from shore.

The barge will then pass the end of the separate shore end cable to the main lay vessel, where an in-line joint to the main lay cable will be constructed. Where the near-shore and main-lay are to be carried out at different times, the cable end is laid down with suitable end sealing and recovery line attached.

Figure A-3: Cable lay barge offshore end with plough on the beach

Direct Landing

Once the cable ship is set up in position, using moorings or dynamic positioning (DP) depending on conditions, a messenger line is sent ashore to the beach team, or to the HDD exit point where it is joined to preinstalled pulling rope.

Using this messenger line, a hauling line is set up between the vessel and a winch on the beach or at the landside opening of the HDD duct.

Cable is then paid out from the cable ship, with floats attached at appropriate intervals, to provide sufficient buoyancy to support the cable.

The cable end is then floated ashore, hauled by the winch and landed on the beach, or guided into the mouth of the HDD duct, removing floats as required.

The cable end will then be pulled up the beach or the HDD duct to the TJP area where it will be secured. Once secured, the floats will be cut off the cable by divers starting at the beach towards the cable vessel.

As the floats are progressively cut off, the cable sinks to the seabed on the cable line, when all the floats have been removed, the cable installation vessel can commence the main lay.

Vertical Injector

An alternative version of the nearshore barge is a Vertical Injector system. This utilises a different burial tool to permit suitable burial. A large jetting share is deployed which the cable(s) are placed with surface fed jetting pumps providing large volumes of water. Figure A-4 shows a vertical injector vessel with the injector unit overboard.

This installation system has the ability to install a bundled system; with reduced risks of handling which a plough and their share depressors would pose if this method was used.

This type of vessel has the ability in suitable seabed to install a cable far greater than other systems (approximately 10m). Consideration on burial depth is important for power cables and their ability to dissipate the heat generated.

Figure A-4: Vertical injector vessel with injector unit over board

Source: www.marinetraffic.com

The use of this vessel type may provide an integrated solution which may:

- Install a full bundled system from shore to a position to handover to a main-lay vessel.
- Install a bundled system where corridor widths constrain the ability to install (near shore or within areas of high constraints where a full corridor is not possible).
- Install within sandwaves providing burial below the troughs of the sandwaves.
- Deep burial in areas of high anchoring risk.
- Deep burial in areas of known or potential dredging (within ports or port approaches).

The vessels do have limitations on the depth of water and cumulative depth of water which the system can operate, being approximate 50m including the tidal range to be encountered.

This system of installation has recently been used off North Wales (Aug - Nov 2011) as part of a HVDC interconnector project (Eirgrid, East-West Inter-Connector EWIC).

Main Lay

Depending on the specified burial method, the cable vessel will either launch the plough and commence simultaneous lay and burial, or commence surface laying.

Ploughing has been specified for major HVAC systems in the past and if successful will generally produce better burial results than post lay burial.

Figure A-5 shows an example of a cable plough. However, for HVDC this process has not been carried out to date due to the requirement for bundling the cable and it passing through the plough in this arrangement. This is technically difficult and has been substituted for post lay burial on some projects.

If surface laying, a second support vessel will usually be used to operate the jetting or trenching spread and this will follow the main lay vessel.

During the period between the cable being surface laid and the burial of the cable, it is recommended that guard vessels are employed to protect the cable.

Figure A-5: Cable plough

Depending on the method of burial (see Table A-7-3), the sediment over the cable can be reinstated mechanically or naturally by normal sedimentary processes. Where cable burial is not possible (e.g. pipeline / cable crossings), mechanical protection will be required using concrete mattresses or rock placement.

Table A-7-3: Cable burial methods

Burial Method	Description
Ploughing	Ploughing is suitable for most types of seabed material, with the exception of rock and some glacial material. The cable is fed from the vessel, through the plough share into the seabed. The forward blade of the plough cuts a narrow trench into the seabed and holds it open long enough to depress the cable into the bottom of the trench. The seabed then closes behind the plough.
Jetting	Jetting is most effective in sandy sediment, and may not be capable of burying cable in more cohesive sediment. Two methods of jetting are typically available: Fluidising the seabed: the cable is laid on the seabed, where a jetting sledge flushes water below it, fluidisng the sand. The cable sinks by its own weight to the depth set by the operator. This will result in increased suspended sediment compared to ploughing or forward jetting. Forward jetting a trench: Water jets are used to jet a trench ahead of the cable lay. The cable can typically be laid into the trench behind the jetting tool. *Jetting and ploughing may be used in combination.*
Rock cutting / trenching	A trench is excavated, displacing the sediment to alongside the trench. The cable is subsequently laid in the trench and the sediment is either returned to the trench or left behind. This can provide an option for burial in harder substrates where the plough and jet burial may not be effective. However, the progress of these machines can be slow and expensive.

A.4 Cable Burial

Initial Burial Recommendations

The key to installation burial will primarily depend on the installation method utilised and the seabed conditions and geology along the route.

A.4.1 Seabed geology

Determining the thickness of the sands and gravels is fundamental to planning the installation and burial methods. A review of expected geophysical data from the area may provide a good baseline understanding of the anticipated thickness ahead of conducting the full route surveys. However, this should never be used for anything other than an indicative preliminary appraisal.

Final burial methodology can only be developed following a thorough burial assessment study (BAS) which will include a review of all constraints, including morphology, slope angles and an appropriate assessment of scour potential. This work will primarily be informed through the geophysical and geotechnical survey work. A full cable risk assessment is recommended, to calculate burial depths, once the geotechnical survey results are available.

A.4.2 Third party threats – fishing

While burying the cable to 0.5m would theoretically protect the cables from interaction with fishing gear, there will be areas of mobile seabed on the route and any changes in seabed profile may result in reduced cable burial which may present risk.

A.4.3 Third party threats – commercial shipping

The risk from commercial shipping hazard is that an anchor is deployed directly onto a cable or dragged into it, either by negligence or as the result of an emergency situation. Contact with an anchor is very often disastrous for submarine cable as the kinetic energy of a moving anchor may be extremely high. Also the power of ships' windlasses will often be great enough to lift and damage a cable should it be hooked.

