US to Ireland Subsea Fibre Optic Cable

APPLICATION FOR MARITIME USAGE LICENCE

FOR MARINE SURVEY & SITE INVESTIGATION WORKS AT CASTLEFREKE, LONG STRAND, CO. CORK & GLANDORE BAY

WORKS METHODOLOGY

14TH May 2024

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Contents

1.0 INTRODUCTION

1.1 The applicant plans to investigate the feasibility of constructing a new subsea telecoms cable system, linking United States to Ireland, from a landfall on the north east coast of the USA to a landfall at Glandore Bay, County Cork on the south west coast of Ireland as shown in Figure 1 below. This Works Methodology is produced in support of an application for a marine survey and site investigations licence under the Maritime Area Planning Act 2021, and should not be used for any other purpose apart from that expressly stated in this document. The applicant intends to undertake the survey campaign across the Licence Application Area within the IRL Exclusive Economic Zone (EEZ) and Maritime Area in order to inform the location and design of the cable route and landfall.

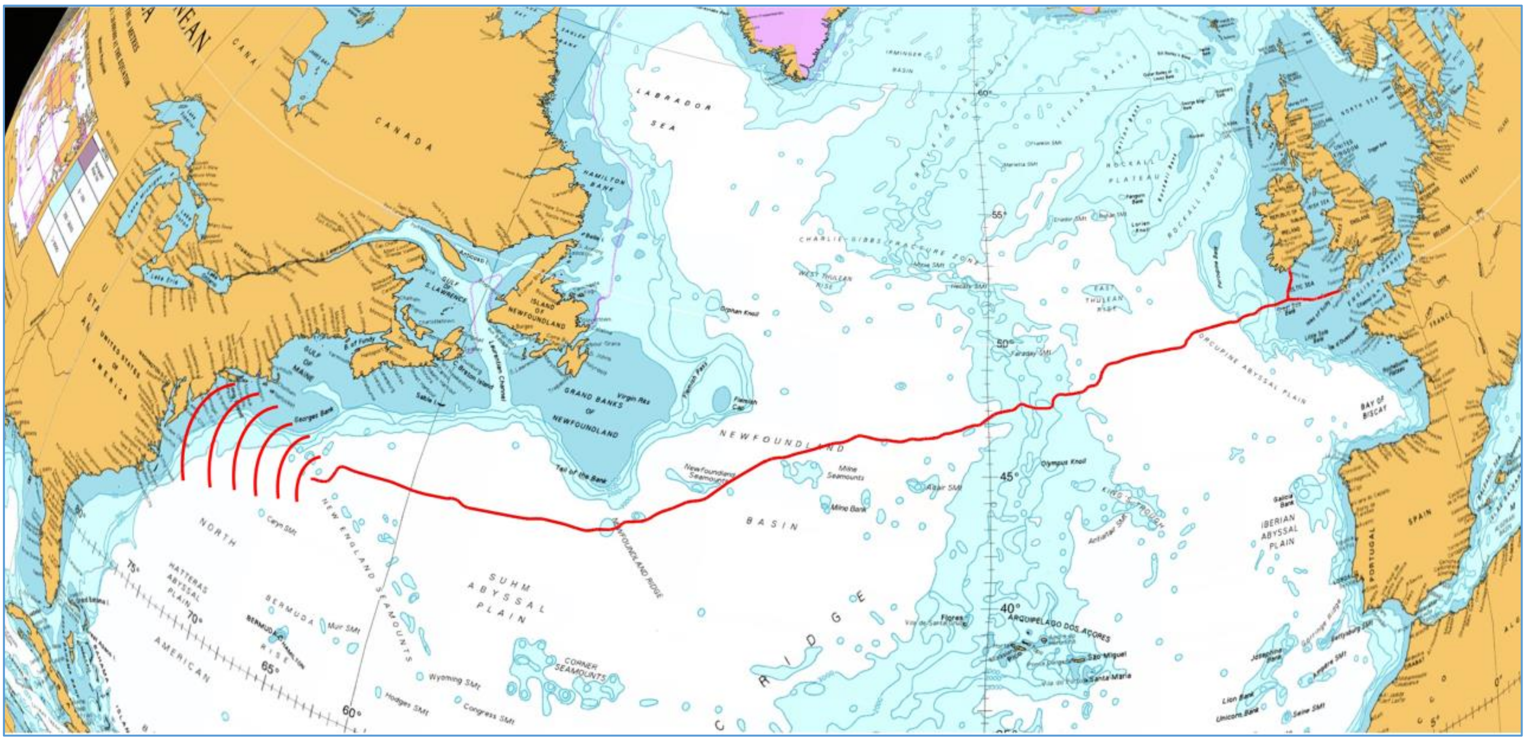

Figure 1. Proposed Telecoms Cable System (final configuration subject to change)

1.2 This Works Methodology has been prepared by McMahon Design and Management Ltd on behalf of the applicant and forms part of an application for a Licence for Marine Survey and Site Investigations for route and landfall options traversing Glandore Bay, County Cork between Galley Head to the East and Creggane Point to the West. The works will be carried out within a 500m corridor within the licensed area predominantly by seabed mapping techniques (geophysical survey) with some selective sampling of the upper layers of the seabed (geotechnical survey). The licence application area is wider than the survey corridor to give flexibility to move the survey corridor within the permitted area based on the cable route planning experts view. Once the results of the survey are obtained and analysed a preferred route corridor will be determined, design and method statements will be developed and a final Route Position List (RPL) will be defined as part of a further submission for a Maritime Area Consent and Planning consent for the installation works.

2.0 PROPOSED SURVEY ROUTE AND SURVEY LICENCE APPLICATION AREA IN IRISH MARITIME AREA

Licence Application Area

2.1 The License Application Area is situated off the coast of County Cork (Figure 2). The survey corridor has length of 898.5 km and a total area of 16,880 km^2. A cable route corridor of approx. 500m width will be surveyed within the licence application area. The survey corridor will be approximately 3 x Water Depth (up to 10km in width) in areas where the water depth is greater than 1500m off the Continental Shelf. The general lines of the proposed offshore survey corridors within Irish EEZ are shown in Figure 3 overleaf.

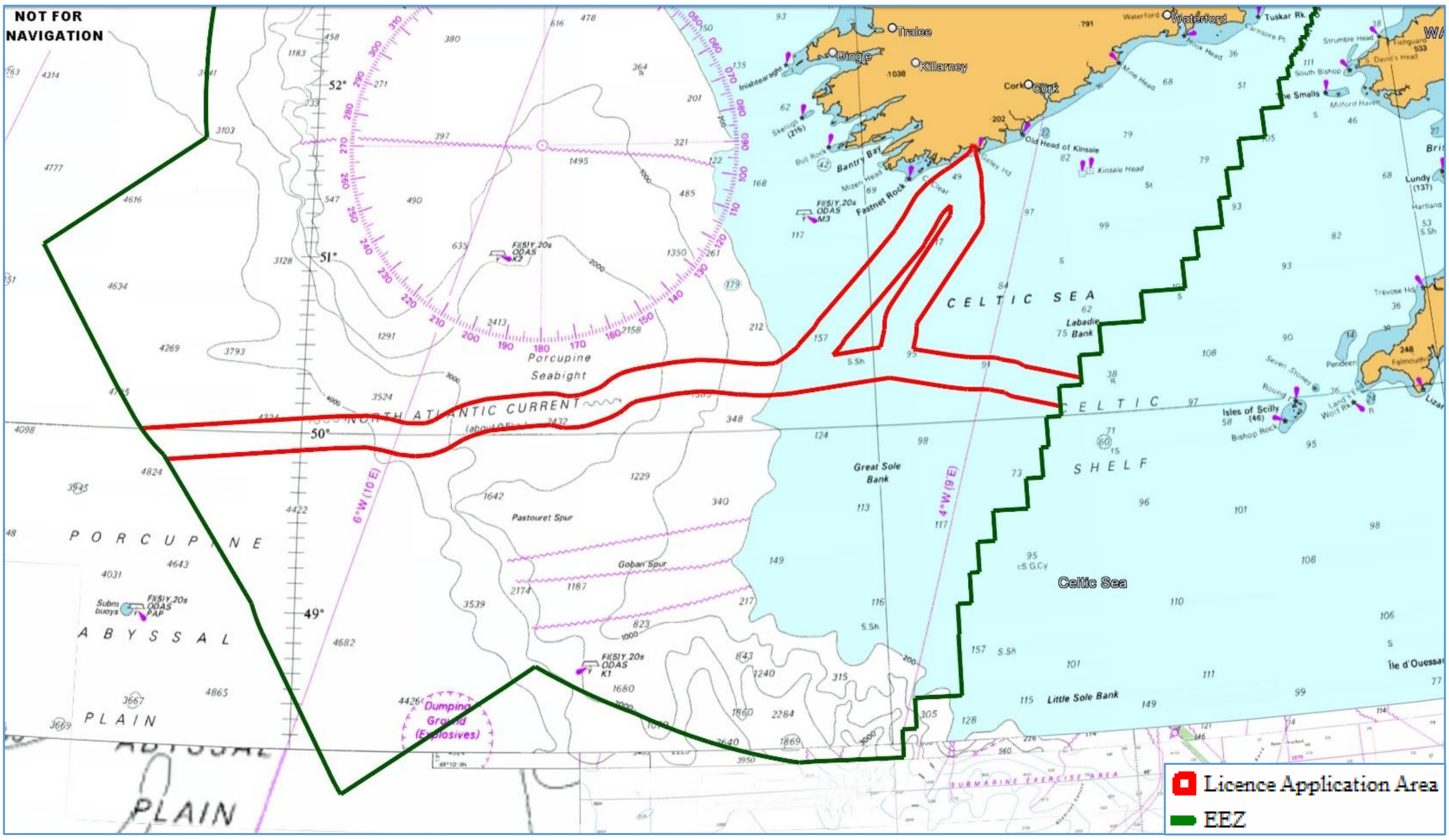

Figure 2. Proposed Survey Licence Application Area.

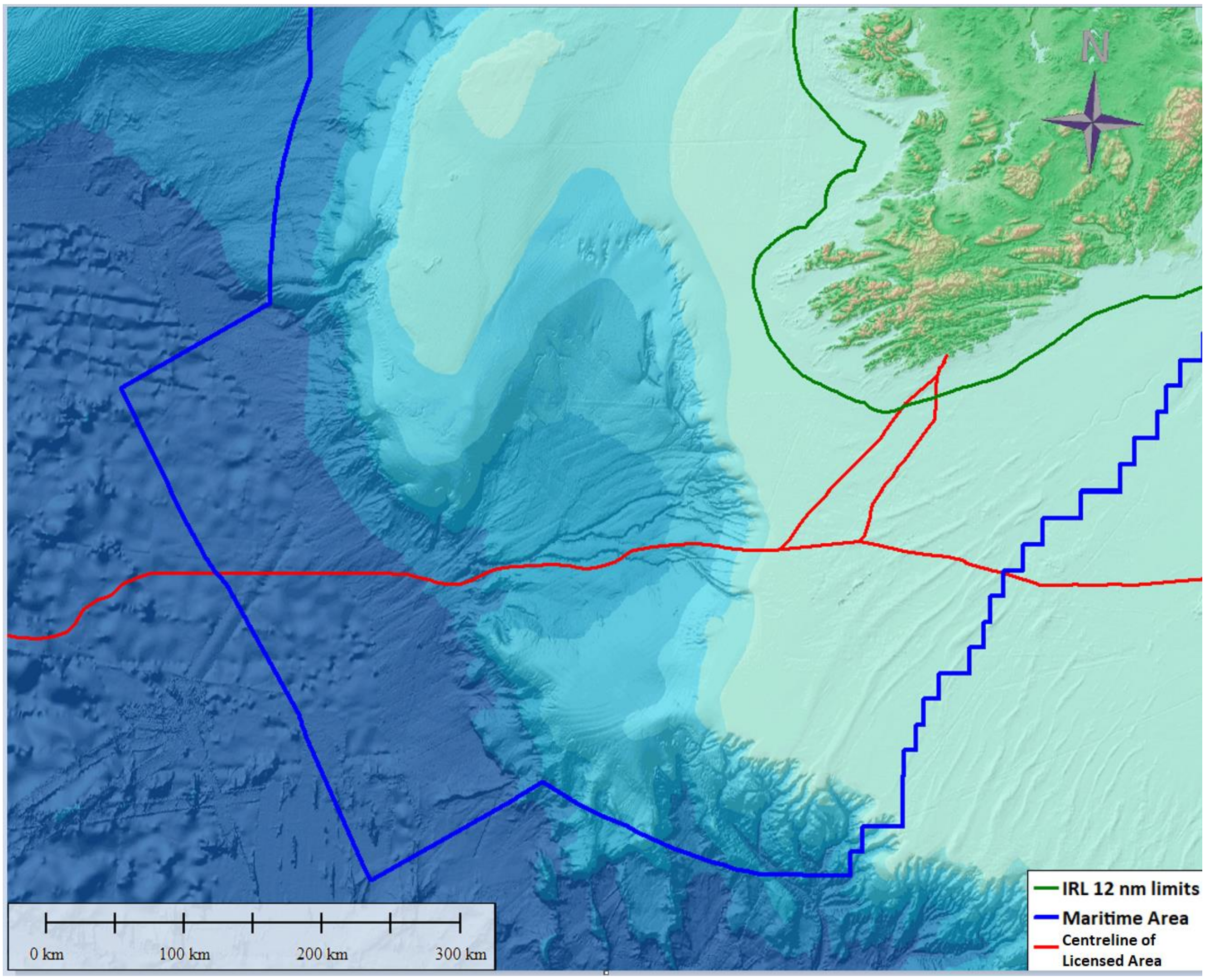

Figure 3. Offshore Survey Route.

