Natura Impact Statement
for the Short-term Deployment
of a Tidal Energy Test Device in the Fergus Estuary

Produced by

AQUAFACT International Services Ltd

On behalf of

DesignPro Ltd.

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1. Introduction

1.1. Requirement for an Article 6 Assessment

The Birds Directive (2009/147/EC) and the Habitats Directive (92/42/EEC) put an obligation on EU Member States to establish the Natura 2000 network of sites of highest biodiversity importance for rare and threatened habitats and species across the EU. In Ireland, the Natura 2000 network of European sites comprises Special Areas of Conservation (SACs, including candidate SACs) and Special Protection Areas (SPAs, including proposed SPAs). SACs are selected for the conservation of Annex I habitats (including priority types which are in danger of disappearance) and Annex II species (other than birds). SPAs are selected for the conservation of Annex I birds and other regularly occurring migratory birds and their habitats. The annexed habitats and species for which each site is selected correspond to the qualifying interests of the sites and from these the conservation objectives of the site are derived.

The Birds and Habitats Directives set out various procedures and obligations in relation to nature conservation management in Member States in general, and of the Natura 2000 sites and their habitats and species in particular. A key protection mechanism is the requirement to consider the possible nature conservation implications of any plan or project on the Natura 2000 site network before any decision is made to allow that plan or project to proceed. Not only is every new plan or project captured by this requirement but each plan or project, when being considered for approval at any stage, must take into consideration the possible effects it may have in combination with other plans and projects when going through the process known as Appropriate Assessment (AA).

The obligation to undertake Appropriate Assessment (AA) derives from Article 6(3) and 6(4) of the Habitats Directive, and both involve a number of steps and tests that need to be applied in sequential order. Article 6(3) is concerned with the strict protection of sites, while Article 6(4) is the procedure for allowing derogation from this strict protection in certain restricted circumstances. Each step in the assessment process precedes and provides a basis for other steps. The results at each step must be documented and recorded carefully so there is full traceability and transparency of the decisions made.

The location of the proposal is within the Lower River Shannon cSAC (Site Code: IE001265) and the River Shannon and River Fergus Estuaries SPA (Site Code: IE004077) and the proposal is not directly connected with or necessary to the management of the Natura 2000 sites. For these reasons, it is regarded as necessary that the proposal should be subject to the AA process. This assessment can be found in Section 3

of this report.

1.2. The Aim of this Report

The purpose of this report is to inform the AA process as required under the Habitats Directive (92/43/EEC) in instances where a plan or project may give rise to significant impacts on a Natura 2000 site. This NIS aims to inform the Appropriate Assessment process in determining whether the proposal, both alone and in combination with other plans or projects, is likely to have a significant impact on the Natura 2000 sites in the study area in the context of their conservation objectives and specifically on the habitats and species for which the sites have been designated. The NIS provides a description of the proposed project, a description of the receiving environment, it identifies the Natura 2000 sites within and close to the test site and it considers the potential for adverse effects on the conservation objectives and qualifying interests within the affected Natura 2000 site(s).

This report has been prepared in accordance with the current guidance:

- Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities (DEHLG 2009, Revised February 2010);
- Marine Natura Impact Statements in Irish Special Areas of Conservation – A Working Document. April 2012 (DAHG, 2012)
- EU Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC (EC, 2007);
- Assessment of plans and projects significantly affecting Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC (EC, 2002); and
- Managing Natura 2000 Sites: The provisions of Article 6 of the ‘Habitats’ Directive 92/43/EEC (EC, 2000).

The report is laid out as follows:

Section 2 outlines the Appropriate Assessment procedure. Section 3 provides a description of the project, which includes details on the project, the receiving environment and the potential impacts. Section 4 covers the Stage 1 Appropriate Assessment Screening phase and Section 5 covers the Stage 2 Natura Impacts Statement section. Section 6 includes mitigation and monitoring and Section 7 contains a summary.