Risks may result from:

- Negligent anchoring.
- Emergency anchoring (where an anchor is deployed to prevent a collision or grounding situation).
- Accidental anchoring (where an anchor falls unexpectedly from a vessel due to equipment failure or operator error).
- A vessel being anchored inadequately and a dragging episode results.

Anchor drag may occur through:

- Laying out insufficient scope of anchor cable, bearing in mind the mass of the anchor chain in the scope mainly constrains the vessel, or
- The forces acting on the vessel being or becoming greater than the holding power of the anchor or ground, usually following deterioration in weather.

The incidence of negligent anchoring was thought to be rare in UK waters. However, since the requirement for all vessels over 400 GRT on international voyages to have Automatic Identification System (AIS) transmitters fitted, and the opportunity for cable owners to identify vessels in the vicinity of cable faults at the time of the damage, it has emerged that faults that have previously had an unknown cause, or were attributed to fishing activity, have actually been the result of vessels losing their anchors, or anchoring indiscriminately.

The depth an anchor will penetrate to will vary with the mass, size and design of anchor, the sediment type and strength and the towing force applied to the anchor via the anchor chain. Many permutations are possible with these parameters and therefore a 'model' anchor size representing the whole ship profile is used to determine a typical embedment depth.

The "Hall" pattern anchor is used as a model as this is typical of standard Admiralty or US Navy standard type anchors in common use, especially on older and former eastern bloc vessels. This type of anchor has a relatively long fluke length for its unit mass and a greater opening angle, which creates more penetration for a given fluke length.

In determining penetration depth it is assumed that the anchor will always penetrate to its design depth, but no further. It is assumed the ground in the relevant section of the cable route is 'good holding ground' with medium to dense sand.

The maximum anchor penetration depth is estimated to be 1.5m; however this will vary depending on seabed conditions. In areas of hard ground this penetration will be reduced.

We recommend that a full burial risk assessment is carried out, using the results of the geotechnical survey and that the target burial depth is determined for each section of the cable depending on external threats levels and the local geological conditions.

A.5 Additional Cable Protection

Cable and Pipeline Crossings

Additional cable protection measures will be required at cable and pipeline crossings in order to protect and separate both the crossed cable or pipeline and the crossing power cable.

This protection is normally in the form of pre-lay and post-lay rock placement, or the installation of concrete mattresses.

The aim in both cases is to stabilise the crossing point and create a vertical separation of, typically a nominal 0.3m between the two assets, and ultimately to provide adequate protection for the asset raised above the seabed at the crossing.

The design of the crossing will depend on local conditions and the requirements of both the crossed and crossing parties. It will also be necessary to check the implications of crossing live cables from other developments as this may affect the crossing design, and whether multiple cables and bundles will have the same basic criteria for pipeline crossings.

As commercial and technical crossing agreement is entered into, it is recommended that at least 12 months is allowed for negotiation of the commercial agreements. The technical component is generally agreed during the later stages of pre-installation when vessel and burial equipment has been determined and method statements agreed.

Nearshore & Landing Areas

Cables are usually buried in near shore and landing areas. However, due to certain conditions such as mobile sand waves, strong currents and high wave loading, the protective sediments may be washed away over time, leaving the cables exposed.

In these situations, additional cable protection such as rock placement, concrete mattresses, grout bags and frond mats may be applied to stabilise the cables. Additional permits, consents and surveys will be required for these works due the introduction of new substrates to the seabed which may have some effects on commercial fisheries and benthic communities.

Appendix B Marine Nature Conservation Sites

B.1 Key Legislation

B.2 The Convention for the Protection of the Marine Environment of the North-East Atlantic 1992 (OSPAR Convention)

The United Kingdom, Ireland and France are contracting parties to the 1992 OSPAR Convention with the Department of Environment, Heritage and Local Government co-ordinating for Ireland, the Department for Environment, Food and Rural Affairs (Defra) for the UK, and PREMAR for France. The main aims of the convention are:

- Hazardous Substances – to reach concentrations equivalent to near background levels for naturally occurring substances and close to zero for man-made synthetic substances in the marine environment.
- Radioactive substances – to reach concentrations equivalent to near background values for naturally occurring substances close to zero for artificial radioactive substances in the marine environment.
- Eutrophication – to eliminate eutrophication where it occurs in the north east Atlantic and to prevent further occurrences.
- Protection of ecosystems and biological diversity – entry in to force of the new Annex, and identification of human activities that need to be addressed under it, along with promoting the establishment of a network of marine protected areas.

B.3 Environmental Impact Assessment Directive (EU Directive 85/336/EEC as amended by 97/11/EC and 2003/35/EC)

The Environmental Impact Assessment Directive applies to the assessment of the environmental effects of developments that are likely to have significant effects on the environment. Member States of the EU are required to adopt all measures necessary to ensure that, before consent is given, projects likely to have significant effects on the environment by virtue of their nature, size or location, decisions are made subject to a requirement for development consent and an assessment with regard to their effects.

B.4 The Habitats Directive (92/43/EEC)

The Habitats Directive 92/43/EEC manages the conservation of natural habitats and of wild fauna and flora and aims to sustain biodiversity through the conservation of natural habitats and wild fauna and flora in the territory of European Member states. These targets are met through the establishment of Special Areas of Conservation (SACs). The directive has been transposed to member states law through the Conservation Regulations 1994 (UK), European Communities Regulations 1997 (Ireland), and Wildlife Amendment Act 2000 (France). The directive requires that any activities, plans, or projects inside or outside a Natura 2000 site that are likely to have a significant effect on the conservation status of the site's features, shall be the subject of an Appropriate Assessment of the implications for the site in view of the site's conservation objectives.

Therefore where a potential cable installation is located within, or would be likely to significantly affect, a designated, proposed, or candidate 'Natura 2000' Site (SAC and/or Special Protection Areas (SPA)), consenting authorities must ensure an 'Appropriate Assessment' (as part of a Habitats Regulation Assessment (HRA)) is carried out under the Directive.

B.5 The Birds Directive (2009/4147/EC)

Offers protection for wild birds, their eggs, nests and habitats in the EU by the protection of potential habitats, where the preservation, maintenance or restoration of a sufficient diversity and area of habitats is essential to the conservation of all species of birds. These targets are met through the classification of Special Protection Areas (SPAs) under the Directive which are also categorised as Ramsar sites.