2.2 The Route Position List for the Survey Area is presented in Table 1 below.

Idx	Latitude	Longitude	Idx	Latitude	Longitude
1	50° 12' 24.7947" N	8° 12' 00.0000" W	44	51° 15' 27.2163" N	8° 56' 39.4434" W
2	50° 13' 52.6159" N	8° 20' 29.7388" W	45	51° 20' 08.3629" N	8° 56' 44.0419" W
3	50° 13' 59.3369" N	8° 21' 03.0425" W	46	51° 23' 03.7623" N	8° 56' 22.5306" W
4	50° 15' 05.0601" N	8° 27' 14.1305" W	47	51° 30' 59.7680" N	8° 58' 32.5676" W
5	50° 15' 05.8335" N	8° 27' 18.5894" W	48	51° 32' 11.5706" N	8° 58' 35.4110" W
6	50° 17' 30.5697" N	8° 41' 34.3995" W	49	51° 33' 06.7367" N	8° 58' 08.9715" W
7	50° 17' 41.9756" N	8° 41' 52.7713" W	50	51° 33' 29.2953" N	8° 58' 08.4742" W
8	50° 17' 52.7701" N	8° 42' 12.0234" W	51	51° 33' 37.7189" N	8° 58' 34.8189" W
9	50° 18' 00.0218" N	8° 42' 25.6399" W	52	51° 33' 37.2137" N	8° 58' 37.6689" W
10	50° 18' 16.7160" N	8° 42' 59.8586" W	53	51° 33' 36.7325" N	8° 58' 37.8615" W
11	50° 18' 31.4826" N	8° 43' 36.1766" W	54	51° 33' 36.2734" N	8° 58' 37.8551" W
12	50° 18' 44.2141" N	8° 44' 14.3298" W	55	51° 33' 35.3584" N	8° 58' 36.2360" W
13	50° 18' 48.9467" N	8° 44' 30.1228" W	56	51° 33' 22.7922" N	8° 58' 49.9910" W
14	50° 18' 56.7930" N	8° 44' 58.5500" W	57	51° 32' 43.6693" N	8° 59' 31.5684" W
15	50° 19' 03.5083" N	8° 45' 27.6764" W	58	51° 33' 49.6724" N	8° 59' 20.7983" W
16	50° 19' 09.0673" N	8° 45' 57.3922" W	59	51° 33' 52.4838" N	8° 59' 23.9611" W
17	50° 19' 12.1540" N	8° 46' 15.9979" W	60	51° 33' 57.1536" N	8° 59' 43.9247" W
18	50° 19' 14.7808" N	8° 46' 33.0490" W	61	51° 33' 57.1013" N	8° 59' 47.6406" W
19	50° 20' 10.4320" N	8° 53' 05.4726" W	62	51° 33' 56.0684" N	8° 59' 50.5104" W
20	50° 20' 13.0822" N	8° 53' 13.0390" W	63	51° 33' 49.2598" N	8° 59' 50.7161" W
21	50° 20' 25.2505" N	8° 53' 51.5939" W	64	51° 33' 47.9840" N	8° 59' 53.7048" W
22	50° 20' 35.2753" N	8° 54' 31.6293" W	65	51° 33' 49.8527" N	8° 59' 55.0104" W
23	50° 20' 39.5063" N	8° 54' 50.9109" W	66	51° 34' 00.7667" N	8° 59' 55.2567" W
24	50° 20' 46.5931" N	8° 55' 27.7253" W	67	51° 34' 01.8829" N	9° 00' 00.1770" W
25	50° 20' 51.8667" N	8° 56' 05.2771" W	68	51° 34' 02.1284" N	9° 00' 06.8029" W
26	50° 20' 54.1746" N	8° 56' 25.3344" W	69	51° 33' 59.5452" N	9° 00' 09.4498" W
27	50° 20' 56.7699" N	8° 56' 51.9524" W	70	51° 33' 40.0023" N	9° 00' 34.1180" W
28	50° 20' 58.4535" N	8° 57' 18.7492" W	71	51° 32' 34.2711" N	9° 00' 35.6293" W
29	50° 21' 33.0764" N	9° 10' 13.1950" W	72	51° 31' 06.3951" N	9° 02' 23.8692" W
30	50° 22' 33.6653" N	9° 19' 27.3991" W	73	51° 26' 28.5544" N	9° 13' 10.6245" W
31	50° 25' 12.3414" N	9° 39' 03.5705" W	74	51° 25' 39.5883" N	9° 15' 48.8283" W
32	50° 30' 43.9419" N	9° 36' 46.2312" W	75	51° 23' 42.7577" N	9° 20' 35.7655" W
33	50° 32' 59.6297" N	9° 36' 34.4270" W	76	51° 21' 24.7807" N	9° 25' 45.0972" W
34	50° 33' 51.8130" N	9° 36' 16.2691" W	77	51° 18' 22.5455" N	9° 30' 59.9013" W
35	50° 34' 58.3993" N	9° 34' 56.0798" W	78	51° 17' 33.3694" N	9° 32' 11.8681" W
36	50° 50' 42.8301" N	9° 16' 21.1004" W	79	51° 16' 51.1392" N	9° 33' 08.4134" W
37	51° 04' 33.8362" N	8° 59' 49.6290" W	80	51° 13' 20.0250" N	9° 36' 47.1566" W
38	51° 06' 01.7041" N	8° 58' 22.0115" W	81	51° 10' 06.5325" N	9° 40' 03.1335" W
39	51° 07' 00.0804" N	8° 57' 47.7053" W	82	51° 06' 24.4958" N	9° 44' 31.9576" W
40	51° 08' 10.1589" N	8° 57' 17.8808" W	83	51° 05' 48.6931" N	9° 44' 55.5525" W
41	51° 10' 11.4295" N	8° 57' 17.6961" W	84	50° 55' 14.3771" N	10° 00' 05.3184" W
42	51° 10' 54.0956" N	8° 57' 18.8833" W	85	50° 35' 38.9646" N	10° 28' 53.8422" W
43	51° 13' 49.5393" N	8° 56' 37.9742" W	86	50° 34' 13.7565" N	10° 30' 03.3086" W

Idx	Latitude	Longitude	Idx	Latitude	Longitude
87	50° 30' 32.2350" N	10° 35' 43.8587" W	130	50° 03' 50.5006" N	13° 54' 46.3206" W
88	50° 28' 21.2608" N	10° 39' 03.3527" W	131	50° 03' 51.8720" N	14° 03' 46.6143" W
89	50° 27' 30.9308" N	10° 39' 38.9889" W	132	50° 03' 56.9459" N	14° 05' 27.6481" W
90	50° 24' 03.4904" N	10° 47' 06.1042" W	133	50° 05' 14.7727" N	14° 13' 20.7705" W
91	50° 22' 19.5399" N	10° 51' 38.5036" W	134	50° 05' 53.0763" N	14° 20' 04.1122" W
92	50° 22' 12.4232" N	10° 57' 39.4019" W	135	50° 06' 14.2169" N	14° 24' 19.2068" W
93	50° 22' 13.8756" N	11° 00' 07.1365" W	136	50° 05' 56.5160" N	14° 40' 17.0983" W
94	50° 22' 45.2030" N	11° 08' 53.9816" W	137	50° 05' 42.1970" N	14° 47' 00.7019" W
95	50° 22' 47.6390" N	11° 09' 53.8751" W	138	50° 00' 14.0513" N	16° 26' 15.6274" W
96	50° 23' 21.0761" N	11° 15' 45.8819" W	139	50° 00' 08.3564" N	16° 26' 08.6198" W
97	50° 23' 28.4490" N	11° 17' 14.2863" W	140	49° 59' 22.1386" N	16° 25' 09.6488" W
98	50° 23' 52.2735" N	11° 23' 17.8315" W	141	49° 57' 51.2408" N	16° 23' 08.2465" W
99	50° 23' 59.8721" N	11° 26' 43.9291" W	142	49° 55' 40.0233" N	16° 19' 57.7592" W
100	50° 24' 11.1238" N	11° 31' 31.5306" W	143	49° 53' 35.0207" N	16° 16' 37.6427" W
101	50° 24' 10.8972" N	11° 32' 02.3352" W	144	49° 51' 36.5288" N	16° 13' 08.3824" W
102	50° 24' 00.1298" N	11° 35' 54.8087" W	145	49° 50' 07.9693" N	16° 11' 35.7482" W
103	50° 23' 39.7889" N	11° 42' 49.3406" W	146	49° 50' 11.1504" N	16° 11' 09.4136" W
104	50° 23' 32.8918" N	11° 45' 03.9208" W	147	49° 55' 11.2124" N	14° 42' 45.6938" W
105	50° 22' 33.0012" N	11° 55' 20.7298" W	148	49° 55' 39.3435" N	14° 25' 20.5199" W
106	50° 22' 12.0928" N	11° 59' 05.9218" W	149	49° 54' 47.3825" N	14° 17' 06.3631" W
107	50° 21' 36.2752" N	12° 04' 14.3509" W	150	49° 53' 23.9523" N	14° 08' 26.9229" W
108	50° 21' 22.9439" N	12° 06' 05.6057" W	151	49° 52' 47.5154" N	13° 59' 24.7156" W
109	50° 20' 35.2565" N	12° 10' 26.7544" W	152	49° 53' 21.7651" N	13° 51' 05.7692" W
110	50° 20' 20.4908" N	12° 11' 45.0433" W	153	49° 55' 07.6247" N	13° 43' 31.6371" W
111	50° 20' 03.7650" N	12° 12' 47.3296" W	154	49° 58' 25.5099" N	13° 34' 51.3828" W
112	50° 18' 43.4839" N	12° 16' 40.1391" W	155	49° 59' 40.8428" N	13° 30' 26.8608" W
113	50° 18' 23.0556" N	12° 17' 35.8454" W	156	50° 00' 55.2116" N	13° 24' 21.3272" W
114	50° 16' 10.1470" N	12° 21' 50.5649" W	157	50° 01' 33.4532" N	13° 20' 26.1975" W
115	50° 15' 22.0276" N	12° 24' 08.9340" W	158	50° 02' 59.2302" N	12° 57' 00.7986" W
116	50° 14' 11.1239" N	12° 28' 51.6528" W	159	50° 03' 13.8560" N	12° 49' 02.3339" W
117	50° 13' 14.1792" N	12° 33' 30.0508" W	160	50° 02' 41.2465" N	12° 45' 29.7822" W
118	50° 12' 53.3629" N	12° 37' 10.1483" W	161	50° 02' 15.3946" N	12° 42' 42.4966" W
119	50° 12' 51.0564" N	12° 40' 42.6545" W	162	50° 02' 19.6326" N	12° 35' 50.3345" W
120	50° 13' 42.7263" N	12° 46' 23.1301" W	163	50° 02' 51.3673" N	12° 30' 16.9639" W
121	50° 13' 46.0366" N	12° 47' 19.2162" W	164	50° 05' 12.0962" N	12° 19' 07.3160" W
122	50° 13' 45.3192" N	12° 48' 11.8018" W	165	50° 06' 53.4130" N	12° 13' 33.1523" W
123	50° 13' 36.2727" N	12° 57' 08.1169" W	166	50° 07' 56.9095" N	12° 11' 12.1242" W
124	50° 13' 27.0923" N	13° 00' 21.7968" W	167	50° 09' 37.3375" N	12° 08' 03.5175" W
125	50° 12' 00.3844" N	13° 23' 11.3524" W	168	50° 10' 28.8582" N	12° 05' 35.9203" W
126	50° 10' 25.9394" N	13° 32' 54.9254" W	169	50° 10' 58.8310" N	12° 03' 10.5590" W
127	50° 08' 49.3657" N	13° 39' 30.5950" W	170	50° 11' 33.2453" N	11° 57' 40.6937" W
128	50° 06' 15.2202" N	13° 46' 44.5626" W	171	50° 13' 00.4249" N	11° 43' 32.5188" W
129	50° 04' 54.0184" N	13° 50' 11.0431" W	172	50° 13' 17.6376" N	11° 37' 39.5659" W

Idx	Latitude	Longitude	Idx	Latitude	Longitude
173	50° 13' 35.6983" N	11° 31' 43.1639" W	194	50° 09' 54.8634" N	8° 58' 35.4923" W
174	50° 13' 22.0632" N	11° 25' 11.5198" W	195	50° 09' 50.9752" N	8° 58' 14.6499" W
175	50° 12' 58.1970" N	11° 19' 42.0965" W	196	50° 09' 45.4662" N	8° 57' 40.7929" W
176	50° 12' 13.5902" N	11° 11' 39.4218" W	197	50° 09' 41.4744" N	8° 57' 06.4249" W
177	50° 12' 13.4355" N	11° 09' 14.8841" W	198	50° 09' 41.0728" N	8° 57' 02.1220" W
178	50° 11' 50.9770" N	11° 04' 16.6517" W	199	50° 09' 04.0902" N	8° 52' 40.9073" W
179	50° 11' 36.4628" N	10° 58' 14.1489" W	200	50° 08' 44.7053" N	8° 52' 07.4655" W
180	50° 11' 40.7220" N	10° 53' 36.0400" W	201	50° 08' 27.3146" N	8° 51' 31.4698" W
181	50° 11' 56.3894" N	10° 44' 56.1893" W	202	50° 08' 20.7334" N	8° 51' 16.5027" W
182	50° 12' 47.1228" N	10° 34' 07.2453" W	203	50° 08' 09.0373" N	8° 50' 47.8865" W
183	50° 15' 14.2903" N	10° 02' 26.8876" W	204	50° 07' 58.6034" N	8° 50' 18.1139" W
184	50° 15' 55.0301" N	9° 52' 18.9596" W	205	50° 07' 49.4790" N	8° 49' 47.3197" W
185	50° 15' 55.8673" N	9° 52' 11.5538" W	206	50° 07' 44.6810" N	8° 49' 29.5835" W
186	50° 11' 59.2029" N	9° 22' 47.4828" W	207	50° 07' 36.4346" N	8° 48' 55.7606" W
187	50° 11' 56.6586" N	9° 22' 26.7085" W	208	50° 07' 29.7680" N	8° 48' 21.1067" W
188	50° 10' 52.3624" N	9° 12' 38.7127" W	209	50° 04' 40.5338" N	8° 31' 39.0166" W
189	50° 10' 49.9882" N	9° 12' 13.2755" W	210	50° 03' 35.9283" N	8° 25' 45.4688" W
190	50° 10' 48.4482" N	9° 11' 47.6835" W	211	50° 03' 15.2034" N	8° 24' 06.7466" W
191	50° 10' 17.0718" N	9° 00' 03.7540" W	212	50° 10' 00.0012" N	8° 24' 00.0000" W
192	50° 10' 12.2892" N	8° 59' 47.7565" W	213	50° 10' 00.0012" N	8° 12' 00.0000" W
193	50° 10' 02.6878" N	8° 59' 12.1428" W			

Table 1. Survey Area RPL.

Landfalls & Inshore Survey Corridors.

2.3 The survey area covers two potential landfalls close to Rosscarbery, County Cork, with survey corridors through Rosscarbery Bay to a potential landfall at Ownahincha / Little Island Strand to the West and a landfall at Long Strand to the East. The general location is shown in Figure 4.

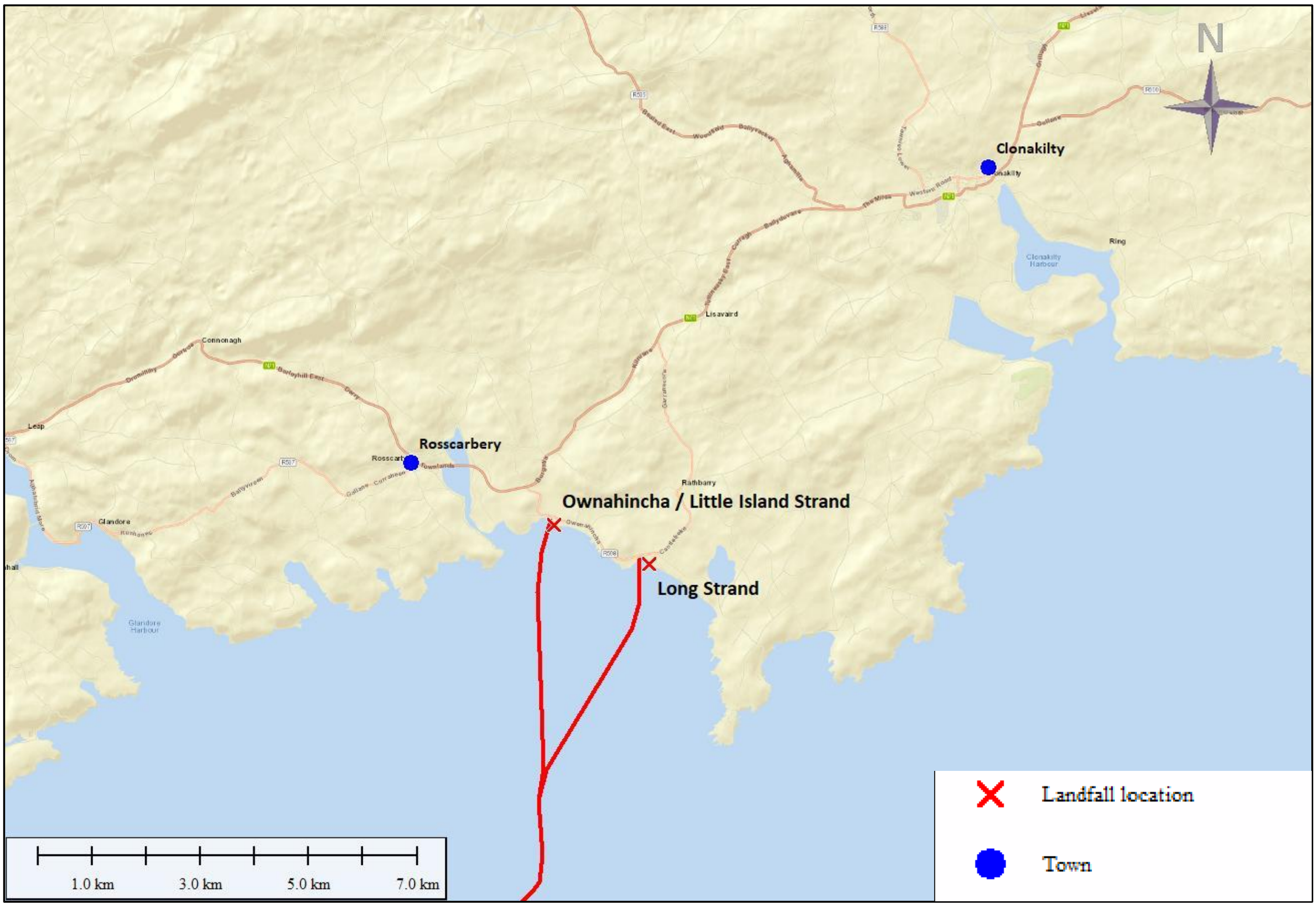

Figure 4. Landfall Locations.

Long Strand

2.4 The survey area covers a potential landfall at Long Strand. The beach is a long and uninterrupted stretch of sand and is buffered to the North from the R598 (Clonakilty Rd) and L4006 (to Galley Head) by a belt of grassy coastal sand dunes. (Figure 5.) Any requirement for beach access for vehicles or equipment will be solely via the existing track way adjacent to the Fish Basket Café. (Figure 6.) No vehicles or equipment will traverse the sand dune system.