1.3. Consultation

During the preparation of this document, consultation was carried out with the National Parks and Wildlife Service (NPWS) of the Department of Arts, Heritage and the Gaeltacht (DAHG) to identify the scoping opinion of the NPWS in relation to the proposal and to the ecological constraints and sensitivities of the habitats and species in the area. Appendix 1 shows the consultation letter and responses.

2. Appropriate Assessment Process

2.1. Legislative Context

The requirements for AA derive directly from Article 6(3) of the EU Habitats Directive (Directive 92/43/EEC) (DEHLG, 2009). AA is an impact assessment process that fits within the decision-making framework and tests of Articles 6(3) and 6(4). The AA process encompasses all of the processes covered by Article 6(3) of the Habitats Directive *i.e.* the screening process, the NIS, the AA by the competent authority and the record of decisions made by the competent authority at each stage of the process, up to the point at which Article 6(4) may come into play following a determination that a plan or project may adversely affect the integrity of a Natura 2000 site.

Article 6(3) states:

> *'Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.'*

Article 6 (4) states that:

> *'If, in spite of a negative assessment of the implications for the [Natura 2000] site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, Member States shall take all compensatory measures necessary to ensure that the overall coherence of Natura*

2000 is protected. It shall inform the Commission of the compensatory measures adopted'.

'Where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest'.

In addition, the European Court of Justice (Waddenzee Ruling – Case C-127/02) has made a ruling in relation to AA:

'*Any plan or project not directly connected with or necessary to the management of the site is to be subject to an appropriate assessment of its implications for the site in view of the sites conservation objectives if it cannot be excluded, on the basis of objective information, that it will have a significant effect on that site, either individually or in combination with other plans of projects and that the plan or project may only be authorised where no reasonable scientific doubt remains as to the absence of such effects'*

It is the responsibility of the competent authorities, in this instance the Department of the Housing, Planning and Local Government, to make a decision as to whether or not the proposed temporary installation of a test tidal device (both alone and in combination with other plans and projects) should be permitted, taking into consideration any potential impact upon the Natura 2000 sites in question.

2.2. Stages of AA

The Commission's methodological guidance (EC, 2002) promotes a four-stage process to complete the AA, and outlines the issues and tests at each stage. An important aspect of the process is that the outcome at each successive stage determines whether a further stage in the process is required.

The four stages are summarised diagrammatically in Figure 3.1 below.

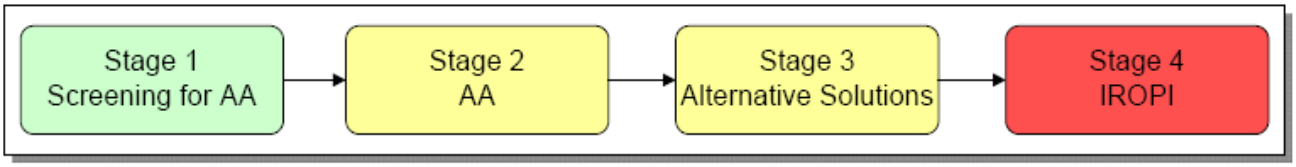

Figure 2.1: Stages in the AA process (Source: DEHLG, 2009).

2.2.1. Stage 1. Screening for Appropriate Assessment

Screening is the process that addresses and records the reasoning and conclusions in relation to the first two tests of Article 6(3):

i. whether a plan or project is directly connected to or necessary for the management of the site, and

ii. whether a plan or project, alone or in combination with other plans and projects, is likely to have significant effects on a Natura 2000 site in view of its conservation objectives.

If the effects are deemed to be significant, potentially significant, or uncertain, or if the screening process becomes overly complicated, then the process must proceed to Stage 2 Appropriate Assessment (preparation of an NIS). Screening should be undertaken without the inclusion of mitigation, unless potential impacts clearly can be avoided through the modification or redesign of the plan or project, in which case the screening process is repeated on the altered plan. The greatest level of evidence and justification is needed in circumstances where the process ends at the screening stage on grounds of no impact.