B.6 The Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971 (Ramsar Convention)

Ireland, the UK, and France are signatory to the Ramsar Convention. This allows for the designation of wetlands of international importance. The sites are known as Ramsar sites. In all three countries Ramsar sites are afforded the same level of protection as European sites within the Natura 2000 network and are treated accordingly.

B.7 Council Directive 2000/60/EC (The Water Framework Directive)

Ireland, the UK and France are signatory to the European Water Framework Directive (WFD). This aims to protect and enhance water bodies within Europe and covers all estuarine and coastal waters (including nearshore marine) out to a distance of 1 nautical mile.

Potential Designations

B.7.1 Recommended Marine Conservation Zones (rMCZ)

The MCZ Project consisted of four regional MCZ projects covering the south-west (Finding Sanctuary), Irish Sea (Irish Sea Conservation Zones), North Sea (Net Gain) and south-east (Balanced Seas). The Celtic Interconnector project crosses the Finding Sanctuary area. MCZs aim to conserve areas of UK waters, protecting rare, threatened and representative habitats and species and helping to ensure long-term sustainability of marine resources. Social and economic factors are taken in to account when identifying and possible sites. MCZs complement existing marine protected areas such as SACs and SPAs.

Between December 2012 and March 2013, formal public consultation was held on all recommended MCZs and DEFRA indicated which sites they felt had a case for designation in 2013. Within the Finding Sanctuary project area, two rMCZs have been taken forward as designated MCZs; East of Haig Fras and the Scilly Isles MCZ. The remainder of the recommended areas are currently under review, and may become designated at some point in the future.

The rMCZs not taken forward for designation in 2013 have been considered as if they are designated as their future status is uncertain. Cable burial within a rMCZ is considered acceptable if the integrity of the broad scale habitat (BSH) or feature of conservation interest (FCI) are not adversely impacted, and if cable protection measures are kept to a minimum (MMO pers comms 2013).

B.7.2 Potential Annex I Habitat (PAIH)

There are four marine habitats present in UK waters away from the coast for which the European Commission has stated that additional SACs must be designated. Habitat types listed on Annex I to the Habitats Directive include:

- Sandbanks which are slightly covered by seawater all the time.
- Reefs.
- Submarine structures made by leaking gases.
- Submerged or partially submerged sea caves.

JNCC and the Statutory Nature Conservation Bodies (SNCBs) are currently working to identify areas which may contain these habitat types, to put forward for designation. Possible areas have been mapped as Potential Annex I Habitat (PAIH). Areas identified as PAIH do not necessarily comprise Annex I habitats, and require verification via survey to confirm the presence and quality of PAIH.

A large area within the Celtic sea has been identified by JNCC as being PAIH rocky reef. The PAIH are areas where available evidence suggests that Annex I reef may be present. The Annex I habitat, bedrock and stony reef, occurs where bedrock, boulders and cobbles arise from the surrounding seabed. This habitat has strong vertical zonation and can support a variety of benthic communities including corals, sponges and sea squirts as well as fish and crustaceans such as crabs and lobsters (JNCC 2014). . Reef habitat is particularly vulnerable to disturbance by cable installation due to the slow recovery rates it exhibits to damage. The absence of annex I habitat must be established through survey to enable cable laying to proceed through the area. If identified the cable route may be micro routed to avoid impacting the habitat.

B.7.3 Proposed Natural Heritage Area (pNHAs)

Within Irish waters, this is an area considered important for the habitats present or which holds species of plants and animals whose habitat needs protection. Statutorily proposed for the significance of wildlife and/or habitats. The status offers limited protection from development until formally adopted, however for the purposes of cable routing these areas will be treated as though they are fully designated.

B.8 Key Designations within the Celtic Interconnector Study Area

Designation	Description
Special Areas of Conservation (SAC)	Under the EC Habitats Directive (92/43/EEC) and relating to habitat types with certain pecies/habitats listed for protection in the Annexes of the Directive. In the UK all onshore SACs will also be designated as Sites of Special Scientific Interest (SSSIs). There are a number of sites in the UK at varying stages of the SAC selection process (stages described below).
Candidate Special Area of Conservation (cSAC):	European Designation. A site has been submitted to European Commission (EC), but has not yet had formal approval from Europe. There are currently five offshore cSACs in the UK.
Possible Special Area of Conservation (pSAC)	European designation. A site that has had Cabinet Committee approval to go to consultation. A site remains a pSAC until it is submitted to the EC. There are currently six offshore pSACs in the UK.
Draft Special Area of Conservation (dSAC)	European designation. A site that has been formally recommended to Defra by JNCC. A site remains a dSAC until it has had Cabinet Committee approval to go out to formal public consultation. There are currently two offshore dSACs in the UK.
Site of Community Importance(SCI)	European Designation. Following approval for designation the cSAC is considered to be a Site of Community Importance (SCI) by the European Commission until it is formally designated by a nations government.
Special Protection Areas (SPA)	European designation. Special Protection Areas (SPA are statutory designated sites that are classified under European Union (EU) law in accordance with Article 4 of the EC Directive on the conservation of wild birds (79/409/EEC) (known as the Birds Directive). They are classified for rare and vulnerable birds, listed in Annex I of the Birds Directive, and for regularly occurring migratory species. In the UK all onshore SPAs will also be designated as SSSIs.
Ramsar sites	International designation. Designated under the Convention of Wetlands (Iran, 1971), which requires member states to designate wetlands that meet the criteria for inclusion on the List of Wetlands of International Importance (Ramsar list). In the UK all Ramsar sites will also be designated as SSSIs and many will also be SPAs.
Recommended Marine Conservation Zones (rMCZ)	UK National Designation. A site which has been recommended to JNCC, NE and the science Advisory Panel by the regional MCZ projects.
Sites of Special Scientific Interest (SSSI) ZNIEFFI	UK National designation. An area of land or water (above mean low water) designated under the UK Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000). They provide legal protection for the best areas of wildlife and geology.
National Nature Reserve (NNR)	UK National designation. A nationally important nature reserve designated by Natural England under the Wildlife and Countryside Act and managed