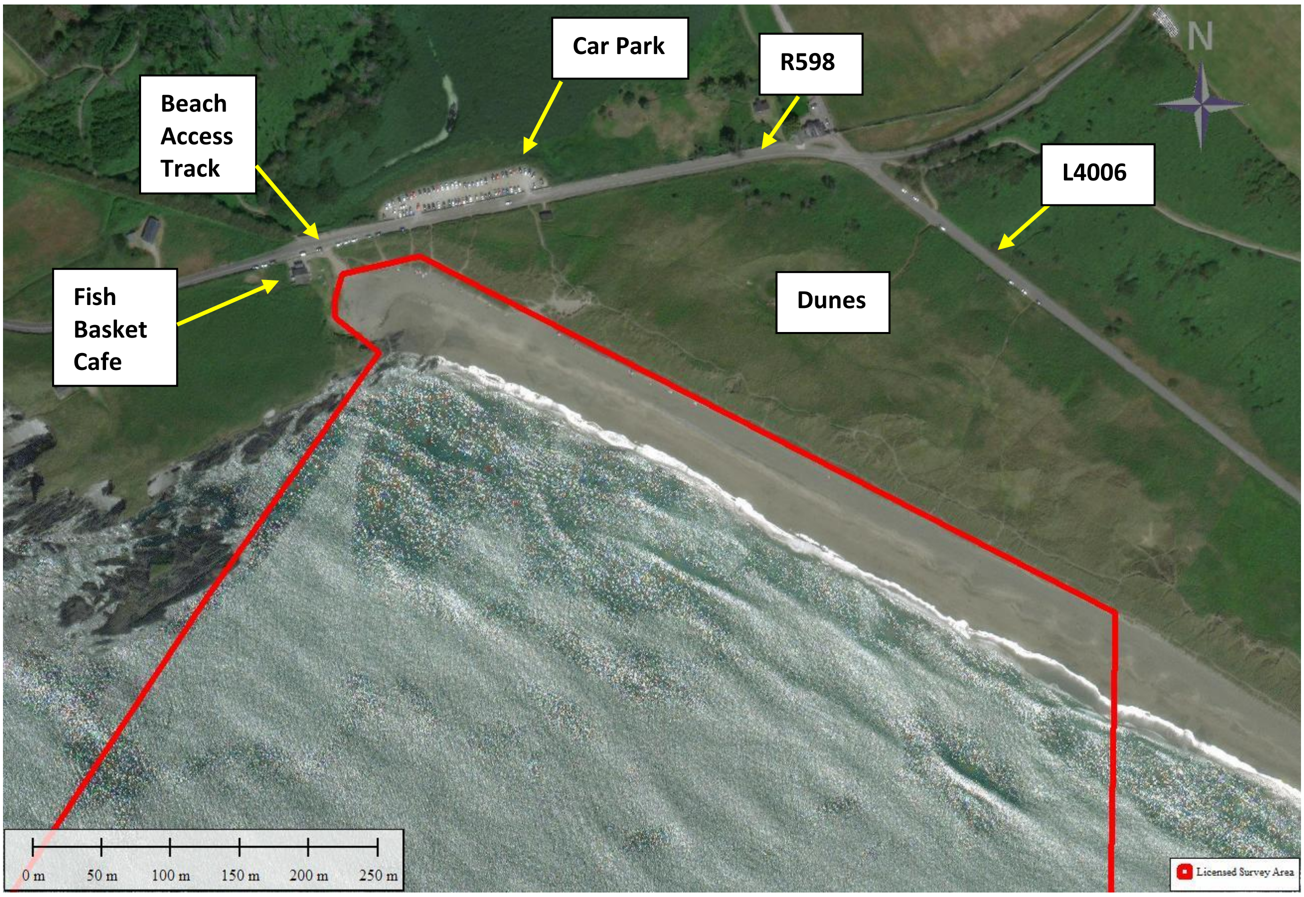

Figure 5. Long Strand.

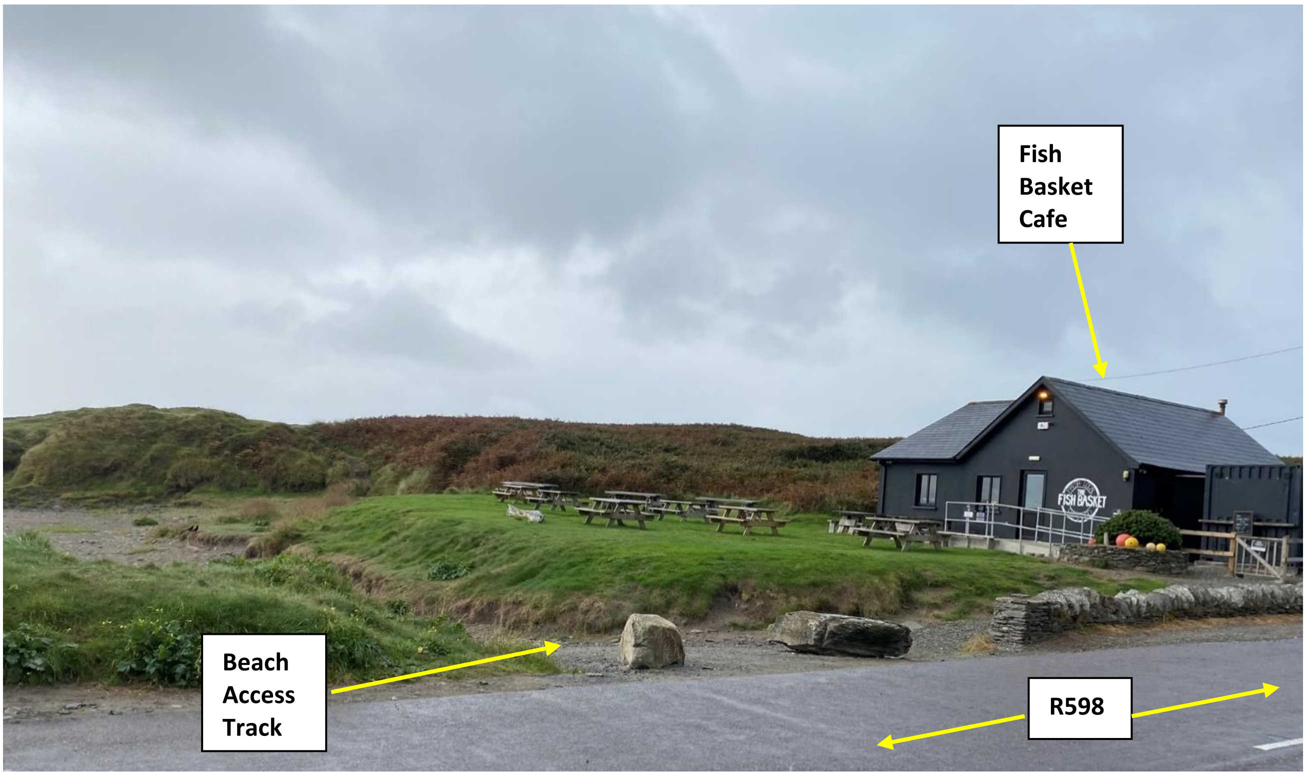

Figure 6. Beach Access track at Long Strand.

2.5 The survey area covers a potential landfall at Ownahincha / Little Island Strand. This is effectively two beaches linked by a spit at Iron Rock with shingle and Ownahincha River to the west and with sand, dunes and rocky inlets to the east. The R598 (Clonakilty Rd) runs parallel to the beach, separated by a belt of grassy coastal sand dunes on the eastern side. (Figure 7.) Any requirement for beach access for vehicles or equipment will be via the existing established access tracks from the R598. (Figures 8 & 9). No vehicles or equipment will traverse the sand dune system.

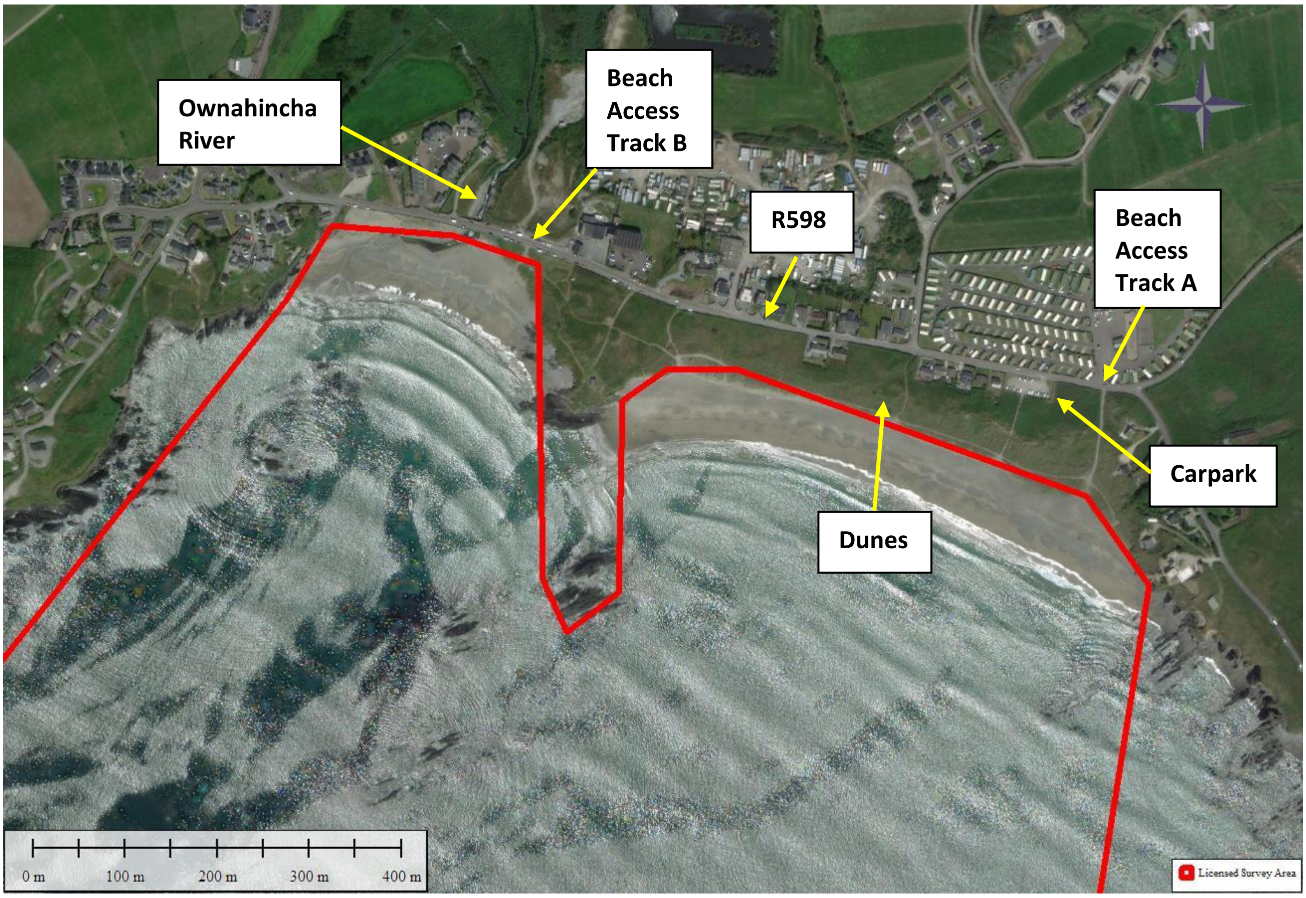

Figure 7. Ownahincha / Little Strand.

Figure 8. Little Island Beach Access A.

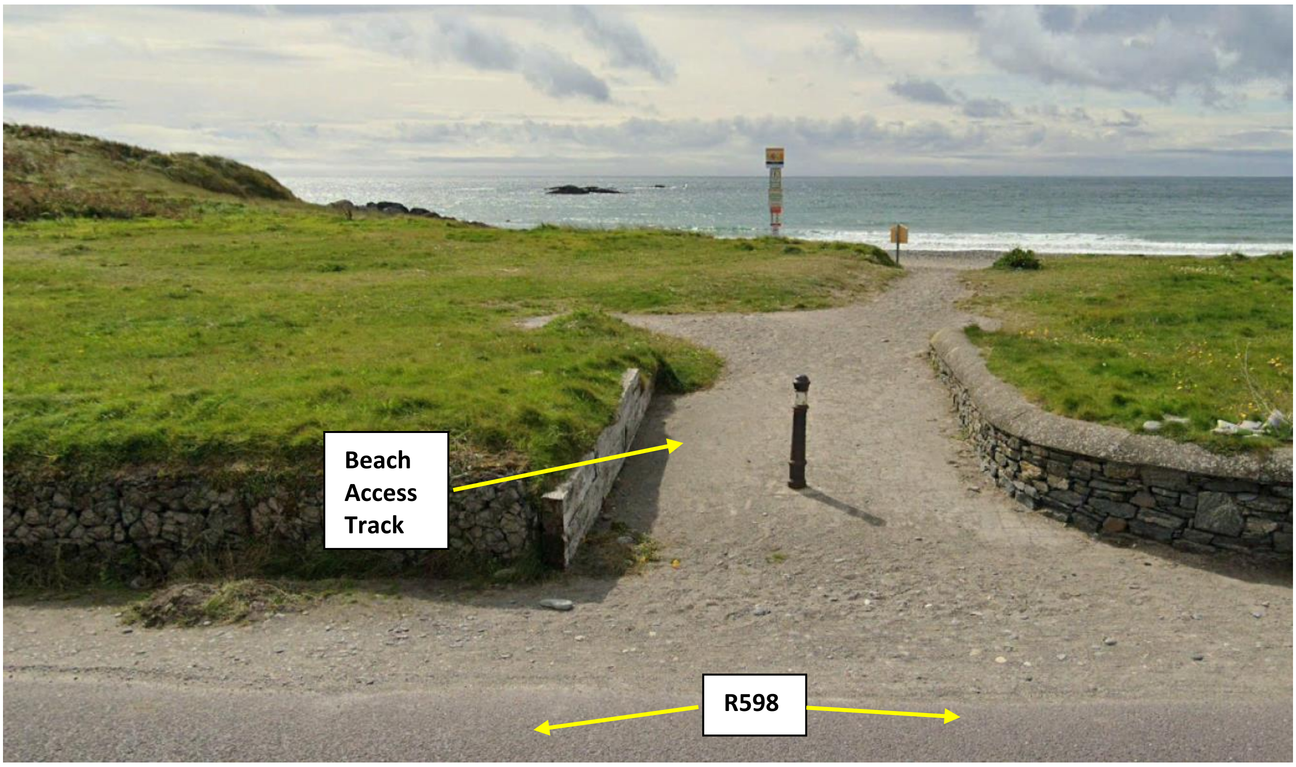

Figure 9 Ownahincha Beach Access B.

2.7 The landfall locations shown on Admiralty and Ordnance Survey Maps are provided in Drawings 1355-A-101 Licence Map, 1355-A-102 Site Layout Map 1 & 1355-A-103 Site Layout Map 2 and included with the Licence Application.

2.6 The general line of the inshore section of the proposed survey route is shown on an Admiralty Chart base in Figure 10 within which a 500m corridor will be surveyed. After approx. 2.5km, the survey corridors converge in Glandore Bay and head in a south westerly direction from the landfalls, staying west of Galley Head.