According to DAHG (2012) Marine NIS Guidelines, AA Screening should include:

1. Description of the plan or project, and local site or plan area characteristics;
2. Identification of relevant SAC, compilation of information on their qualifying interests and conservation objectives;
3. Assessment of the likely effects – direct, indirect, cumulative – undertaken on the basis of available information (desk study, field survey and/or primary research), which will result in a screening assessment and screening statement.

2.2.2. Stage 2. Appropriate Assessment (NIS)

This stage considers whether the plan or project, alone or in combination with other projects or plans, will have an adverse effect on the integrity of a Natura 2000 site, and includes any mitigation measures necessary to avoid, reduce or offset negative effects. The proponent of the plan or project will be required to submit a **Natura Impact Statement (NIS)**, *i.e.* the report of a targeted professional scientific examination of the plan or project and the relevant Natura 2000 sites, to identify and characterise any possible implications for the site in view of the site's conservation objectives, taking account of in combination effects. This should provide information to enable the competent authority to carry out the appropriate assessment. If the assessment is negative, *i.e.* adverse effects on the integrity of a site cannot be excluded, then the process must proceed to Stage 4, or the plan or project should be abandoned. The AA is carried out by the competent authority, and is supported by the NIS.

2.2.3. Stage 3. Alternative Solutions

This stage examines any alternative solutions or options that could enable the plan or project to proceed without adverse effects on the integrity of a Natura 2000 site. The process must return to Stage 2 as alternatives will require appropriate assessment in order to proceed. Demonstrating that all reasonable alternatives have been considered and assessed, and that the least damaging option has been selected, is necessary to progress to Stage 4.

2.2.4. Stage 4. Imperative Reasons of Overriding Public Interest (IROPI)/Derogation

Stage 4 is the main derogation process of Article 6(4) which examines whether there are imperative reasons of overriding public interest (IROPI) for allowing a plan or project that will have adverse effects on the integrity of a Natura 2000 site to proceed in cases where it has been established that no less damaging alternative solution exists. The extra protection measures for Annex I priority habitats come into effect when making the IROPI case[1]. Compensatory measures must be proposed and assessed. The Commission must be informed of the compensatory measures. Compensatory measures must be practical, implementable, likely to succeed, proportionate and enforceable, and they must be approved by the Minister.

[1] IROPI reasons that may be raised for sites hosting priority habitats are those relating to human health, public safety or beneficial consequences of primary importance to the environment. In the case of other IROPI, the opinion of the Commission is necessary and should be included in the AA

3. Description of the Project

3.1. Description of the Proposed Activity

3.1.1. Background

G-Kinetic (www.G-Kinetic.com) was founded in 2014 by Vincent McCormack and is based in Newcastle West, County Limerick. GKinetic Ltd. is an Irish developer of a submerged tidal energy device composed of twin, vertical-axis turbines mounted either side of a teardrop shaped bluff body that will be moored to the seabed. The full scale device is intended to be of the order of 500kW and the system could potentially address a number of weaknesses traditionally associated with vertical-axis turbines.

The concept has undergone staged development, in-time with industry best practice. Previous testing has been undertaken at NUI Galway, the IFREMER flow tank facility in France, Limerick Docks and numerical modelling for design optimisation. Funding has previously been secured through the EU FP7 MaRINET programme which included scientific evaluation and is an additional sign of technical quality. GKinetic has been working with DesignPro since 2014 on the manufacture of the turbine and control system. DesignPro have recently secured €2m funding through the competitive H2020 SME instrument and are using the GKinetic IP to develop and qualify market ready DPR (DesignPro Renewables) turbine systems.

To date Limerick Docks have been used as a test site. The shipping area of the dock is operated by Shannon Foynes Port Company, while the test site itself is operated by GKinetic and is located on the banks of the River Shannon in Limerick City. The testing is carried out in a secure, enclosed wet dock facility with controlled water levels maintained at a minimum of 5m. GKinetic are partly funded by the Sustainable Energy Authority of Ireland to carry out testing in the Limerick Docks facility.