Designation	Description
	by either Natural England or an approved body. NNRs will usually be designated as SSSIs.
Natural Heritage Areas (NHA)	Irish designation. This is an area considered important for the habitats present or which holds species of plants and animals whose habitat needs protection.
Annex 1 Habitat	European Designation. Member States to take measures to maintain or restore natural habitats and wild species listed on the Annexes to the Habitats Directive at a favourable conservation status, introducing robust protection for those habitats and species of European importance.
Important Bird Areas Zones Importantes pour la Conservation des Oiseaux (ZICO)	International. Non statuatory. These are areas of major interest harboring wild birds staff considered of European importance. These are areas that are home to significant numbers of birds, whether species crossing staging, wintering or breeding, reaching numerical thresholds at least one of three criteria: global significance, European significance, importance in the European Union.
Important Natural areas for Fauna and Flora (ZNIEFF1)	French designation. It is areas with a biologic interest including rare species, protected or endangered species. These areas do not have a formal designation, but are restrictive for settlement projects.
Important Natural areas for Fauna and Flora (ZNIEFF2) Zones Naturelles d'Importance pour la Faune et la Flore	French designation. They are extensive rich natural areas, which offer important biological potentiality. Uselly, they are bigger and less sensitive than ZNIEFF type 1. They do not have any formal designation.
Regional Nature Park Parc naturel régional (PNR)	French designation. The establishment in France between local authorities and the French national government covering an inhabited rural area of outstanding beauty, in order to protect the scenery and heritage as well as setting up sustainable economic development in the area.
Marine Nature Park	French designation. IUCN category V area. To protect and sustain important landscapes/seascapes and the associated nature conservation and other values created by interactions with humans through traditional management practices.
Biosphere Reseve	Biosphere reserves are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Programme to promote sustainable development based on local community efforts and sound science.
Biotope Protection Order Arrêté de protection de biotope	French designation. Offers protection to conservation of species of fauna and flora of community interest, especially as a framework of the Natura 2000 network (mainland France and Corsica) and also as a tool for the protection of globally threatened species (overseas).
Nature Reserve Réserve Naturelle	French designation. It is offered a high national protection for areas with important natural and ecological interest.

Appendix C Protected Sites

Table C-1: Protected Sites within 5km of potential route

Site Name	Designation	Feature	Distance
Trunk 1 - Cork Coast to Côte des Légendes - Inside UK TWs			
North East of Haig Fras	rMCZ	Subtidal sand, subtidal mud and mixed sediment habitats	Intersected for 4km
East of Haig Fras MCZ	MCZ	Moderate energy circalittoral rock, subtidal coarse sediment and subtidal sands	Intersected for 10km
Western Channel rMCZ	rMCZ	Subtidal coarse sediment, subtidal mixed sediment and moderate energy circalittoral rock.	Intersected for 15km
Abers Côtes des Legendes	SCI		7.8km south of route
-	PAIH	Potential rocky reef area	Intersected for 90km
Trunk 2 - Cork Coast to Côte des Légendes - Outside UK TWs			
-	PIAH	Potential rocky reef area	Intersected for 112km
Trunk 3 - Waterford/Wexford Coast to Côte des Légendes - Inside UK TWs			
South of Celtic Deep	rMCZ	Subtidal coarse sediment, subtidal mixed sediments and subtidal sands	Intersected for 22km
Western Channel	rMCZ	Subtidal coarse sediment, Subtidal mixed sediments, and subtidal sand	Intersected for 15km
The Celtic Deep	rMCZ	Subtidal mud and mud habitats in deep water	4.8km east of route
-	PAIH	Potential rocky reef area	Intersected for 138km
Trunk 4 - Waterford/Wexford Coast to Côte des Légendes - Outside UK TWs			
South of Celtic Deep	rMCZ	Subtidal coarse sediment, subtidal mixed sediments and subtidal sands	Intersected for 24km
East of Haig Frais	MCZ	Moderate energy circalittoral rock, Subtidal coarse sediment and Subtidal sand	Intersected for 22km
-	PAIH	Potential rocky reef area	Intersected for 125km
Trunk 5 – Cork Coast to Rade de Brest - Outside UK TWs			
-	PAIH	Potential rocky reef area	Intersected for 119km
Iroise Marine Nature Park & Biosphere Reseve (PNMI)	MPA	Important area for bird, and European Protected Species - harbouring 25% of the population of sea mammals in France. with colonies of seals, dolphins and sea otters. Other notable species include asking shark	Intersected for 66km
Ouessant-Molene			Intersected for 36km
Trunk 6 - Waterford/Wexford Coast to Rade de Brest - Inside UK TWs			
-	PAIH	Potential rocky reef area	Intersected for 84km
Iroise Marine Nature Park & Biosphere Reseve (PNMI)	MPA	Important area for bird, and European Protected Species - harbouring 25% of the population of sea mammals in France. with colonies of seals, dolphins and sea otters. Other notable species include asking shark	Intersected for 66km
Ouessant-Molene			Intersected for 36km

Table C-2: Protected Sites within 5km of Branches

Site Name	Designation	Feature of conservation interest	Branches within 5km
Cork Branches			
Blackwater River	SAC	**Annex I habitats that are a primary reason for selection of this site:** Estuaries Mudflats and sandflats not covered by seawater at low tide Perennial vegetation of stony banks Salicornia and other annuals colonizing mud and sand Atlantic salt meadows (Glauco-Puccinellietalia maritimae) Otter (Lutra lutra) Mediterranean salt meadows (Juncetalia maritimi) Killarney fern (Trichomanes speciosum) Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation Old sessile oak woods with Ilex and Blechnum in British Isles Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) Taxus baccata woods of the British Isles **Annex II species that are a primary reason for selection of this site**: Freshwater pearl mussel (Margaritifera margaritifera), White-clawed crayfish (Austropotamobius pallipes), Sea lamprey (Petromyzon marinus), Brook lamprey (Lampetra planeri), River lamprey (Lampetra fluviatilis), Allis shad (Alosa alosa), Twaite shad (Alosa fallax fallax), Salmon (Salmo salar)	Claycastle Beach (5)
Blackwater Estuary	SPA and Ramsar site	**Supporting important winter populations of Annex II listed species:** Black-tailed Godwit (*Limosa limosa*) Curlew (*Numenius arquata*) **Supporting nationally important wintering populations of 6 bird species:** Wigeon (Anas penelope), Golden Plover (*Pluvialis apricaria*), Lapwing (*Vanellus vanellus*), Dunlin (*Calidris alpina*), Bar-tailed Godwit (*Limosa lapponica*), Redshank (*Tringa totanus*) **Internationally important wetland of conservation importance for overwintering bird species**	Claycastle Beach (5)
Ballymacoda Bay	SPA and Ramsar site	**Supporting important European populations of Annex II listed species:** Black-tailed Godwit (*Limosa limosa*) **Regularly supporting at least 20,000 waterfowl:** Overwinter, the area regularly supports 22,000 individual waterfowl. **Supporting nationally important wintering populations of 15 bird species** **Internationally important wetland**	Redbarn Beach (4) and Claycastle Beach (5)
Ballycotton	SPA and	**Supporting European important populations of Annex II**	Ballinwilling