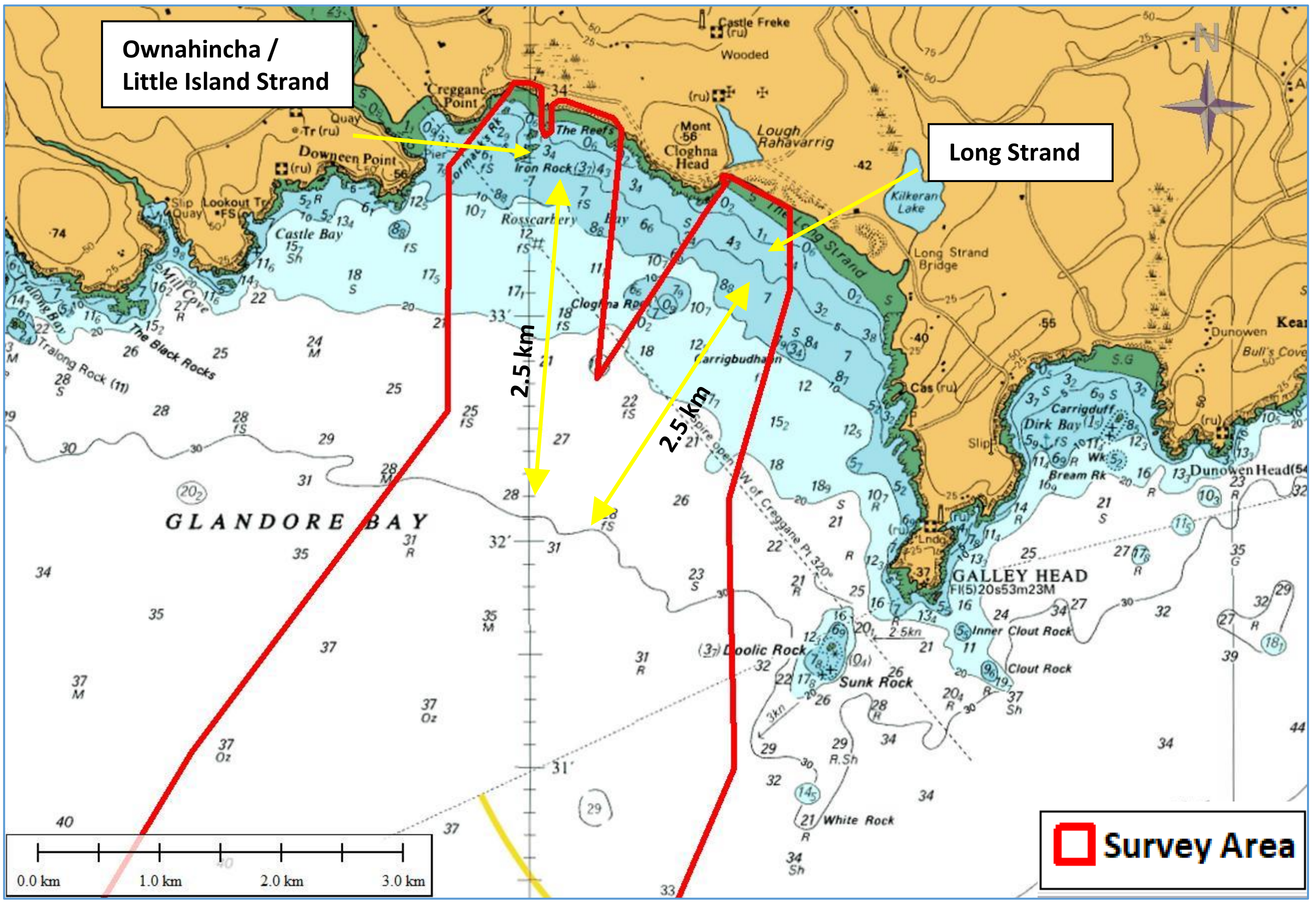

Figure 10. Inshore Sections and Landfalls.

2.8 After exiting Glandore Bay, the survey corridor continues in a southwestern direction with eastern and western route options as shown on Figure 11. The survey will be carried out on one of the route options and will survey a 500m swathe within the licensed area. Approximately 150km form the landfall, the route corridor changes to an east-west orientation. The route east across the Celtic Sea towards Cornwall, UK stays South of the Labadie Bank.

2.9 The route west (Figures 12 & 13) crosses the continental shelf to enter the deep waters of the Porcupine Seabight, south of the primary Gollum Channel and the Mound Provinces which are located north of the Gollum Channel System. The route traverses the ultra deepwaters of the Porcupine Abyssal Plain before leaving the Irish Maritime Area and continuing in a westerly direction towards the United States.

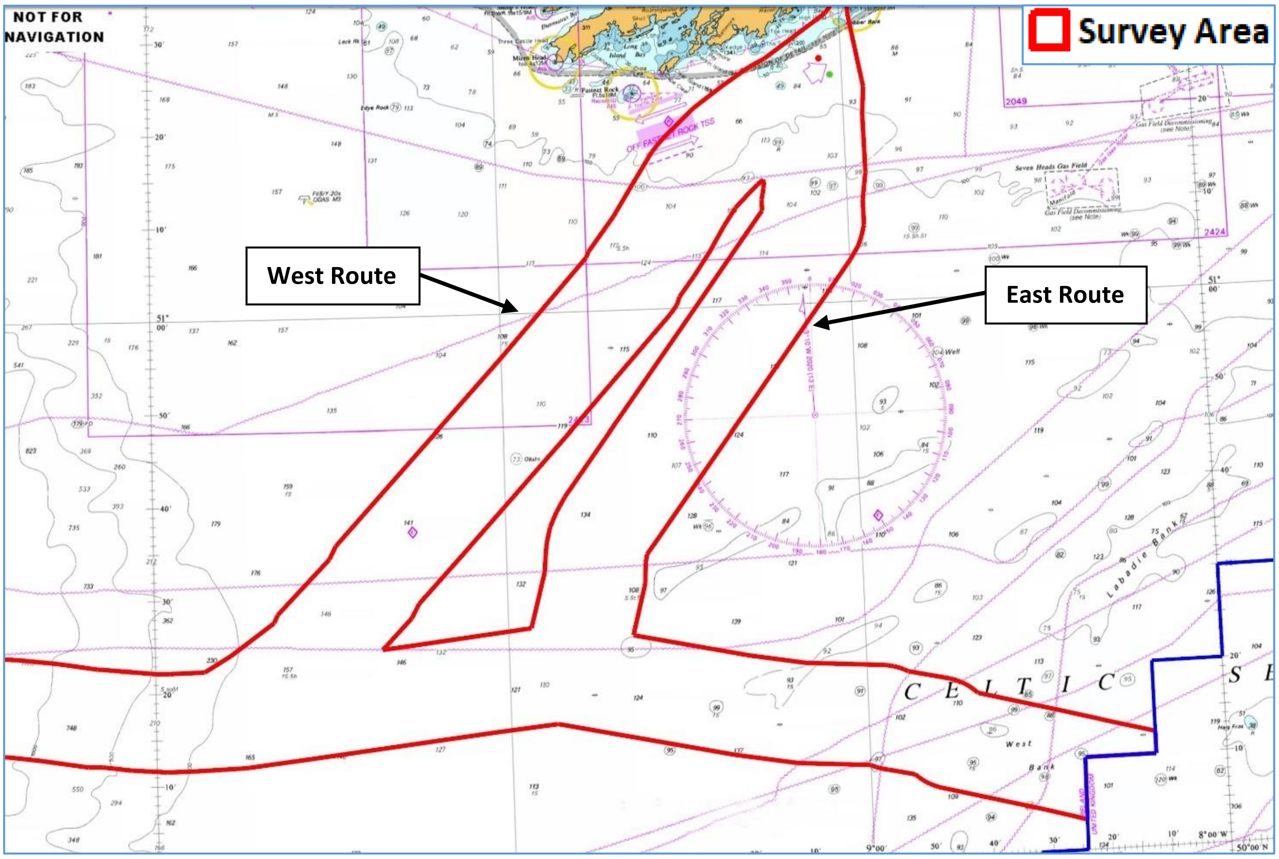

Figure 11. Offshore Survey Corridor options.

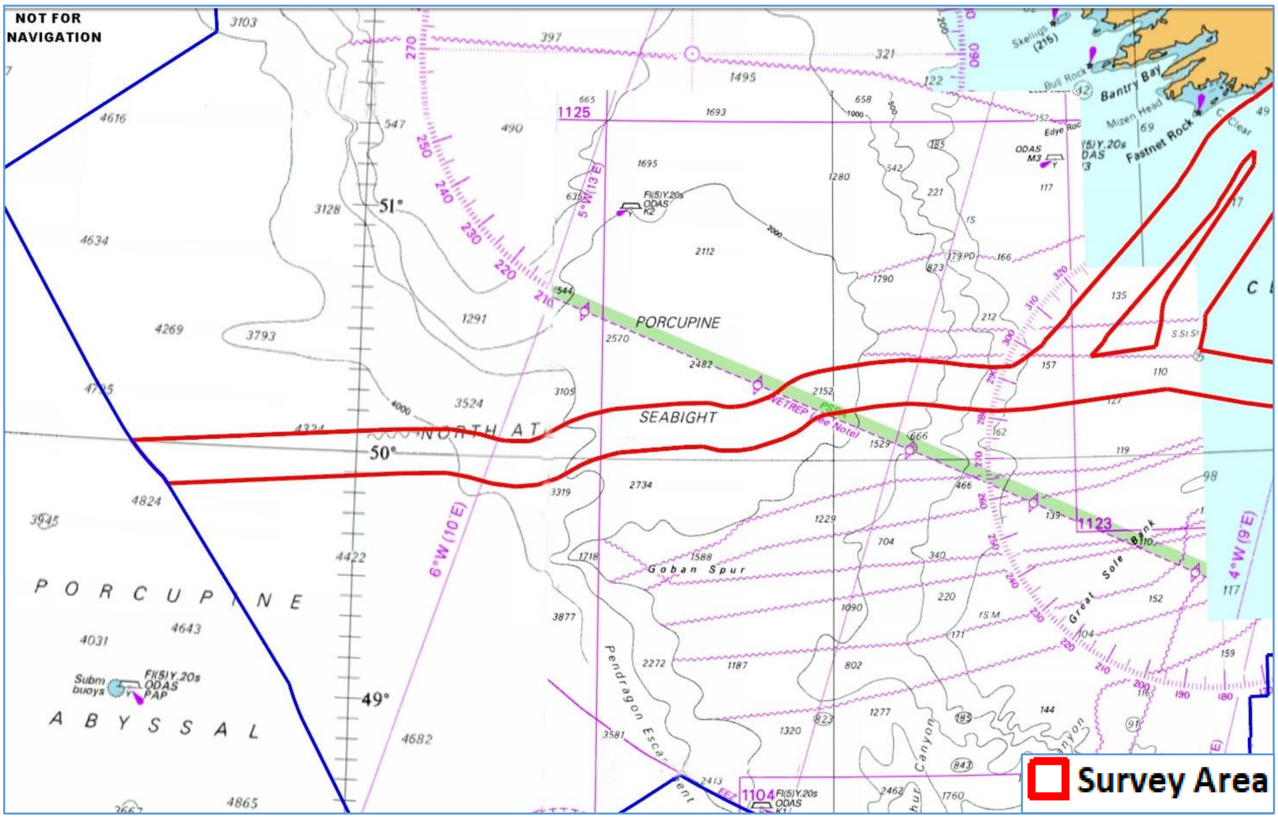

Figure 12. Deepwater Survey Corridor.

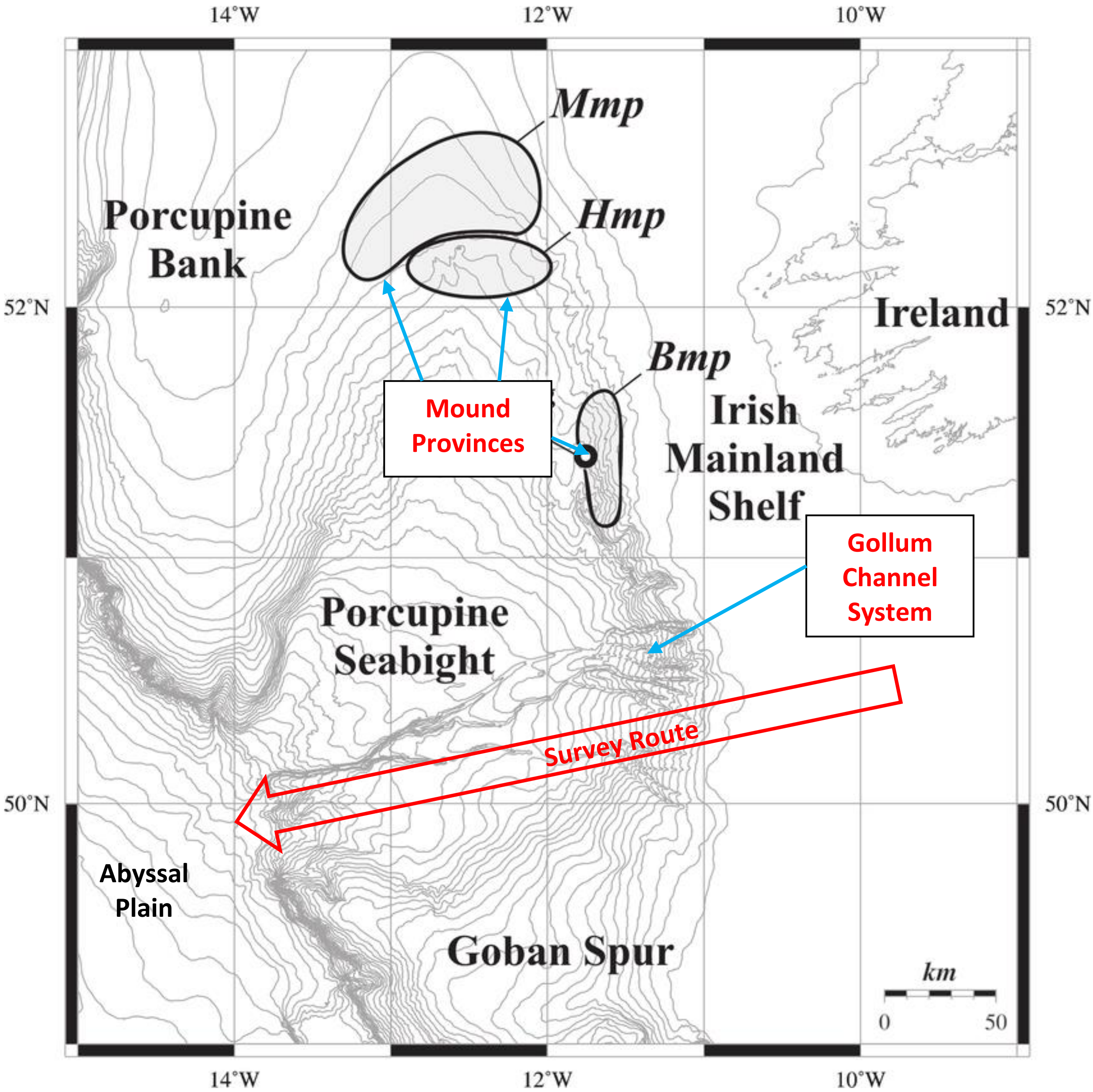

Figure 13. Porcupine Sea Bight.

3.0 PROPOSED MARINE SURVEY & SITE INVESTIGATIONS SCHEDULE OF WORKS

3.1 The principal objective of the Marine Survey & Site Investigations is to ascertain a feasible and safe route for cable system design, deployment, survivability and subsequent maintenance with due regard for environmental and ecological considerations. The survey will also enable decisions to be made on cable armouring and burial. The survey will identify the necessary water depths, route features, seabed obstructions, seabed geomorphology and cable hazards and will also provide detailed information on the seabed sediment, subsurface stratigraphy and upper sediment layers to support cable route and installation engineering. The site investigations will provide "ground-truthing" of the geophysical data along the route.

3.2 The objectives of the marine geophysical survey shall be:

- To collect up to date high-resolution bathymetry along a 500m wide cable corridor (or 3 x Water Depth up to 10km in Deepwater) within the Maritime Usage License Application Area;
- To obtain information on the seabed surface (type, texture, variability, etc.) and in particular, to identify any seabed features that may be of interest.
- Identify any shallow geohazards and man-made hazards (including but not limited to outcropping, boulders, shallow gas, wrecks, debris etc.);
- Determine the stratigraphy of the upper layers of the seabed along the cable route and quantify the variability in the lateral and vertical extents to depths of 2-5m
- Identify any seabed obstructions;
- Identify sensitive marine habitats which will need to be avoided during site investigations and sampling.

3.3 The survey operations will be broken down into separate but overlapping areas, with boundaries defined by water depth as specified in the technical requirements outlined below. These water depth boundaries may be adjusted due to suitability of the survey vessel(s) and survey spread. The survey and survey line spacing will be designed to ensure adequate coverage and overlap of geophysical measurements.

- Landfall Beach Survey – Terrestrial Beach and Intertidal Zone
- Inshore Survey – from 3m Chart Datum to 15m Chart Datum
- Offshore Survey – Water depths greater than 15m Chart Datum up to 1500m
- Deepwater Survey - Water depths greater than 1500m Chart Datum

3.4 In order to ensure data continuity, coverage between the survey areas is required with indicated overlap below;

- Landfall Beach Survey to Inshore Survey – 50m overlap
- Inshore Survey to Offshore Survey – 500m overlap
- Offshore Survey to Deepwater Survey – 500m overlap

Landfall Beach Survey & Site Investigations

3.5 A non-intrusive topographic and geophysical survey of the beach along the line of the proposed cable route at each landfall is required to the low water mark.

3.6 The topographical survey would typically be carried out by GPS Rover, Total Station or UAV Aerial Drone using photogrammetry or LiDAR techniques. The terrestrial geophysical survey will comprise remote sensing techniques such as Ground Penetrating Radar to establish subsurface features and depth to bedrock and magnetometer or handheld marine metal detector to locate buried ferrous objects.