The timeline of research and development to date includes the following:

- October 2014 - GKinetic contracted DesignPro to build a 1:20 scale device for flume testing in France;
- November 2014 - Test device deployed at IFREMER in Boulogne-Sur-Mer, France with support from SEAI; test device operates above industry standard
- September 2015 –GKinetic setup custom test facility collaborating with Shannon Foynes Port Company (SFPC);
- October 2015 –Successful demonstration of a 8kW device at Limerick Docks with support from SEA and working with SFPC, MaREI (Marine Renewable Energy Ireland), NUI Galway and Windworks;
- December 2015 –Machine build partners DesignPro successful in Horizon 2020 Phase 1 funding

aiming to commercialise small scale river devices;

- November 2016 - Machine build partners, DesignPro Ltd secure Horizon 2020 Seal of Excellence for application to commercialise GKinetics technology concept;
- March 2017 - DesignPro Ltd. Successful in Horizon 2020 Phase 2 Funding to commercialise small scale river devices using GKinetics technology for a €2.7 million project;
- July 2017 – GKinetic secure €99,562 in funding from the SEAI's Prototype Development Fund to carry out further optimisation and testing in the Limerick Docks.
- August 2017 – Further demonstration of the 8kW device at Limerick Docks (through to October 2017).
- April 2018 – Deployment of a 25kW device at the SEENEOH test site in Bordeaux, France to provide further information on environmental impacts and to establish protocols for deployment systems and monitoring.

The key next step in this process is to make available a tidal site for DesignPro to commercialise the small scale river devices using GKinetic's technology financed by the H2020 Phase 2 funding. In order to achieve this, DesignPro Ltd are proposing to deploy a 60kW test device (DPR 60) in the Shannon Estuary for a period of no more than 12 months from September 2018. There may be periods of time within this 12 month window where the device will be removed from the water, however 12 months will cover all stages of the testing as required by the Horizon 2020 funding. A Foreshore Licence is required from the Department of Housing, Planning and Local Government (DHPLG) for a test site in order to allow the deployment of the test device. This project has hard deadlines tied into the funding and the turbine therefore needs to be tested from September 2018. If a site is not secured in the Shannon Estuary then testing will be undertaken in CHTTC in Canada. http://www.chttc.ca/ (Canadian Hydrokinetic Turbine Test Centre).

3.1.2. Installation and Operation

The DPR 60 tidal device consists of a floating platform with submerged twin, vertical-axis turbines that will be moored to the seabed by a multiple point anchoring system. Figure 3.1 shows a schematic of the tidal device proposed for deployment in the channel west of Canon Island and east of Inishtubbrid at the entrance to the Fergus Estuary. The device is a floating tidal turbine of approximate dimensions 11.5m in length, x 9.5m wide and 8.5m in height (*c.* 4.5m submerged and 4m above the surface), with a dry weight of *c.* 20T. Figure 3.2 shows the dimensions of the device and Table 3.1 shows the device specifications.

The device will be made primarily from steel and aluminium and is designed to minimise the risk of leakage of pollutants. The section above the water line will consist of a deck/work platform and all of the electrical components, gearboxes and motors will be sealed and housed in a steel hull. All paint used will be approved anti-fouling paint. Below the water line, two rotors are positioned either side of a bluff body. The turbines are the only moving parts of the device. The turbine blades are 2.4m in length and the rotor diameter is 2.2m. The distance between the blades is 334mm. The swept area of the device that captures power is 22.8m^2. The RPM will be in the region of 20 RPM and blade tip speed will be 0.5 (i.e. half the speed of the water flowing around it). The blades will be moving slower than the surrounding water. The device will occupy a surface area of 108.68m^2 on the sea surface, the total under water swept area is 33.5m^2, the total area of the turbines is 10.6m^2 and the device will occupy a volume of 486.89m^3 of the water column.