Site Name	Designation	Feature of conservation interest	Branches within 5km
Bay	Ramsar Site	**listed species:** Bar-tailed Godwit (*Limosa lapponica*) Golden Plover (*Pluvialis apricaria*) **Supporting nationally important wintering populations of 9 bird species:** Teal (Anas crecca), Ringed Plover (Charadrius hiaticula), Golden Plover (Pluvialis apricaria), Grey Plover (Pluvialis squatarola), Lapwing (*Vanellus vanellus*), Black-tailed Godwit (Limosa limosa), Bar-tailed Godwit (Limosa lapponica), Curlew (Numenius arquata), Turnstone (Arenaria interpres), Common Gull (Larus canus) and Lesser Black-backed Gull (Larus fuscus). **Internationally important wetland.**	Beach (3)
Ballycotton, Ballynamona and Shanagarry	pNHA- 0076	Coastal vegetation and bird species	Ballinwilling Beach (3)
Capel Island and Knockadoon Head	pNHA- 0083	Coastal vegetated cliffs. Capel Island is important for nesting Cormorants, gulls, fulmar and black guillemot	Redbarn Beach (4) and Claycastle Beach (5)
Ballyvergan Marsh	pNHA-0078	Coastal sand & clay cliffs and fresh water marsh Supports a diversity of bird species including Annex I Species - Hen Harrier Important as a pre-migration stop-over point for various passerine species on their way to wintering grounds further south and as a breeding site for Reed Warbler.	Redbarn Beach (4) and Claycastle Beach (5)
Waterford/Wexford Landfall Area Branches			
Hook Head	SAC	**Annex I habitats that are a primary reason for selection of this site:** Reef Large shallow inlets and bays Vegetated sea cliffs of the Atlantic and Baltic coasts	Rathmoylen Beach (1) intersects for 17km; Baginbun Beach (2) intersects for 8.5km; Newtown Beach (3) intersects for 8km; Bannow Beach (4)
Saltee Island	SAC	**Annex I habitats that are a primary reason for selection of this site:** Reef Mudflats and sandflats not covered by seawater at low tide Large shallow inlets and bays Vegetated sea cliffs of the Atlantic and Baltic coasts Submerged or partly submerged sea caves	Cullenstown Beach (5) intersected for 700m

Site Name	Designation	Feature of conservation interest	Branches within 5km
		Annex II species that are a primary reason for selection of this site: Grey seal (Halichoerus grypus)	
Ballyteige Burrow	SAC	**Annex I habitats that are a primary reason for selection of this site:** Estuaries Mudflats and sandflats not covered by seawater at low tide Coastal lagoons Annual vegetation of drift lines Perennial vegetation of stony banks Salicornia and other annuals colonizing mud and sand Spartina swards (Spartinion maritimae) Atlantic salt meadows (Glauco-Puccinellietalia maritimae) Mediterranean salt meadows (Juncetalia maritimi) Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi) Embryonic shifting dunes Shifting dunes along the shoreline with Ammophila arenaria (white dunes) Fixed coastal dunes with herbaceous vegetation (grey dunes)	Bannow Beach (4); Cullenstown Beach (5) intersected for 700m
Saltee Island	SPA and Ramsar Site	**Annex II species that are a primary reason for selection of this site:** Fulmar (*Fulmarus glacialis*), Gannet (*Morus bassanus*), Cormorant (*Phalacrocorax carbo*), Shag (*Phalacrocorax aristotelis*), Lesser Black-backed Gull (*Larus fuscus*), Herring Gull (*Larus argentatus*), Kittiwake (*Rissa tridactyla*).Guillemot (*Uria aalge*) Razorbill (*Alca torda*) and Puffin (*Fratercula arctica*) **Internationally important wetland**	Cullenstown Beach (5)
Keeragh Islands	SPA and Ramsar Site	**Annex II species that are a primary reason for selection of this site:** Breeding Cormorant (*Phalacrocorax carbo*) **Internationally important wetland**	Newtown Beach (3); Bannow Beach (4); Cullenstown Beach (5)
Bannow Bay	SPA and Ramsar Site	**Annex II species that are a primary reason for selection of this site:** Light-bellied Brent Goose (*Branta bernicla hrota*), Shelduck (*Tadorna tadorna*), Pintail (*Anas acuta*), Oystercatcher (*Haematopus ostralegus*), Golden Plover (*Pluvialis apricaria*), Grey Plover (*Pluvialis squatarola*), Lapwing (*Vanellus vanellus*), Knot (*Calidris canutus*), Dunlin (*Calidris alpina*), Black-tailed Godwit (*Limosa limosa*), Bar-tailed Godwit (*Limosa lapponica*), Curlew (*Numenius arquata*) and Redshank (*Tringa totanus*). **Internationally important wetland**	Newtown Beach (3) intersects for 2.5km; Bannow Beach (4)
Bannow Bay	SSSI	Sheltered estuarine environment, bird species.	Baginbun Beach (2); Newtown