3.7 An intertidal and beach survey (walkover survey) will be carried out on the beach by the project ecologist. The intertidal surveys will be undertaken at low or Spring tides in line with guidance in the JNCC Marine Monitoring Handbook (Davies et al., 2001).

3.8 An intertidal and beach survey (walkover survey) will be carried out on the beach by the project archaeologist under licence from the National Monuments Service. The intertidal surveys will be undertaken at low or Spring tides. A camera, GPS and marine metal detector will be deployed, scanning a series of survey lines in a grid pattern on the beach and intertidal zones. All archaeological survey will be carried out to determine the location of all known archaeological or cultural heritage features in advance of the landfall site investigations.

3.9 Landfall Site Investigations will be undertaken on the beach to establish the depth and nature of the sediment and depth to bedrock. The focus of the site investigations will be on the upper layers of sediment to assess the feasibility of cable burial and installation techniques. The following may be undertaken at each landfall:

- 3 Trial Pits on the beach (target depth 2.5m).
- Bar probes on the beach at 10m spacing (approx. 6 to 8).
- Bar probes from the Low Water Line to the 3m water depth contour at 10m spacing. (approx. 6 to 8)

3.10 The Trial Pits will be positioned at approximately 30m centres starting seaward of the High Water Mark. The Trial Pits will be excavated, logged, photographed and backfilled in a single tidal cycle. The trial pits will be backfilled with the original excavated materials in the sequence in which they are excavated.

3.11 A summary Method Statement for excavation of any Trial Pits is as follows;

- Excavate sand and place to one side.
- Excavate substrate and place separate from sand.
- Measure, log and photograph each Trial Pit.

- Backfill in sequence compacting with bucket of back-hoe as the backfilling proceeds.

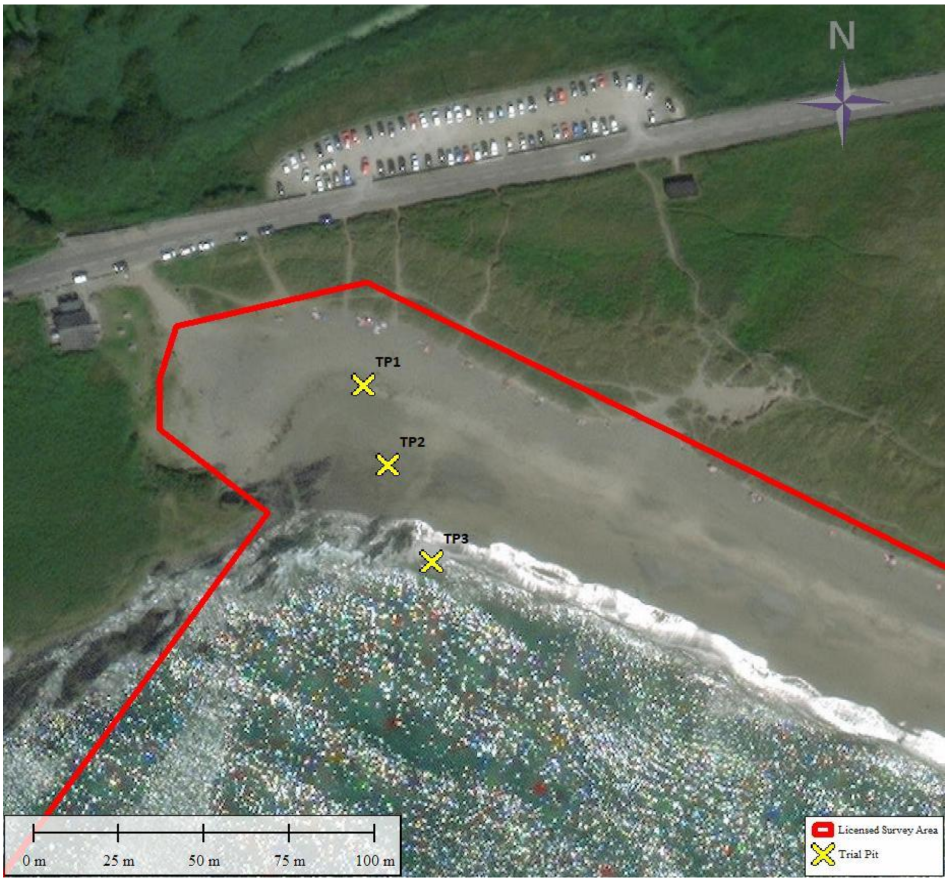

Figure 14 Long Strand Trial Pit Locations.

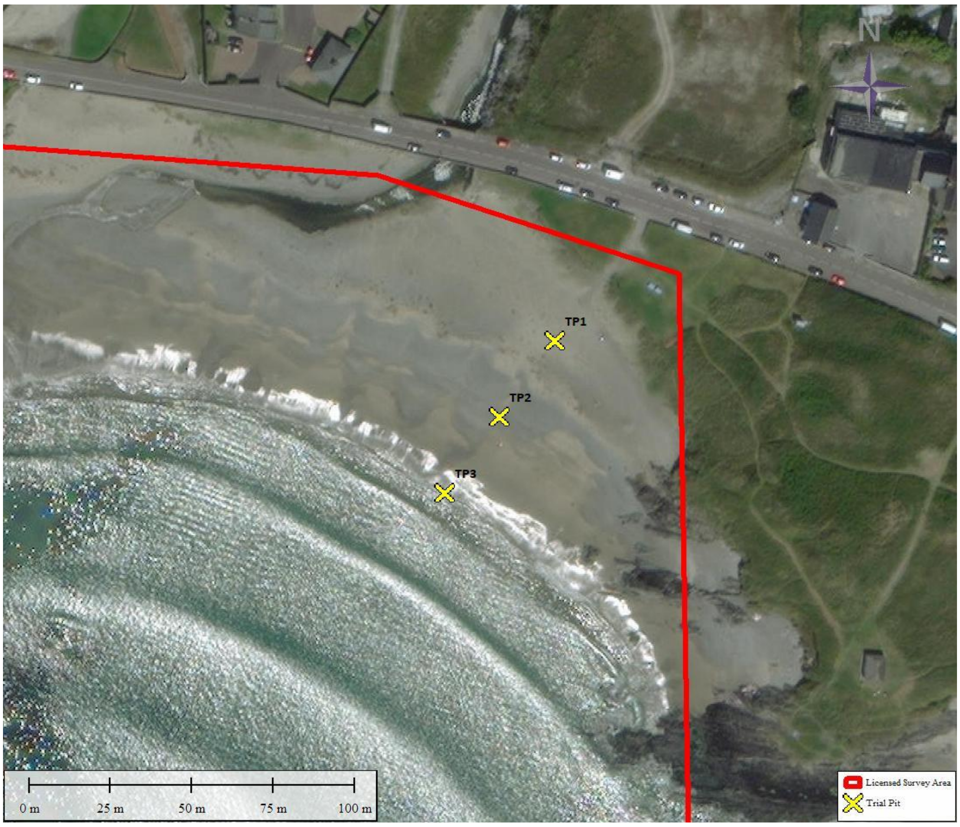

Figure 15 Ownahincha Trial Pit locations.

3.12 The bar probes on the beach are manually driven to a depth of 2 metres simply to prove the depth of upper layers of sand, gravel or soft material.

3.13 A non-invasive Electrical Resistivity Tomography (ERT) survey may be required (tbc) and would be utilized within the Study Area on the beach. ERT survey involves the measurement of electric potential differences between a series of dispersed electrodes that are generated by an electrical current that is injected into the subsurface. Typically, this involves the placement of multiple vertical electrode strings (VES) in the ground where the electrodes are equally spaced. Additional electrodes can also be placed, temporarily, just beneath the surface to aid measurements. The ERT survey provides:

a) Depth of Penetration below ground,

b) High resolution of vertical geomorphic boundaries and

c) Is not sensitive to velocity inversions.

Furthermore, the combined results of the ERT and topographic survey (Section 3.6) will allow for a better understanding of the existing stratigraphy.

Inshore Marine Survey

3.14 The area extending seaward from the low water mark at each landfall and inshore of the safe working draft limits of the primary survey vessel will be accurately surveyed with a small craft or Unmanned Survey Vessel (USV) using Multibeam Echosounder (MBES), sidescan sonar, marine magnetometer and sub-bottom profile equipment. Sub-bottom profile equipment will be able to discern the nature and density of the upper 3 metres of seabed and will be used on a non-interfering basis with other sounding systems. A minimum of seven survey lines, based upon the Survey RPL, is required.

3.15 Features such as shallow reefs, surge channels, debris fields, archaeological features or anything that could be a hazard to the cable or installation team will be noted. General reconnaissance of the survey corridor beyond the planned survey lines and tie-lines may be necessary to describe the seabed as accurately as possible. A line plan showing number of survey lines as a function of depth will be determined prior to start of survey operations.

Survey Area	Depth Range	Survey Corridor Width	Min. # of Lines	Min. Overlap	Typical Survey Speed
Inshore	3m to 15m	500m	7	SSS: 100% MBES Bathy: 20%	4 knots

Table 2 Inshore Survey.

Offshore Marine Survey

3.16 The area extending seaward from the outer limits of the inshore survey to the 12nm limits will be surveyed by the primary survey vessel using Multibeam Echosounder (MBES), sidescan sonar, marine magnetometer and sub-bottom profiler equipment. A continuous bathymetric swathe along with side scan sonar imagery and sub-bottom traces will be obtained, centred on the preliminary route and along all wing lines needed to complete the route corridor coverage. A minimum of five survey lines, based upon the Survey RPL, is required.

3.17 Sub-bottom profile equipment will be able to discern the nature and density of the upper 3 metres of seabed and will be used on a non-interfering basis with other sounding systems.

Survey Area	Depth Range	Survey Corridor Width	Min. # of Lines	Min. Overlap	Typical Survey Speed
Offshore	15m to 100m	500m	7	SSS: 100% MBES Bathy: 20%	4 knots
Offshore	100m to 1,000m	500m	5	SSS: 100% MBES Bathy: 20%	4 knots
Offshore	1,000m to 1,500m	500m	7	SSS: 100% MBES Bathy: 20%	4 knots

Table 3. Offshore Survey.

Deepwater Survey

3.18 The area extending seaward from 1,500m water depth to the Maritime Area limits will be surveyed by the primary survey vessel using Multibeam Echosounder (MBES) equipment. A continuous bathymetric swathe will be obtained, centred on the preliminary route and along all wing lines needed to complete the route corridor coverage. One survey line, based upon the Survey RPL, is required.

3.19 The width of the seabed covered by a single survey line increases as a function of water depth, with the width approximately equal to up to 3 times the water depth. This is illustrated in Figure 19 below. Therefore, in deep water the survey corridor width increases as the survey progresses into deeper waters. The maximum water depth of the survey within the Maritime Area is approximately 4,000m. Based on previous experience of deepwater cable route surveys, the survey corridor width will therefore extend up to a maximum of approximately 10,000m at the Maritime Area extents.

Table 4: Deep Water Survey

Survey Area	Depth Range	Survey Corridor Width	Min. # of Lines	Min. Overlap	Typical Survey Speed
Offshore	> 1,500m	3 x WD Max. approx. 10,000m	1	NA	4 knots

Marine Site Investigations and Seabed Sampling

3.20 The purpose of the marine site investigations and seabed sampling is to evaluate the physical properties of the superficial seabed sediments along the cable route. These methodologies will ensure that a full understanding of the subsurface is achieved, focussing on the upper 3 metres of sediment to subsequently develop a cable burial assessment, installation and burial plan.

3.21 The scheduled site investigations and seabed sampling within the maritime area limits will comprise of the following techniques:

- Up to 96 CPTs (2m to 3m)
- Up to 48 Gravity Cores / Vibrocores (3m)
- Up to 26 Grab Samples

3.22 Indicative locations for the relevant site investigation activities (Gravity or Vibrocore, Grab Samples and CPT's) are shown in Figure 16 - 18. Site investigations and seabed sampling will only be undertaken up to a limit of 1,500m water depth. Typically, individual sampling positions will be determined following initial interpretation of the geophysical survey data. The positioning of individual site investigation locations will also take into consideration environmental constraints such as the position of sensitive habitats or archaeological features.

3.23 Two or more attempts may be made at each location to acquire a suitable sample. If an acceptable sample is achieved on the first attempt, there is no need to perform a second attempt.

3.24 An acceptable sample is defined as;

- Grab Sample – recovery of approximately a full bucket of sediment. Recovery of large size granular material may be taken as indication of a hard seabed.
- Gravity Core / Vibrocore – recovery of < 3m core of soil. If stiff or hard soils are encountered and are clearly indicated in the sample, it sample may be deemed acceptable. Any sample site yielding less than 1m of recovery must be investigated a second or third time unless there is obvious damage to the coring equipment indicating a hard or rocky substrate.
- CPT – Penetration to the 2m target depth or refusal. Any push resulting in less than 2m penetration will warrant a second attempt.

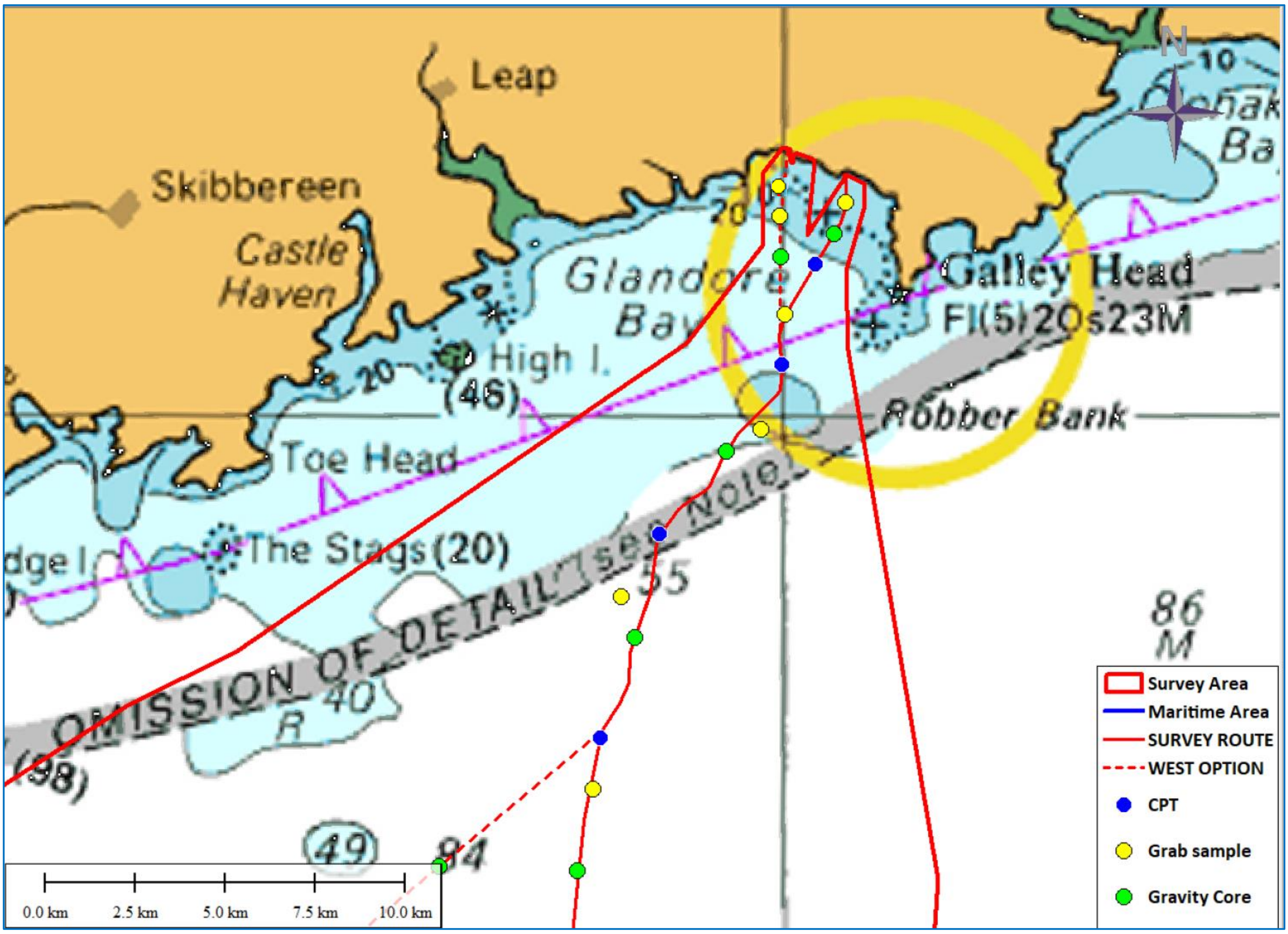

Figure 16. Indicative CPT, Grab sample and GC Locations.