Table 3.1: Device specifications

Power	Device Width	Device Length	Blade Length	Swept Area	Rotor Diameter	Mass	Draft
60 kW	9.5m	11.44m	2.4m	22.8m^2	2.2m	20 T	4.48m

The GKinetic concept involves two vertical axis turbines placed on either side of the buoyant vessel. The shape of the vessel increases the speed of water into the turbines, which causes the turbines to rotate (Figure 3.3 shows a schematic of the operating turbine). The combination of the accelerated flow along with a patented Blade Pitch Control System results in higher power outputs. The technology exploits the natural phenomena that occurs when fluid accelerates around and outside an obstacle. This allows for significant energy to be generated in low flows.

The device will be moored with the rotor and bluff body section facing into the current and the deployment platform will be free to rotate in the reversing tide direction. The bluff body will divert flow into the rotors and thereby increase the inflow current speed to the rotors. The blades, which will be self-aligning to the

flow, will rotate a central drive shaft connected to the AC generators (which will be contained within the housings on the surface). The electricity produced within the generators will be conditioned using the on-board switch gear, and this power will be dissipated using an on-board load bank. **The device will not require a connection/cabling along the foreshore to land.**

The functionality of an electrical cable connection will be tested in a simulation mode. **There will be no electrical connection from the cable to the shore**. There will be no electrical connection from the cable to the platform. The electrical cable will be tested in a simulation mode. This simulation mode will require that the cable (which is not live) is terminated and attached at a fixed position seabed anchor while the tidal turbine is allowed to move around its mooring as necessary.