Site Name	Designation	Feature of conservation interest	Branches within 5km
			Beach (3); Bannow Beach (4)
Dunmore East Cliffs	pNHA	Large kittiwake (gull) colonies on several cliffs, well studied.	Rathmoylen Beach (1)
Hook Head	pNHA	Sea cliff vegetation and bird species	Rathmoylen Beach (1)
Côte des Légendes Branches			
Abers - Côtes des Legendes	SCI	**Annex I habitats that are a primary reason for selection of this site:** Estuaries Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	Dibbenou (1) intersects for 4km
Anse de Goulven, Dunes de Keremma	SCI	**Annex I habitats that are a primary reason for selection of this site:** Mudflats and sandflats not covered by seawater at low tide Annual vegetation of drift lines Reefs Vegetated sea cliffs of the Atlantic and Baltic coasts Salicornia and other annuals colonising mud and sand Spartina swards (Spartinion maritimae) Atlantic salt meadows (Glauco-Puccinellietalia maritimae) Embryonic shifting dunes Shifting dunes along the shoreline with *Ammophila arenaria* ("white dunes") Fixed dunes with herbaceous vegetation ("grey dunes") Humid dune slacks	Poulfoen (2); Kerfissien (3); Pontusval (5)
Baie de Morlaix	SPA	**Annex I habitats that are a primary reason for selection of this site:** Mudflats and sandflats not covered by seawater at low tide Vegetated sea cliffs of the Atlantic and Baltic coasts Salicornia and other annuals colonising mud and sand Spartina swards (Spartinion maritimae) Coastal lagoons Large shallow inlets and bays Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	Mogueriec (4)

Appendix D Overviews of Route Options and Constraints

© The GEBCO Digital Atlas published by the British Oceanographic Data Centre on behalf of IOC and IHO, 2003. © SeaZone Solutions, 2013, [SZ Licence Number: 102013.019] © British Crown Copyright, 2013. All rights reserved. Muséum national d'Histoire naturelle. © Crown copyright 2013. Copyright National Parks & Wildlife Service. Collated and published by JNCC © Contains public sector information licensed under the Open Government Licence v2.0. Contains derived data from BGS © NERC. Contains derived data from Ordnance Survey © Crown copyright. 100019741 (2013).

© Metoc Ltd, 2013. All rights reserved.

© The GEBCO Digital Atlas published by the British Oceanographic Data Centre on behalf of IOC and IHO, 2003. © SeaZone Solutions, 2013, [SZ Licence Number: 102013.019] Based upon BGS, with the permission of the British Geological Survey'2003/143

© Metoc Ltd, 2013. All rights reserved.

© The GEBCO Digital Atlas published by the British Oceanographic Data Centre on behalf of IOC and IHO, 2003. © SeaZone Solutions, 2013, [SZ Licence Number: 102013.019] © British Crown Copyright, 2013. All rights reserved.

© Metoc Ltd, 2013. All rights reserved.

© The GEBCO Digital Atlas published by the British Oceanographic Data Centre on behalf of IOC and IHO, 2003. © SeaZone Solutions, 2013, [SZ Licence Number: 102013.019] © British Crown Copyright, 2013. All rights reserved. © Crown Copyright, 2012. All rights reserved. License No. EK001-0617-MF0067. Data supplied by FINDMaps. Not to be used for Navigation.

© Metoc Ltd, 2013. All rights reserved.

Appendix E RPLs

		Longitude (E/W)			Latitude (N/S)		
Tranch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
1	1	-7	50	20.4	51	39	21.6
1	2	-7	50	16.8	51	39	21.6
1	3	-7	28	26.4	51	23	2.4
1	4	-7	15	18	51	6	54
1	5	-7	5	20.4	51	0	43.2
1	6	-7	3	14.4	50	58	26.4
1	7	-6	49	1.2	50	47	34.8
1	8	-6	47	42	50	45	18
1	9	-6	43	37.2	50	41	27.6
1	10	-6	42	21.6	50	39	43.2
1	11	-6	37	22.8	50	35	31.2
1	12	-6	35	42	50	33	54
1	13	-6	27	39.6	50	31	1.2
1	14	-6	23	24	50	27	43.2
1	15	-6	7	4.8	50	11	20.4
1	16	-6	6	21.6	50	9	10.8
1	17	-6	5	34.8	50	8	27.6
1	18	-6	1	26.4	50	6	54
1	19	-5	56	6	50	2	56.4
1	20	-5	55	44.4	49	58	1.2
1	21	-5	56	38.4	49	51	57.6
1	22	-5	55	22.8	49	48	43.2
1	23	-5	52	30	49	44	52.8
1	24	-5	30	14.4	49	29	49.2
1	25	-4	55	15.6	49	6	50.4
1	26	-4	45	28.8	49	0	54
1	27	-4	43	8.4	48	56	38.4
1	28	-4	24	10.8	48	45	28.8

		Longitude (E/W)			Latitude (N/S)		
Tranch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
2	1	-7	50	16.8	51	39	21.6
2	2	-7	8	38.4	50	20	45.6
2	3	-7	4	48	50	16	33.6
2	4	-7	0	21.6	50	6	36
2	5	-6	52	15.6	50	0	43.2
2	6	-6	50	31.2	49	57	43.2
2	7	-6	43	4.8	49	45	36
2	8	-6	41	31.2	49	42	18
2	9	-6	32	38.4	49	36	57.6
2	10	-6	27	39.6	49	33	18
2	11	-6	8	13.2	49	25	19.2
2	12	-6	4	26.4	49	23	49.2
2	13	-6	2	34.8	49	22	51.6
2	14	-6	1	48	49	22	12
2	15	-6	1	37.2	49	21	32.4
2	16	-6	0	54	49	20	56.4
2	17	-5	58	48	49	19	58.8
2	18	-5	51	43.2	49	15	10.8
2	19	-5	28	1.2	49	6	3.6
2	20	-5	27	0	49	5	27.6
2	21	-5	26	27.6	49	4	44.4
2	22	-5	25	55.2	49	4	26.4
2	23	-5	24	18	49	3	54
2	24	-5	16	19.2	49	1	19.2
2	25	-5	13	37.2	49	0	32.4
2	26	-5	13	1.2	49	0	18
2	27	-5	12	3.6	48	59	34.8
2	28	-5	10	22.8	48	58	48
2	29	-5	7	30	48	58	26.4
2	30	-5	4	48	48	58	15.6
2	31	-4	24	10.8	48	45	28.8