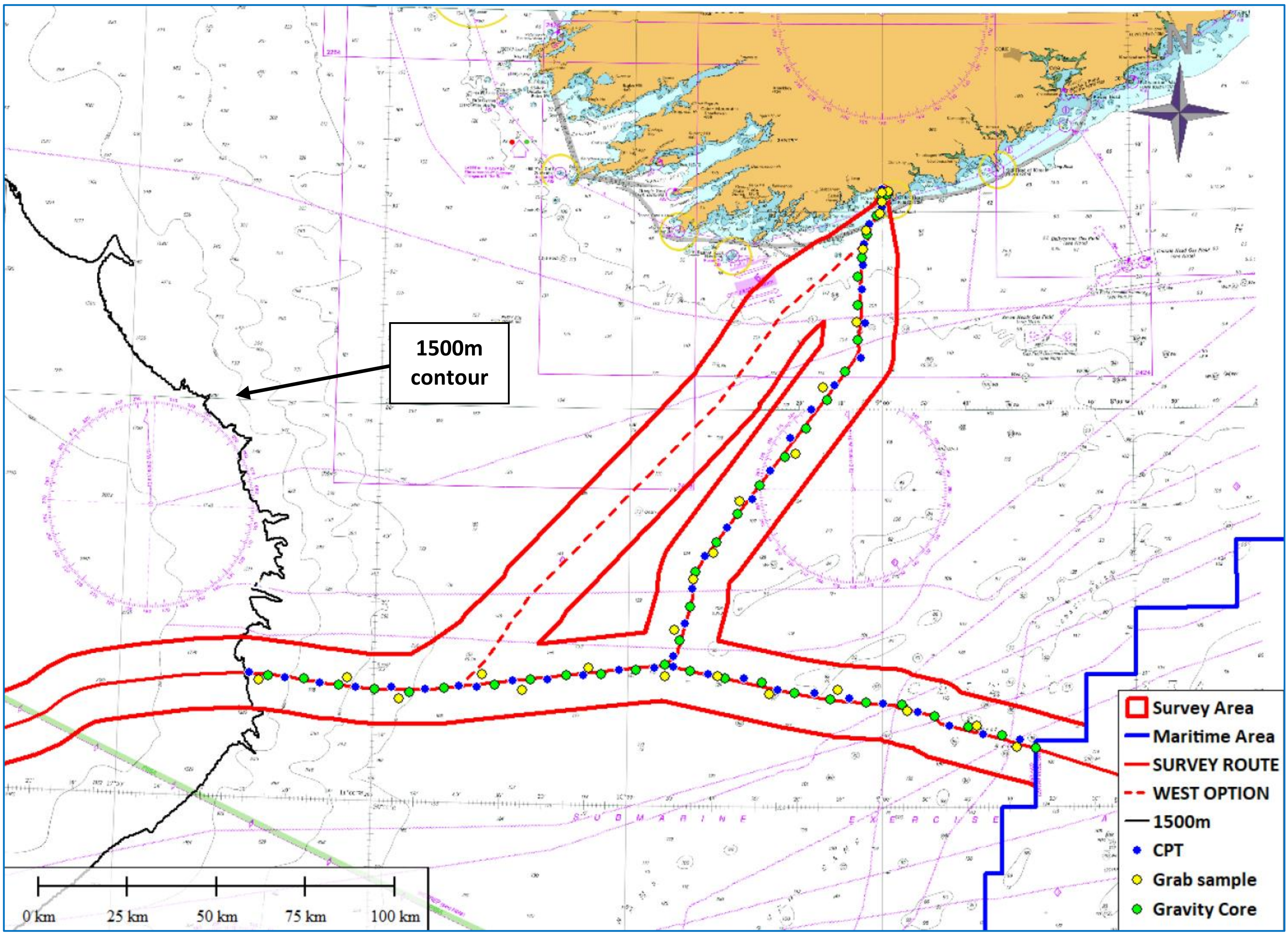

Figure 17. Indicative Sampling Locations - Eastern Route Option

Seabed Sampling

3.25 The total overall scope of the Site Investigations is as follows

- Trial Pits — Up to 3 No. on the beach.
- Bar Probes — 16 No. on the beach.
- Bar Probes — 16 No. from Low Water to 3m contour.
- Grab Samples — 26 No. along the route corridor.
- Gravity Cores / Vibrocores — 48 No. along the route corridor.
- Cone Penetration Tests — 96 No. along the route corridor.

Underwater Video Survey

3.26 Underwater video camera system may be used for inspections of the seabed to investigate seabed obstructions, marine archaeology or benthic habitats. An underwater drop-down camera system or similar may be used in a series of video transects which would be georeferenced and later mapped in GIS.

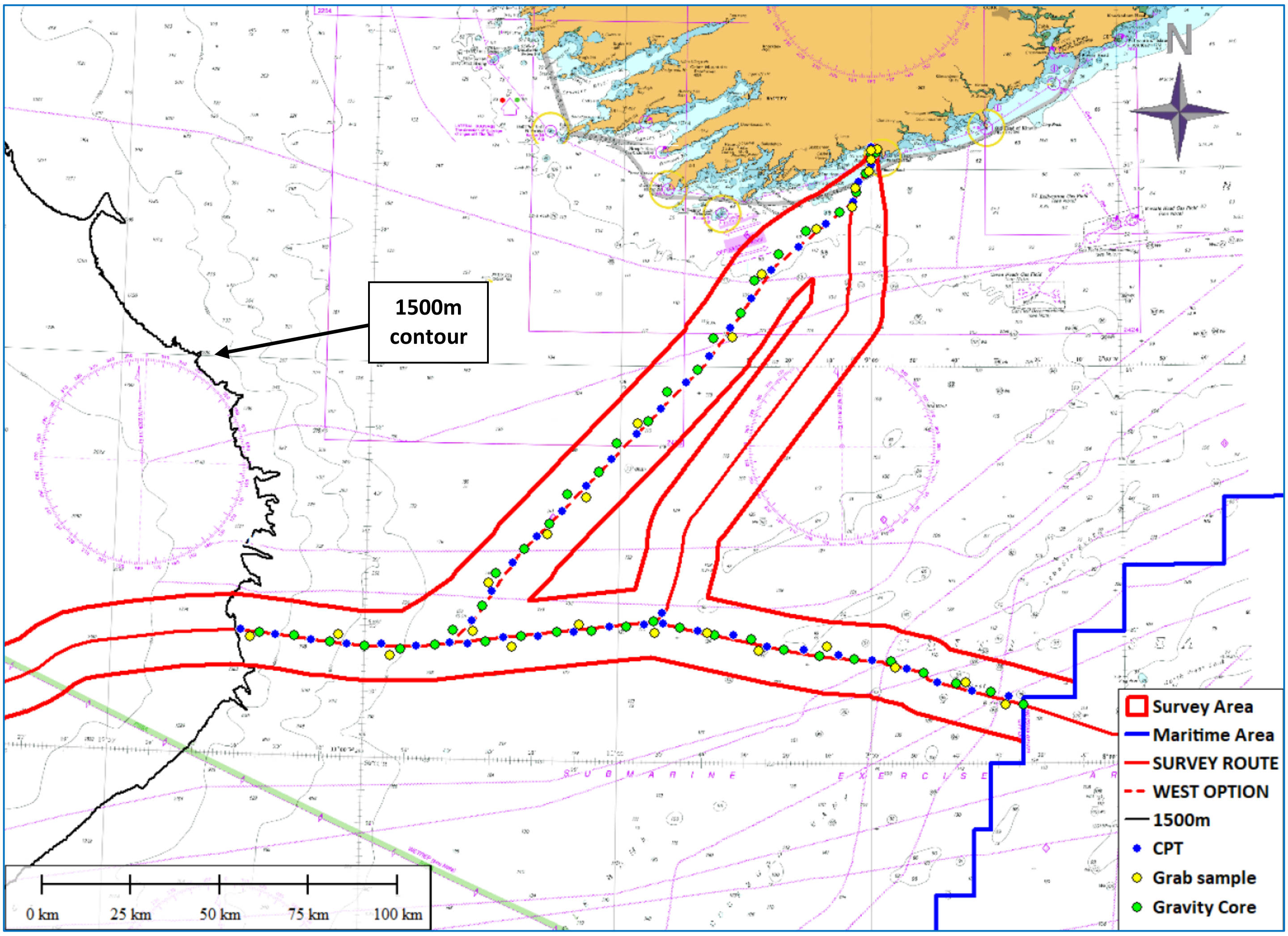

Figure 18. Indicative Sampling Locations - Western Route Option

Archaeological Survey

3.27 The proposed survey specification takes into account archaeological data acquisition to enable professional archaeological interpretation and analysis of data. The survey equipment deployed and data acquisition and processing shall comply with the requirements of the National Monuments Service, Underwater Archaeology Unit. Walk over surveys will be conducted within the intertidal area to check for marine archaeology features and evidence of features of cultural heritage significance.

3.28 All archaeological assessments will be carried out under by a suitably qualified and experienced marine archaeologist to determine the location of all known archaeological features in advance of the intrusive site investigations and seabed sampling. The data collected will be used to support the archaeological assessments.

4.0 SURVEY EQUIPMENT PARAMETERS

Multibeam Echosounder (MBES)

4.1 Echo-sounders are a diverse group of acoustic sources used to collect information on bathymetry, seabed features and objects in the water column (e.g. Multi beam echosounder, scientific echo-sounders/ fish-finders). They measure water depth by emitting rapid pulses of sound towards the seabed and measuring the sound reflected back.

4.2 Multibeam Echosounder (MBES) will be used during the marine survey to provide detailed 3 dimensional bathymetric mapping of the cable route corridor using multiple beams elongated in the across-track direction to cover a fan-shaped sector (or swath) (Figure 19). Measurements of the across-track beam from MBES showed 3 dB beam widths of 150-160°; in the along-track orientation beam width is narrow, typically ~1.5-3.0° (Crocker & Fratantonio 2016).

4.3 MBES is non-intrusive and does not interact with the seabed. The MBES system will be used will be confirmed following the appointment of a survey contractor but typical systems which can be taken as examples would be the R2 Sonic 2024, Kongsberg EM2040 or Teledyne Seabat T50 which would be hull mounted on the survey vessel.

4.4 A specific deepwater Multibeam system will be required for surveying in water depths greater than 1,500m. The deepwater MBES system that will be used will be confirmed following the appointment of a survey contractor but a typical system which can be taken as examples would be the Kongsberg EM122 operating at 12kHz with 1x1 degree beamwidth.

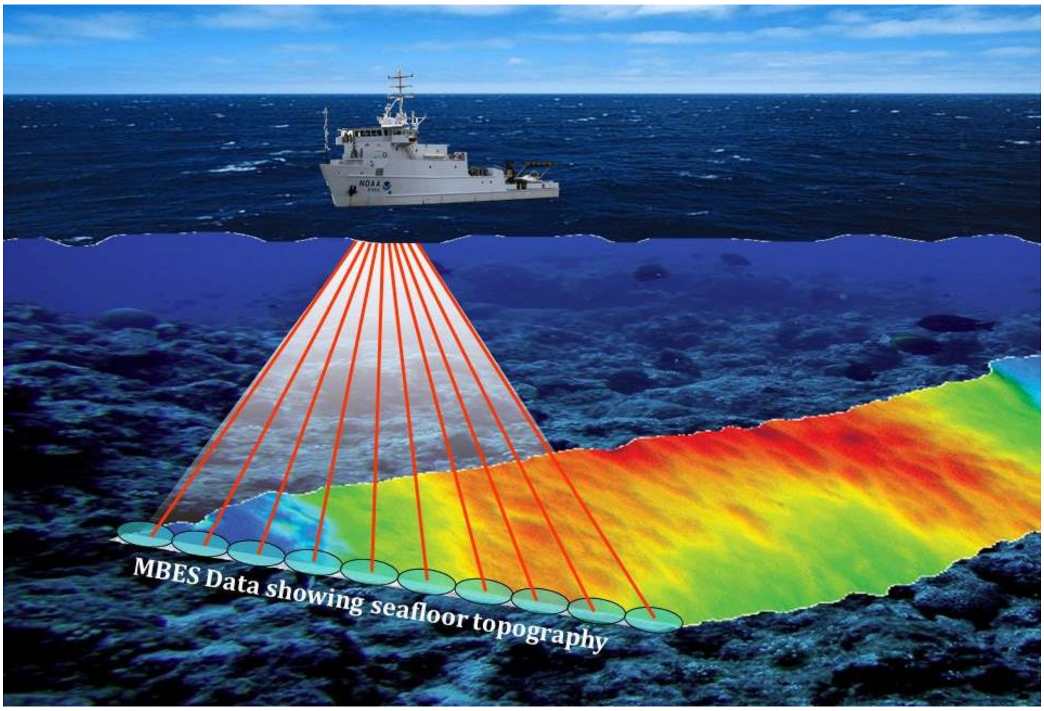

Figure 19 Graphic of MBES survey in operation.

4.5 The acoustic signal emitted by MBES systems is short duration, typically of a few milliseconds or less, and can be configured to within the range 0.05-10 ms for certain systems. Repetition rates are highly customisable, varying with signal frequency and water depth. Ping rates of up to 10-20 pings per second may be used in very high frequency systems, whereas there may be several seconds between pings in low-frequency deep-water applications.

4.6 For collecting information on the seabed, emitted sound frequencies are typically between 12 – 400 kHz depending on water depth, with surveys in continental shelf applications operating at between 70 to 150 kHz, and in shallower waters of less than 200 m using multi-beam echosounders operating at between 200 and 500 kHz The typical operating frequencies for the cable route survey within the Maritime Usage Licence application area will be in the range of 200kHz to 500kHz in shallow water and 12kHz in deep water (>1500m) . (Danson 2005, Hopkins 2007, Lurton and DeReutier 2011)

4.7 Maximum sound source pressure levels of MBES have been reported as ranging from 210-245 dB re 1µPa at 1m with the highest levels corresponding to the lowest frequency systems (DECC 2011, Lurton and DeReutier 2011, Lurton 2016, BEIS 2020). The highest measured source levels among three MBES systems when operated at maximum power for central operating frequencies of ≥100 kHz was between Lp,pk 225-228 dB re 1µPa at 1m (LE,p 181-197 dB re 1µPa^2 s at 1m (Crocker & Fratantonio 2016).

Side-scan sonar

4.8 Side-scan sonar (SSS) is a seabed imaging technique used to provide high-resolution and detailed 2 dimensional imagery of the seabed for a variety of purposes. SSS involves the use of an acoustic beam to obtain an accurate image over a narrow area of seabed to either side of the instrument.

4.9 Piezoelectric transducers in the SSS generate high-frequency acoustic pulses which are directed either side of the tow fish. The transducers are oriented such that the acoustic signal covers a wide angle perpendicular to the path of the tow fish through the water, providing information on a strip either side of the device (port and starboard). The intensity of the acoustic reflections from the seafloor is recorded in a series of cross-track images. When stitched together along the direction of motion, these images form a waterfall view of the sea floor within the swath of the beam. The range (swath width) is dependent upon the frequency, power and other source configurations, but is typically between 50-300 m on both sides.

4.10 Analysis of SSS data can aid identification of seafloor sediment, surficial bedrock outcrops and geomorphology mapping. Obstacles rising proud of the seafloor, such as shipwrecks, boulders, pipelines, outfalls, exposed cables, fishing gear etc. can cast shadows on the resulting seafloor image where no acoustic signal is returned. The size of the shadow can be used to determine the size of the feature casting it (Figure 20).

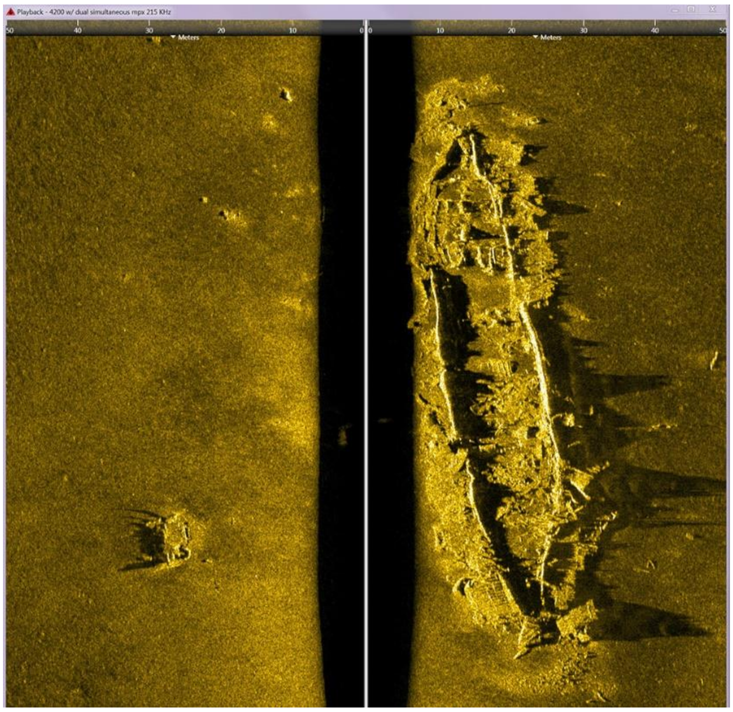

Figure 20. SSS image of shipwreck on seabed and nadir gap.