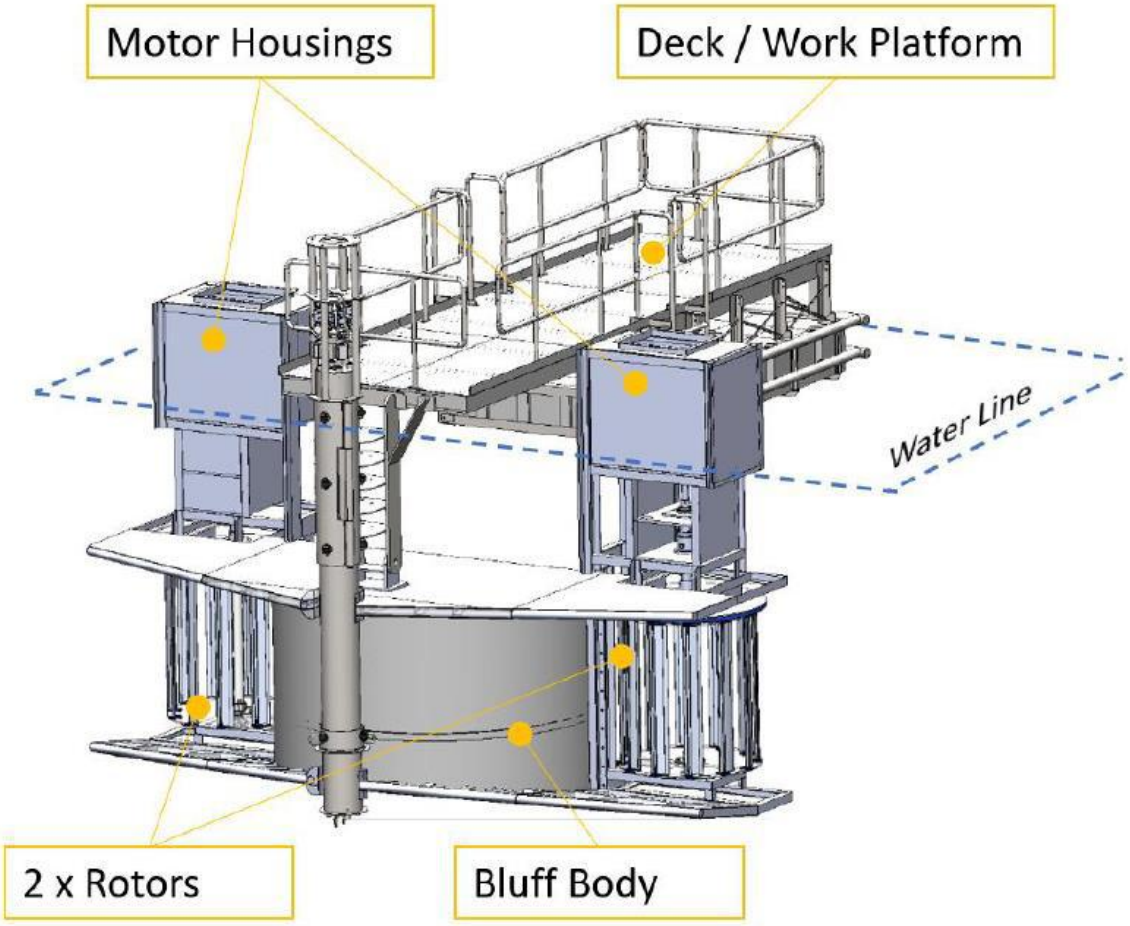

Figure 3.1: Tidal turbine in operating configuration

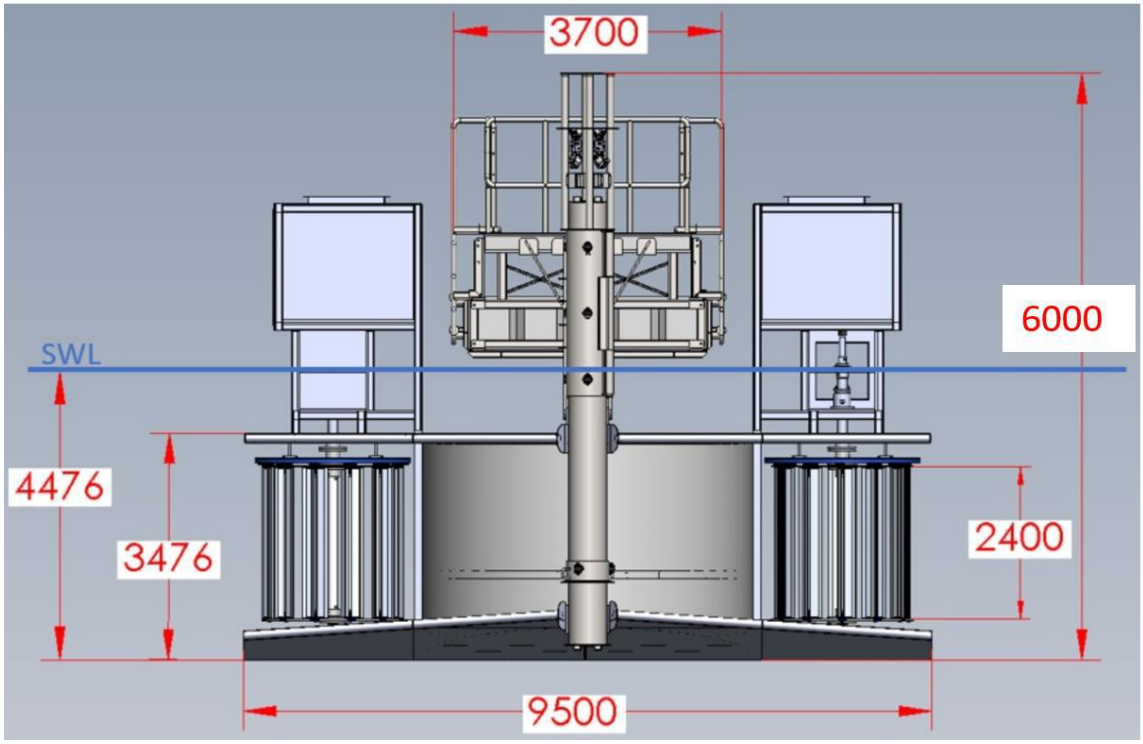

Figure 3.2: Schematic of device (Dare Technology)