		Longitude (E/W)			Latitude (N/S)		
Tranch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
3	1	-6	44	31.2	52	2	6
3	2	-6	44	34.8	52	1	44.4
3	3	-6	44	24	52	0	32.4
3	4	-6	32	52.8	51	42	54
3	5	-6	32	31.2	51	39	32.4
3	6	-6	33	50.4	50	56	52.8
3	7	-6	33	21.6	50	53	42
3	8	-6	25	48	50	35	27.6
3	9	-6	7	4.8	50	11	20.4
3	10	-6	6	21.6	50	9	10.8
3	11	-6	5	34.8	50	8	27.6
3	12	-6	1	26.4	50	6	54
3	13	-5	56	6	50	2	56.4
3	14	-5	55	44.4	49	58	1.2
3	15	-5	56	38.4	49	51	57.6
3	16	-5	55	22.8	49	48	43.2
3	17	-5	52	30	49	44	52.8
3	18	-5	30	14.4	49	29	49.2
3	19	-4	55	15.6	49	6	50.4
3	20	-4	45	28.8	49	0	54
3	21	-4	43	8.4	48	56	38.4
3	22	-4	24	10.8	48	45	28.8

		Longitude (E/W)			Latitude (N/S)		
Tranch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
4	1	-6	44	34.8	52	1	44.4
4	2	-6	44	52.8	51	44	56.4
4	3	-6	43	48	50	38	9.6
4	4	-6	43	15.6	50	31	8.4
4	5	-6	45	21.6	50	29	27.6
4	6	-6	47	13.2	50	26	9.6
4	7	-6	46	22.8	49	55	40.8
4	8	-6	46	8.4	49	52	30
4	9	-6	45	14.4	49	49	51.6
4	10	-6	43	4.8	49	45	36
4	11	-6	41	31.2	49	42	18
4	12	-6	32	38.4	49	36	57.6
4	13	-6	27	39.6	49	33	18
4	14	-6	8	13.2	49	25	19.2
4	15	-6	4	26.4	49	23	49.2
4	16	-6	2	34.8	49	22	51.6
4	17	-6	1	48	49	22	12
4	18	-6	1	37.2	49	21	32.4
4	19	-6	0	54	49	20	56.4
4	20	-5	58	48	49	19	58.8
4	21	-5	51	43.2	49	15	10.8
4	22	-5	28	1.2	49	6	3.6
4	23	-5	27	0	49	5	27.6
4	24	-5	26	27.6	49	4	44.4
4	25	-5	25	55.2	49	4	26.4
4	26	-5	24	18	49	3	54
4	27	-5	16	19.2	49	1	19.2
4	28	-5	13	37.2	49	0	32.4
4	29	-5	13	1.2	49	0	18
4	30	-5	12	3.6	48	59	34.8
4	31	-5	10	22.8	48	58	48
4	32	-5	7	30	48	58	26.4
4	33	-5	4	48	48	58	15.6
4	34	-4	24	10.8	48	45	28.8

		Longitude (E/W)			Latitude (N/S)		
Tranch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
5	1	-7	50	16.8	51	39	21.6
5	2	-7	8	49.2	50	20	56.4
5	3	-7	4	48	50	16	33.6
5	4	-7	0	21.6	50	6	36
5	5	-6	52	15.6	50	0	43.2
5	6	-6	43	4.8	49	45	36
5	7	-6	41	31.2	49	42	18
5	8	-6	5	49.2	49	6	39.6
5	9	-6	4	22.8	49	2	45.6
5	10	-6	0	7.2	48	59	38.4
5	11	-5	59	6	48	56	20.4
5	12	-5	15	7.2	48	27	39.6
5	13	-5	10	15.6	48	23	42
5	14	-5	1	58.8	48	18	7.2
5	15	-4	58	12	48	17	2.4
5	16	-4	54	28.8	48	16	37.2
5	17	-4	50	31.2	48	16	26.4
5	18	-4	48	28.8	48	16	26.4
5	19	-4	42	3.6	48	17	34.8
5	20	-4	41	13.2	48	17	45.6
5	21	-4	34	40.8	48	20	27.6
5	22	-4	34	19.2	48	20	31.2
5	23	-4	32	49.2	48	20	42
5	24	-4	31	40.8	48	20	49.2
5	25	-4	28	44.4	48	19	58.8
5	26	-4	28	33.6	48	19	55.2
5	27	-4	27	28.8	48	20	2.4
5	28	-4	26	45.6	48	19	55.2

		Longitude (E/W)			Latitude (N/S)		
Tranch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
6	1	-6	44	34.8	52	1	44.4
6	2	-6	44	24	52	0	32.4
6	3	-6	32	52.8	51	42	54
6	4	-6	32	31.2	51	39	32.4
6	5	-6	33	50.4	50	56	52.8
6	6	-6	33	21.6	50	53	42
6	7	-6	25	48	50	35	27.6
6	8	-6	7	4.8	50	11	20.4
6	9	-6	6	21.6	50	9	10.8
6	10	-6	5	34.8	50	8	27.6
6	11	-6	1	26.4	50	6	54
6	12	-5	56	6	50	2	56.4
6	13	-5	55	44.4	49	58	1.2
6	14	-5	56	38.4	49	51	57.6
6	15	-5	55	22.8	49	48	43.2
6	16	-5	48	10.8	49	34	15.6
6	17	-5	46	51.6	49	32	38.4
6	18	-5	28	4.8	48	54	7.2
6	19	-5	26	27.6	48	52	8.4
6	20	-5	15	7.2	48	27	39.6
6	21	-5	10	15.6	48	23	42
6	22	-5	1	58.8	48	18	7.2
6	23	-4	58	12	48	17	2.4
6	24	-4	54	28.8	48	16	37.2
6	25	-4	50	31.2	48	16	26.4
6	26	-4	48	28.8	48	16	26.4
6	27	-4	42	3.6	48	17	34.8
6	28	-4	41	13.2	48	17	45.6
6	29	-4	34	40.8	48	20	27.6
6	30	-4	34	19.2	48	20	31.2
6	31	-4	32	49.2	48	20	42
6	32	-4	31	40.8	48	20	49.2
6	33	-4	28	44.4	48	19	58.8
6	34	-4	28	33.6	48	19	55.2
6	35	-4	27	28.8	48	20	2.4
6	36	-4	26	45.6	48	19	55.2