4.11 SSS is non-intrusive and does not interact with the seabed. The SSS system will be used will be confirmed following the appointment of a survey contractor but typical systems which can be taken as examples would be the Klein 3000 or Edgetech 4200 (Figure 21). The SSS may be hull mounted but is typically towed at depth behind the survey vessel on an armoured tow cable.

Figure 21. Deployment of Edgetech 4200 Tow fish.

4.12 Acoustic signal durations of SSS systems are short (0.4ms – 1.0ms), but vary between models and configurations with longer signal durations are required to survey greater ranges. Repetition rates are highly customisable with ping rates of up to several tens of pings per second (Crocker & Fratantonio 2016). The frequencies used by side-scan sonar are relatively very high, typically between 100 and 900 kHz. Most SSS systems offer real-time dual frequency operation which allows acquisition of both frequencies across a swath independently and simultaneously. The higher frequency produces higher resolution data and sharper images but with a narrow swath width while the lower frequency results in wider seabed coverage at lower resolutions.

4.13 SSS typically offer a selection of two operational frequencies in the range of 100-500 kHz, or may operate both simultaneously. Some models may offer an upper frequency of up to 900 kHz for applications requiring the highest resolution data. Across-track resolutions vary between 1-8 cm with finer resolution at higher operating frequencies. The typical operating frequencies for the cable route survey within the Maritime Usage Licence application area will be between 200 to 700 kHz.

4.14 The line spacing for the survey will be determined after consideration of all factors including water depth and prevailing conditions at time of survey. Generally for SSS, full coverage requires two passes with 100% overlap over a given area of sea-floor, with the two passes each insonifying the sea-floor from opposite directions to ensure targets are adequately imaged. This also ensures that the 'nadir gap' or the centre of the image directly under the path of the towfish is fully covered (Figure 20).

4.15 Sound source pressure levels of SSS systems have been reported typically in the range Lp,pk 200-240 dB re 1µPa at 1m. (BOEM 2016, BEIS 2020, DAHG 2014). Maximum calibrated source levels, (sound pressure) measured by Crocker & Fratantonio (2016) were Lp, pk 227 dB re 1µPa at 1m for a 0.1 ms pulse, whereas the highest energy source level of LE, p 205 dB re $1\mu Pa^2$ s at 1m corresponded to a longer pulse of 1.1 ms at lower maximum pressure (Lp, pk 210 dB re 1µPa at 1m).

Marine Magnetometer

4.16 A marine magnetometer is a passive towed sensor used to measure magnetic field strength and to detect variations in the total magnetic field of the underlying seafloor. The magnetometer does not transmit any signals into the marine environment.

4.17 Usually, the increased magnetization is caused by the presence of ferrous (unoxidized) iron on the seafloor or buried below the surface, whether from a shipwrecked vessel made of steel or from natural rock formations containing grains of magnetite. After corrections are made to measurements of the total magnetic field, magnetic data is used to locate existing infrastructure such as buried pipelines, undersea cables and to identify shipwrecks and potential unexploded ordnance.

4.18 Marine magnetometers are non-intrusive and do not interact with the seabed. They are towed at depth at least two and a half ship-lengths behind the survey vessel, so that the ship's magnetic field does not interfere with magnetic measurements. The marine magnetometer may be integrated and towed in tandem with the SSS. The marine magnetometer will be of the Caesium Vapour type and capable of recording variations in magnetic field strength during survey to an accuracy of ±0.5nT.

4.19 The marine magnetometer system to be used will be confirmed following the appointment of a survey contractor but typical systems which can be taken as examples would be the Geometrics G-882 or Marine Magnetics SeaSpy (Figure 22). The line spacing and coverage will generally match the SSS as they are towed in tandem and the parameters of the survey may be determined by the requirements of the Underwater Archaeology Unit of the National Monuments Service.

Figure 22. Marine Magnetics SeaSpy towfish.

Sub-bottom profiler

4.20 Sub-bottom profilers (SBPs) encompass a range of acoustic systems which are designed to collect information on the characteristics of strata below the seabed, establish changes in sediments and detect and image structures buried within the sediments (Figure 23). Shallow Sub-bottom profiling can penetrate the seabed to a range of depths, from a few metres to tens of metres depending on the geological conditions encountered, and with vertical resolutions from a few centimetres to a few metres. Most are towed behind a survey vessel, either at/near the surface or at depth, whereas some smaller devices may be hull-mounted or lowered over the side of a vessel on a pole mount

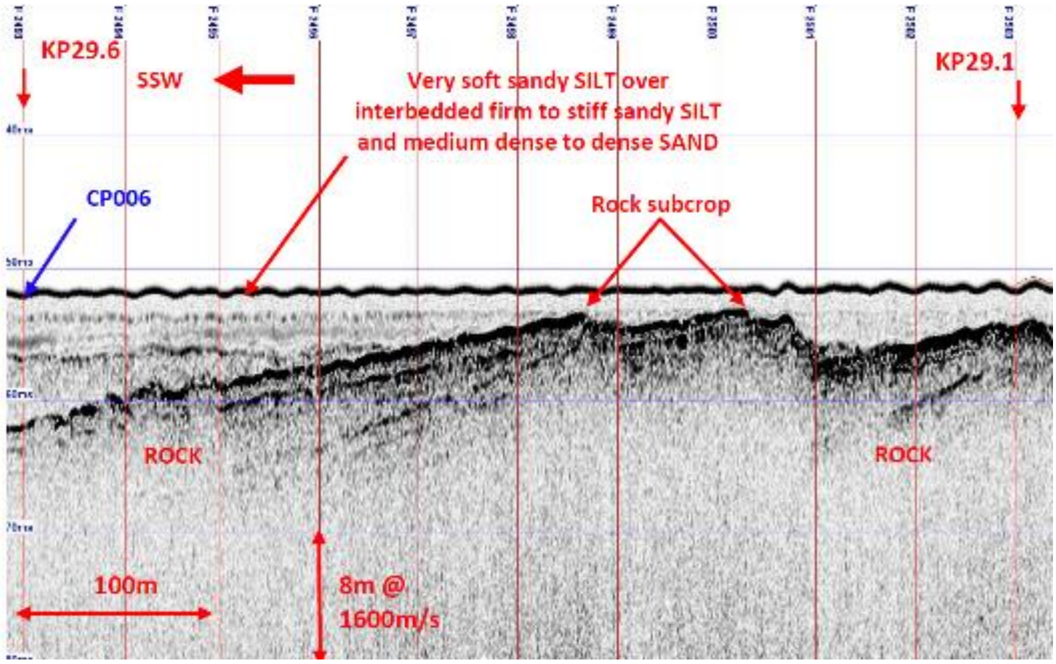

Figure 23. Interpreted SBP seabed profile.

4.21 Pulsed waveform SBPs generate an acoustic signal either through the impulsive physical processes of electrostatic discharge, as in sparkers, or electromechanically via accelerated water mass, as in boomers. All periodic waveform SBPs i.e. pingers, chirpers and parametric SBPs are electromechanical sources which employ piezoelectric transducers to generate an acoustic waveform by converting electrical energy into mechanical movement i.e. vibrations. Through the reverse of this process, the transducers can also detect sound. As such, these sources are highly customisable; in many cases, the signal is modulated in frequency and/or amplitude to improve its detectability and performance.

4.22 The systems most commonly used for high-resolution surveying are the boomer (such as the Applied Acoustics S-Boom), pinger (such as the Kongsberg GeoPulse), chirp (such as the Edgetech SB-424, Figure 24) and parametric chirp systems (such as the Innomar SES-2000). Whereas the boomer system provides best results for coarser sediments, the pinger and chirp systems deliver detail for finer sediments.

4.23 The objective of the SBP cable route survey is to investigate the upper layers of the seabed sediments for cable burial potential and installation risk from seabed obstructions such as subcropping rock formations and is not focussed on deep seabed conditions such as required for investigation of offshore wind farm foundations or deepwater seismic surveys carried out by Oil and Gas Exploration. The SBP system used for the survey will be confirmed following the appointment of a survey contractor and the most appropriate system chosen depending on the seabed, anticipated geological environment and the survey vessel capabilities.

4.24 Sound source pressure levels of various SBP systems have been reported typically in the range Lp,pk 185-247 dB re 1µPa at 1m. (Hartley Anderson 2020, Crocker & Fratantonio 2016). A summary of the Maximum Sound Pressure Levels for SBP systems is described in Table 4 below. The SBP survey is non-intrusive therefore does not interact with the seabed.

Figure 24. Edgetech SB-424 tow body.

Equipment Type	Frequency Range	Duration	*Maximum* Source Pressure Level (re 1µPa at 1 m)	Reference
Sub-bottom Profiler (SBP) - Pinger	2 kHz to 15 kHz	0.5 - 30 ms	214 dB.	Hartley Anderson 2020
Sub-bottom Profiler (SBP) - Chirper	2 kHz to 13 kHz	5 - 40 ms	185 - 215 dB.	Crocker & Fratantonio 2016, Hartley Anderson 2020
Sub-bottom Profiler (SBP) - Boomer	500 Hz to 15 kHz	0.5 - 1.0 ms	205 - 215 dB.	Crocker & Fratantonio 2016
Sub-bottom Profiler (SBP) - Parametric	4 to 15 kHz, 85 to 115 kHz	0.2 - 30 ms	238 - 247 dB. 200 - 206 dB.	Hartley Anderson 2020

Table 4. Typical SBP specifications.

Ultra-Short Baseline (USBL) Subsea Positioning

4.25 An Ultra-Short Baseline (USBL) is a subsea positioning system widely used by the offshore marine industry and scientific research vessels to accurately track the position of towed equipment and sensors. The USBL system consists of a transceiver mounted to the survey vessel, and transponders on the towed equipment.

4.26 To calculate a subsea position, the USBL calculates both a range and an angle from the transceiver to the subsea beacon. Angles are measured by the transceiver, which contains an array of transducers. The transceiver emits an acoustic signal at predetermined periods (often 0.5 seconds) which is returned by the transponder and allows for the bearing and distance to be calculated.

4.27 USBL systems are designed for close range transmission and thus typically emit pulses of medium frequency sound (20 to 50 kHz). Manufacturers report SPL values of 194 to 207dB re 1µPa at 1m depending on the model used, taking as an example the higher range of USBL source (Kongsberg HiPAP) with a SPL of 207dB re 1µPa at 1m.

Cone Penetration Test (CPT)

4.28 The survey vessel will position itself over the target position to carry out the CPT. The seabed CPT rig (such as a Neptune 3000, Figure 25) is deployed to the seabed from the vessel crane, A-frame or dedicated Launch and Recovery System (LARS). Once on the seabed, in a stable position, a steel rod with a conical tip (typically an apex angle of 60° and a diameter of 35.7 mm) is pushed at a steady rate into the seabed until it reaches target penetration depth of 3 to 6m or refusal. The penetration resistance at the tip and along a section of the shaft (friction sleeve) is measured and recorded for later analysis

4.29 Refusal is indicated by peak system thrust, excessive load on the tip or excessive inclination of the cone. If target penetration depth is not met, the CPT rig may be moved to a nearby position on the seabed and the test repeated. The time taken to complete a shallow CPT is typically less than 10 minutes but the total time in the water from deployment to recovery may be 1 to 2 hours at each position, depending on water depth and sea state.

4.30 There is very little published information on the sound pressure levels generated from CPT equipment, collected either from field experimentation or from manufactures specifications. Data from a similar device indicates that sound pressure source levels are typically within the range 118 - 145 decibels (dB) (BOEM 2012, EIRGRID 2014).

Figure 25. Neptune 3000 CPT rig.

Gravity Core

4.31 Gravity corers (Figure 26) provide a rapid means of obtaining a continuous core sample in water depths from a few metres down to several thousand metres. A gravity corer consists of a steel tube in which is inserted a plastic liner to hold the core sample. Gravity corers are commonly used for cable route investigations.

4.32 A set of heavy weights, up to 750 kg, is attached at the top end of the tube above which is a fin arrangement to keep the corer stable and vertical during its fall to the seabed. The sampler penetrates the seabed under its own weight. Normal practice is to lower the device to within 10 m of the seabed before releasing. The penetration depth is between 1 m and 3 m. Penetration in stiffer clays or sands is usually limited

4.33 The penetrating end of the tube is fitted with a cutter and a concave spring-steel core-catcher to retain the sample when the corer is retracted from the soil. The suction caused when withdrawing a core barrel from a soft soil such as clay, can pull the sample from the barrel, or in other ways disturb its homogeneity. By fitting a piston above the sample, the partial vacuum caused above the piston, when the barrel is withdrawn, keeps the sample from being pulled out of the tube.

4.34 Upon refusal or at target depth of 3m, the sampler is recovered on deck where the sample is split, typically into 1m lengths, logged, sealed and stored for later laboratory analysis. The typical diameter of the liner is in the region of 90mm with a typical maximum diameter of 120mm.

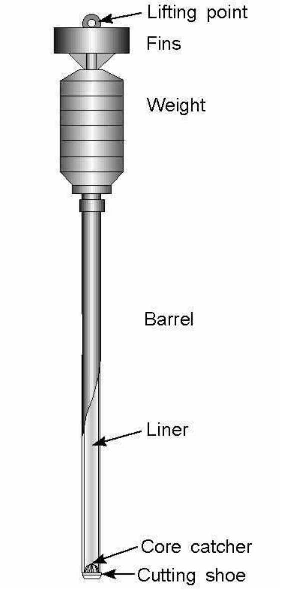

Figure 26. Gravity Corer schematic.

Vibrocorer

4.35 Vibrocorers are used wherever soil conditions are unsuited to gravity corers or where greater penetration of the seabed is necessary. Vibrocore is best suited to non-cohesive soils (e.g. gravel or sand) as samples recovered are considered disturbed. Vibrocorers are commonly used for cable route investigations.

4.36 To penetrate soils such as dense sands and gravels, or to reach deeper into stiff clays, rather than depending on a gravity free-fall, the corer's barrel is vibrated, thus facilitating its penetration into the soil. This vibration energy allows the core barrel to penetrate the sediments under self-weight. In other respects, the barrel and sample retention systems are similar to gravity corers.

4.37 The typical vibrocorer consists of a tall steel frame and tripod support. Within the frame is a standard 102 mm steel coring barrel in which is inserted a PVC liner to contain the sample. The typical diameter of the PVC liner is in the region of 90mm with a typical maximum diameter of 120mm. A spring steel core catcher is fitted to the cutting shoe, as with the gravity corer. Two linear electric motors enclosed in a pressure housing provide the vibratory motion; the core barrel is attached directly to the motor housing. Power is fed to the motors via an electrical control line from the survey vessel.

4.38 Once in motion, the heavy motor housing provides the mass to drive the core barrel into the seabed. The penetration depth can be from 2m to 8m depending on seabed conditions. A typical 6 m vibrocorer will weigh nearly two tonnes and requires a crane for A-Frame or deployment and recovery. Vibrocorers come with barrel lengths of 3m, 6m and 8m with a 3m system proposed for this survey. A normal coring operation in 100 m water depth will take about one hour.

4.39 Once coring is started, the core barrel will penetrate to the target depth. Upon refusal or at target depth of 3m, the vibrocore is recovered on deck where the sample in the liner is removed from the barrel, the sample is split, typically into 1m lengths, logged, sealed and stored for later laboratory analysis.