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
1 KR	1	-8	10	40.8	51	47	42
1 KR	2	-8	10	48	51	47	34.8
1 KR	3	-8	11	6	51	47	6
1 KR	4	-8	11	9.6	51	46	55.2
1 KR	5	-8	11	9.6	51	46	37.2
1 KR	6	-8	10	55.2	51	45	28.8
1 KR	7	-8	10	44.4	51	45	18
1 KR	8	-8	9	7.2	51	44	31.2
1 KR	9	-8	6	39.6	51	43	30
1 KR	10	-7	51	3.6	51	39	50.4
1 KR	11	-7	50	16.8	51	39	21.6

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
2 KR	1	-8	6	43.2	51	48	28.8
2 KR	2	-8	6	14.4	51	47	13.2
2 KR	3	-8	4	51.6	51	45	57.6
2 KR	4	-7	51	3.6	51	39	50.4
2 KR	5	-7	50	16.8	51	39	21.6

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
3 KR	1	-7	58	40.8	51	51	57.6
3 KR	2	-7	58	30	51	51	32.4
3 KR	3	-7	57	28.8	51	51	3.6
3 KR	4	-7	55	48	51	50	42
3 KR	5	-7	55	19.2	51	50	27.6
3 KR	6	-7	55	1.2	51	50	9.6
3 KR	7	-7	54	36	51	48	46.8
3 KR	8	-7	54	14.4	51	47	45.6
3 KR	9	-7	50	16.8	51	39	21.6

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
4 KR	1	-7	52	15.6	51	55	26.4
4 KR	2	-7	51	54	51	55	12
4 KR	3	-7	51	10.8	51	54	25.2
4 KR	4	-7	51	3.6	51	54	10.8
4 KR	5	-7	50	31.2	51	52	55.2
4 KR	6	-7	49	30	51	50	31.2
4 KR	7	-7	49	26.4	51	50	9.6
4 KR	8	-7	50	20.4	51	39	46.8
4 KR	9	-7	50	16.8	51	39	21.6

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
5 KR	1	-7	51	32.4	51	56	2.4
5 KR	2	-7	49	30	51	50	31.2
5 KR	3	-7	49	26.4	51	50	9.6
5 KR	4	-7	50	20.4	51	39	46.8
5 KR	5	-7	50	16.8	51	39	21.6

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
1 GI	1	-7	2	27.6	52	8	16.8
1 GI	2	-7	2	27.6	52	8	13.2
1 GI	3	-7	2	31.2	52	8	9.6
1 GI	4	-7	2	31.2	52	7	58.8
1 GI	5	-7	2	24	52	7	33.6
1 GI	6	-7	1	37.2	52	7	4.8
1 GI	7	-6	58	26.4	52	5	27.6
1 GI	8	-6	45	10.8	52	2	6
1 GI	9	-6	44	49.2	52	1	55.2
1 GI	10	-6	44	34.8	52	1	44.4

		Longitude (E/W)			Latitude (N/S)		
Branch NO.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
2 GI	1	-6	50	2.4	52	10	40.8
2 GI	2	-6	49	37.2	52	10	44.4
2 GI	3	-6	49	8.4	52	10	44.4
2 GI	4	-6	48	54	52	10	37.2
2 GI	5	-6	48	46.8	52	10	30
2 GI	6	-6	48	10.8	52	9	10.8
2 GI	7	-6	44	34.8	52	1	44.4

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
3 GI	1	-6	49	26.4	52	12	21.6
3 GI	2	-6	49	4.8	52	12	3.6
3 GI	3	-6	48	14.4	52	9	39.6
3 GI	4	-6	44	34.8	52	1	44.4

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
4 GI	1	-6	46	55.2	52	12	21.6
4 GI	2	-6	46	44.4	52	10	48
4 GI	3	-6	46	30	52	9	18
4 GI	4	-6	44	34.8	52	1	44.4

Branch No.	RPL Number	Longitude (E/W) Degrees	Minutes	Seconds	Latitude (N/S) Degrees	Minutes	Seconds
5 GI	1	-6	43	8.4	52	12	57.6
5 GI	2	-6	44	34.8	52	1	44.4

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
1 LM	1	-4	24	10.8	48	45	28.8
1 LM	2	-4	28	19.2	48	41	6
1 LM	3	-4	28	22.8	48	40	51.6
1 LM	4	-4	28	15.6	48	40	15.6
1 LM	5	-4	28	8.4	48	39	43.2
1 LM	6	-4	28	4.8	48	39	36
1 LM	7	-4	26	49.2	48	39	3.6
1 LM	8	-4	25	55.2	48	38	34.8
1 LM	9	-4	25	51.6	48	38	31.2
1 LM	10	-4	25	51.6	48	38	24

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
2 LM	1	-4	24	10.8	48	45	28.8
2 LM	2	-4	14	52.8	48	43	1.2
2 LM	3	-4	11	24	48	41	45.6
2 LM	4	-4	10	19.2	48	41	24
2 LM	5	-4	10	12	48	41	9.6

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
3 LM	1	-4	24	10.8	48	45	28.8
3 LM	2	-4	10	51.6	48	42	43.2
3 LM	3	-4	10	26.4	48	42	32.4
3 LM	4	-4	9	57.6	48	41	56.4
3 LM	5	-4	9	39.6	48	41	34.8
3 LM	6	-4	9	36	48	41	24

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
4 LM	1	-4	24	10.8	48	45	28.8
4 LM	2	-4	5	49.2	48	43	8.4
4 LM	3	-4	5	31.2	48	43	4.8
4 LM	4	-4	5	24	48	42	54
4 LM	5	-4	4	30	48	41	38.4
4 LM	6	-4	4	26.4	48	41	31.2
4 LM	7	-4	4	30	48	41	20.4

		Longitude (E/W)			Latitude (N/S)		
Branch No.	RPL Number	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
5 LM	1	-4	24	10.8	48	45	28.8
5 LM	2	-4	19	40.8	48	41	52.8
5 LM	3	-4	19	19.2	48	41	34.8
5 LM	4	-4	19	12	48	41	20.4
5 LM	5	-4	19	26.4	48	40	44.4
5 LM	6	-4	19	26.4	48	40	26.4
5 LM	7	-4	19	22.8	48	40	19.2