4.40 The sounds produced by the operation of a vibrocorer on the seabed consist of a series of impulses corresponding to the movement and impacts of the mechanics of the vibrating motion from the oscillating motors on the core barrel. Expected sound pressure levels generated by vibrocore equipment would be approximately 187.4 dB re 1µPa at 1m (LGL, 2010),

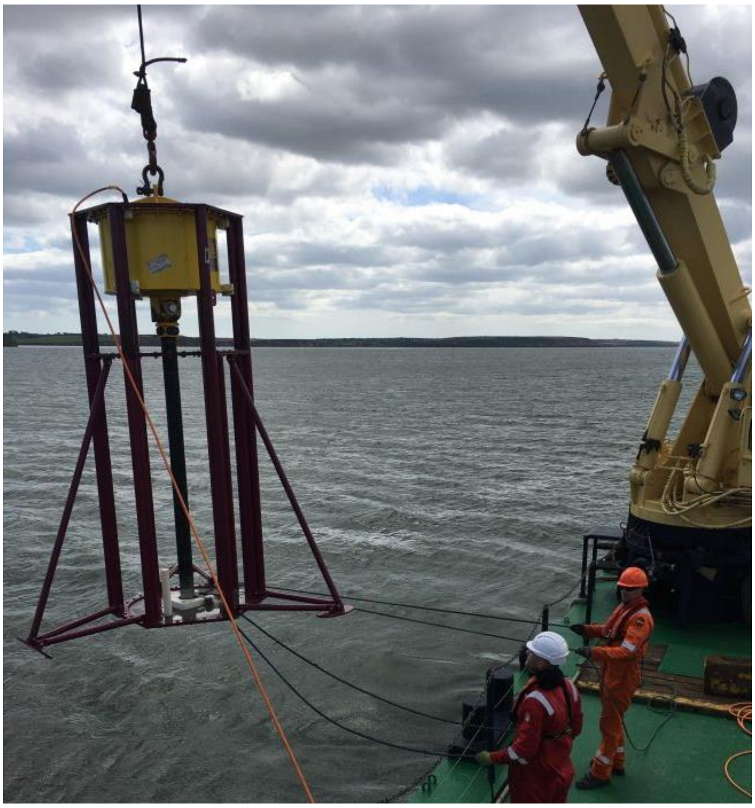

Figure 27. Deployment of Vibrocorer from Survey Vessel.

Grab samplers

4.41 Grab samplers are one of the most common methods of retrieving soil samples from the seabed surface. The grab sampler is a device that simply grabs a sample of the topmost layers of the seabed by bringing two steel clamshells together and cutting a bite from the seabed surface to a depth of 0.1 to 0.5m. The information they provide can be applied in a number of applications such as seabed classification, environmental sampling, chemical and biological analysis and ground truthing for morphological mapping and geophysical survey. Grab samplers can be used to recover samples of most seabed soils, although care is needed in selecting the right size unit for the task.

4.42 There are various grab sampler types to include but not limited to Van Veen (single or double, Figure 28), Hamon, Shipek and Day Grab samplers. Generally, some variants may come both as single or double, and in a variety of different sizes. The grab sampler comprises two steel clamshells acting on a single or double pivot. The shells are brought together either by a powerful spring (Shipek type) or powered hydraulic rams operated from the survey vessel.

4.3 In operation, the grab is lowered from the survey vessel to the seabed with the clamshells in the open position and which trigger shut when the sampler is in contact with the seafloor. The shells swivel together in a cutting action and retains a sample of seabed. The sampler is then recovered to the survey vessel for visual inspection, processing, logging and transfer to suitable sample containers for storage and later laboratory analysis. Typical performance rates are between three and four samples per hour.

4.44 The smaller Shipek type grab sampler is useful for ground truthing geophysical surveys for the surface layer, and samples are taken to about 0.1 m below the seabed. Larger hydraulic grabs are capable of recovering relatively intact samples of consolidated soils to a depth of about 0.5 m. In areas of large cobbles or boulders, grabs can become jammed open and their contents washed away during recovery to the surface. However, the hydraulic grab is more likely to recover cobbles and small boulders than any other system, and in this respect is invaluable. Various grabs will be available for the survey to ensure adequate sampling equipment for various sediment types.

Figure 28. Single and Double Van Veen Grab.

5.0 SURVEY VESSELS

5.1 Offshore survey vessels are typically between 15m and 75m in length with potential for smaller vessels to be used in nearshore / shallow water areas. Offshore survey vessel typically have an endurance of approximately 14 to 28 days. A vessel with a shallow water draft will be utilised for the inshore survey area. An unmanned surface vehicle (USV) and/or autonomous surface vehicle (ASV) may also be used for the geophysical survey. The survey vessels may use a local port for personnel / equipment mobilisation, bunkering and provisioning.

5.2 The marine survey works will consist of a dedicated marine spread which will be suitable for the scope of work required, the water depth and the anticipated seabed conditions of the survey area. The exact equipment to be used will be confirmed following a tender process to procure the marine survey contractor.

5.3 All survey vessels will be fit for purpose, will possess all relevant classification certificates and capable of safely undertaking the survey work required. Health, safety, environment and welfare considerations will be a priority and will be actively managed during the course of the survey scopes of work. Appointed contractors will be required to comply with all legislation relevant to the activities within their scope of work. Prior to survey works taking place under a Maritime Usage Licence, both Project Supervisor for Design Process (PSDP) and Project Supervisor for Construction Stage (PSCS) will be appointed under the relevant legislation and project / survey specific HSE plans will be put in place which will form part of the survey project execution plans.

5.4 The vessels will conform to the following minimum requirements as appropriate:

- Compliance with Safety of Life at Sea (SOLAS), International Maritime Organization (IMO) and national requirements for operating within Irish territorial waters.
- Station-keeping and sea keeping capabilities required to carry out the proposed survey operations safely;
- Calibrated equipment and spares with necessary tools for all specified works;
- Endurance (e.g. fuel, water, stores, etc.) to undertake the required survey works;
- Sufficient qualified staff to allow the survey operations to be carried out efficiently, (typically 24 hour continuous for offshore survey, 12 hour for nearshore survey); and
- Appropriate accommodation and crew welfare facilities.

5.5 Survey vessels will generate some subsea noise in the marine environment from engine noise and dynamic positioning thrusters. Shipping noise is typically within the 50-300 Hz frequency band and is the dominant noise source in deeper water (DECC, 2011). Propellers on vessels all have the potential to produce cavitation noise. This sound is caused by vacuum bubbles that were generated by the collapse of bubbles created by the spinning of the propellers.

5.6 Acoustic broadband source pressure levels typically increase with increasing vessel size, with smaller vessels (<50 m) having source pressure levels 160-175 dB (re 1µPa at 1m), medium size vessel (50-100 m) 165-180 dB (re 1µPa at 1m) and large vessels (>100 m) 180-190 dB (re 1µPa at 1m) (DECC, 2011). Every vessel has a unique noise signature and for each vessel this can change in response to a number of factors, including; ship speed, operational status, vessel load, the condition of the vessel and even the properties of the water that the vessel is operating in.

6.0 MARINE SURVEY AND SITE INVESTIGATIONS SOUND PRESSURE LEVEL SUMMARY

6.1 All survey works that involve the use of acoustic instrumentation will follow the Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters, 2014.

6.2 The ranges of noise frequency and sound pressure levels associated with all the surveys outlined in previous sections is summarised in Tables 5. and 6 below. It can be noted that as the focus of the cable route surveys within the Maritime Usage Licence application area is the seabed surface and upper layers of seabed sediments and generally obtaining higher resolution data, the geophysical equipment such as MBES and SSS is generally operated more towards the higher end of the frequency range where possible.

Equipment Type	Purpose	Frequency Range	Duration	*Maximum* Source Pressure Level (re 1µPa at 1 m)	Reference
Multibeam Echo Sounder (MBES)	Measure detailed bathymetry by transmitting sound pulses (active sonar).	200 kHz to 500 kHz	0.05 - 10 ms	210 - 245 dB.	Danson 2005, Hopkins 2007, DECC 2011, Lurton and DeReutier 2011, Lurton 2016, BEIS 2020, Crocker & Fratantonio 2016
Deepwater Multibeam Echo Sounder (MBES)	Measure detailed bathymetry by transmitting sound pulses (active sonar).	12 kHz	2 – 15 ms	210 Db.	Kongsberg
Side Scan Sonar (SSS)	Determine surficial nature of the seabed and detect objects by transmitting sound pulse.	200 kHz to 700 kHz	0.4 - 1.0 ms	200 - 240 dB.	BOEM 2016, BEIS 2020, DAHG 2014, Crocker & Fratantonio 2016
Sub-bottom Profiler (SBP) - Pinger	Identify different geological layers encountered in the shallow sediments and sediment thicknesses beneath the seabed.	2 kHz to 15 kHz	0.5 - 30 ms	214 dB.	Hartley Anderson 2020
Sub-bottom Profiler (SBP) - Chirper	Identify different geological layers encountered in the shallow sediments and sediment thicknesses beneath the seabed.	2 kHz to 13 kHz	5 - 40 ms	185 - 215 dB.	Crocker & Fratantonio 2016, Hartley Anderson 2020
Sub-bottom Profiler (SBP) - Boomer	Identify different geological layers encountered in the shallow sediments and sediment thicknesses beneath the seabed.	500 Hz to 15 kHz	0.5 - 1.0 ms	205 - 215 dB.	Crocker & Fratantonio 2016
Sub-bottom Profiler (SBP) - Parametric	Identify different geological layers encountered in the shallow sediments and sediment thicknesses beneath the seabed.	4 to 15 kHz, 85 to 115 kHz	0.2 - 30 ms	238 - 247 dB. 200 - 206 dB.	Hartley Anderson 2020
Ultra-Short Base Line (USBL)	Subsea positioning.	20 kHz to 50 kHz	5 - 10 ms	194 - 207 dB.	Kongsberg
Magnetometer	Identify ferrous anomalies for metal obstructions, shipwrecks, etc. on and under the seabed.	Passive	N/A	Passive	N/A
Survey Vessels	Carry out the survey and deploy the equipment.	50 Hz to 300 Hz	N/A	160 - 190 dB.	DECC 2011

Table 5. Marine Survey Activities.

Equipment Type	Purpose	Number of locations within Licence Application Area (up to)	Frequency Range	*Maximum* Source Pressure Level (re 1µPa at 1 m)	Reference
Cone Penetration Test (CPT)	Determine geotechnical engineering properties of seabed sediments.	96	28 Hz	118 - 145 dB.	BOEM 2012, EIRGRID 2014
Gravity Corer	Retrieve a seabed sediment sample by penetrating seabed with a steel core barrel under self-weight	48	N/A	N/A	N/A
Vibrocorer	Retrieve a seabed sediment sample by penetrating seabed with a vibrating steel core barrel	48	30 Hz	187.4 dB.	LGL 2010
Grab Samples	Collect small sediment samples from seabed surface with clamshell mechanism	26	N/A	N/A	N/A

Table 6. Marine Site Investigation Activities.

7.0 TIMELINE AND DURATION OF SURVEY ACTIVITIES

7.1 The intention is to commence the survey as soon as feasible following license award, taking into account survey vessel availability, the overall transatlantic cable route survey programme, seasonality and suitable weather windows. The exact mobilisation dates will not be known until the process of procuring a contractor and issue of the Maritime Usage Licence is complete. It is anticipated that the marine geophysical survey and site investigations activities within the Maritime Usage Licence area will take less than 4 months in total and ideally will be completed in one operation. However, depending on operational factors this may be split up over 8 months.

7.2 The estimated time required to complete the cable route survey campaign activities is described in Table 7 below.

Activity	Typical Time Period Required for Activity	Total Number of Site Investigation Locations	Total Time for Survey Activity	Seabed Area per Location	Seabed Area per Activity (ha)	Total Area (ha)	Area Directly Affected as % of Maritime Usage Licence Application Area
Inshore Geophysical Survey	3 to 4 days (weather and sea state dependent)	500m cable route corridor	3 to 4 days (weather and sea state dependent)	N/A	1.9 km^2	1.9 km^2	0.0113%
Offshore Geophysical Survey	20 to 23 days (weather and sea state dependent)	500m cable route corridor	20 to 23 days (weather and sea state dependent)	N/A	294 km^2	294 km^2	1.7417%
Deepwater MBES Survey	7 to 9 days (weather and sea state dependent)	3 x Water Depth (10km maximum)	7 to 9 days (weather and sea state dependent)	N/A	3915 km^2	3915 km^2	23.1931%
CPT	30 minutes - 3 hours in any one location	96	192 hours within total 16 days of Site Investigations campaign (weather and sea state dependent, excluding transit between locations)	8m^2	0.0008 ha	0.076 ha	0.0002%
Gravity Corer	30 minutes - 3 hours in any one location	48	98 hours within total 16 days of Site Investigations campaign (weather and sea state dependent, excluding transit between locations)	1m^2	0.0001 ha	0.0048 ha	0.0000%
Vibro Corer	30 minutes - 3 hours in any one location	48	98 hours within total 16 days of Site Investigations campaign (weather and sea state dependent, excluding transit between locations)	8m^2	0.0008 ha	0.0384 ha	0.0001%
Grab Samples	20 minutes – 2 hours in any one location	26	36 hours within total 16 days of Site Investigations campaign (weather and sea state dependent, excluding transit between locations)	0.5m^2	0.00005 ha	0.0013 ha	0.0000%

Table 7. Estimated Time and Duration of Survey Activities.

8.0 REFERENCES

BEIS. (2020). Review of Consented Offshore Wind Farms in the Southern North Sea Harbour Porpoise SAC.

Bureau of Ocean Energy Management (BOEM) Office of Renewable Energy Programs (2012). Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts, Environmental Assessment. Published by U.S. Department of the Interior. October 2012.

Bureau of Ocean Energy Management (BOEM) (2016). Characteristics of sounds emitted during high resolution marine geophysical surveys U.S. OCS Study BOEM 2016-044 NUWC-NPT Technical Report 12.

Crocker SE, Fratantonio FD. 2016. Characteristics of High-Frequency Sounds Emitted During High-Resolution Geophysical Surveys. OCS Study, BOEM 2016-44, NUWC-NPT Technical Report 12, 203pp.

D'Amico AD, Pittenger R. 2009. A brief history of active sonar. Aquatic Mammals 35(4), 426-434.

Danson, E. (2005). Geotechnical and geophysical investigations for offshore and nearshore developments. Technical Committee 1, International Society for Soil Mechanics and Geotechnical Engineering, September 2005.

DECC (2011), Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive. Document No: J71656-Final Report –G2

Department of Arts, Heritage and Gaeltacht (2014), Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters.

EIRGRID PLC. (2014). Celtic Interconnector Project: Marine Mammal Risk Assessment. Produced by Intertek Energy and Water consultancy services. Report Reference: Attachment F_P1812_R3691_REV1.

Hartley Anderson (2020), underwater acoustic surveys: review of source characteristics, impacts on marine species, current regulatory framework and recommendations for potential management options. NRW Evidence Report No: 448, 136pp, NRW, Bangor, UK.

Hildebrand JA, 2009. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series 395, 5-20.

Hildebrand JA. 2005. Impacts of anthropogenic sound. In: Reynolds JE, Perrin WF, Reeves RR, Montgomery S, Ragen TJ (eds) Marine mammal research: conservation beyond crisis. Baltimore: The Johns Hopkins University Press p101-124.

Hopkins, A. (2007). Recommended operating guidelines (ROG) for swath bathymetry. MESH.

Kongsberg, (2009). https://www.kongsberg.com/globalassets/maritime/km-products/product-documents/309059_em122_maintenance_manual.pdf

Lam F-P, Kvadsheim PH, Isojunno S, van IJsselmuide S, Wensveen PJ, Hansen RR, Sivle LD, Kleivane L, Martín López LM, Benti B, Dekeling R, Miller PJO. 2018. Behavioral response study on the effects of continuous sonar and the effects of source proximity on sperm whales in Norwegian waters - The 3S-2017 Cruise Report. TNO Report TNO 2018 R10958, 54pp plus appendices.

LGL Alaska Research Associates and Jasco Applied Sciences (2010), Marine Mammal Monitoring and Mitigation during Marine Geophysical Surveys by Shell Offshore Inc. in the Alaskan Chukchi and Beaufort Seas, July – October 2010:90-Day Report

Lurton X, DeRuiter SL. 2011. Sound radiation of seafloor-mapping echo sounders in the water column, in relation to the risks posed to marine mammals. International Hydrographic Review, Nov 2011, 11pp.

Lurton X. 2016. Modelling of the sound field radiated by Multibeam echo sounders for acoustical impact assessment. Applied Acoustics 101, 201-221.

Pei Y, Kan G, Zhang L, Huang Y, Liu Z, Liu B, Yan K. 2019. Characteristics of source wavelets generated by two sparkers. Journal of Applied Geophysics 170, 103819.

Risch D, Wilson B, Lepper P. 2017. Acoustic assessment of SIMRAD EK60 high frequency echo sounder signals (120 & 200 kHz) in the context of marine mammal monitoring. Scottish Marine and Freshwater Science Vol. 8, No. 13, published by Marine Scotland Science, 27pp.