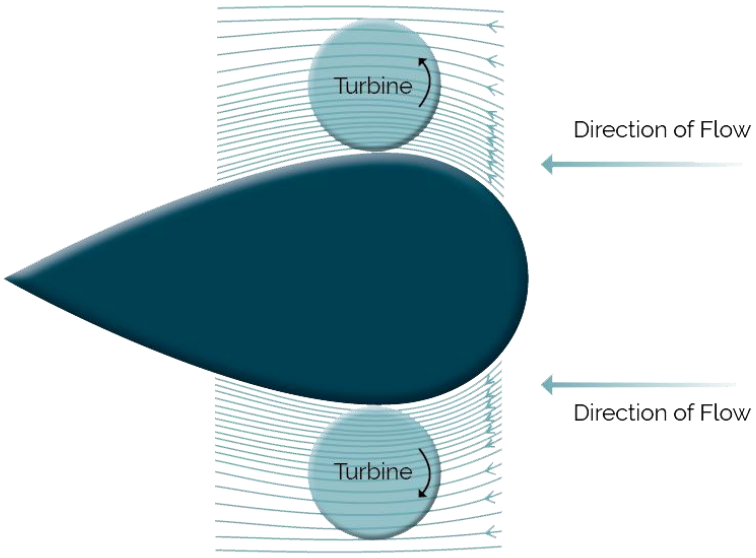

Figure 3.3: Schematic of the operating device

Figure 3.4 shows the proposed location of the test device (ITM: 528299.97E; 657957.86N. ING: 128333.93E; 157914.2N). The device will be installed within 75m of this coordinate. The Foreshore Licence area extends 300m north and south of the device to allow for the deployment of the mooring system. Table 3.2 shows the coordinates of the area and it is for this area that DesignPro Ltd. are seeking a Foreshore Licence. The site will be suitably charted and marked with appropriate lights and shapes as specified by the Commissioner of

Irish Lights (CIL). The foreshore licence area covers an area of 11.47ha (114,700m^2) and is 140m wide at its narrowest point and 600m in length. This allows for a 50m wide passage for small craft to pass between Inishtubbrid and the Foreshore Licence Area

The device will be deployed in waters *c.* 20m deep. The device will be held in place by the use of a 2- point anchoring system. The lines comprising of heavy duty marine grade chain, and wire rope will extend approx. 280m to the northeast of the device location, and approximately 275m to the southeast. At the end of the lines an anchor which has the holding capacity of >180kN will be installed. The details of this anchor will be determined following further site investigation, but it is thought they will be anchor blocks made of concrete (max. size 5m x 5m). All elements of this system will remain submerged at all times and will not interfere with vessels at the surface. The anchor system will be designed to ensure the device remains within 10m of its nominally installed position, particularly at the times of both high and low slack water. An exclusion zone of 75m radius will be set in order to ensure adequate room remains for passing traffic and other marine users in the 200m channel.

The DPR 60 will contain navigational aids for both the installation and operational phase of the project to provide hazard identification, channel and waypoint marking to other seafarers. The navigational markers used will be to the specifications of the CIL recommendations and to the satisfaction of Shannon Foynes Port Company Harbour Master. Once in operation, the device itself will be fitted with a yellow light on the masthead with a minimum of 2 nautical mile visibility. The area upstream and downstream of the test site will be marked with special markings which create the boundary of the proposed exclusion zone around the device.

The installation will be temporary in its nature and will likely be removed and reinstalled approximately 3 times over the 12-month operational phase of the project (particularly during times of poor weather).

The mooring system will be installed in September 2018 in advance of the device installation using a locally sourced vessel (most likely a tug or small multicat) with winch and lifting capabilities. The vessel will launch from Foynes port, *c.* 6.6km to the southwest. It is anticipated that the mooring will be installed over 2 to 3 tidal cycles. The abandoned pennant will be left on the seabed with a pick-up line buoyed to the surface ready for recovery on the day of the device installation. The pick-up line will be clearly marked with a large Norwegian buoy to ensure visible to passing marine traffic.

The device itself will also be installed in September 2018 using a locally sourced vessel (most likely a tug or small multicat) with winch and lifting capabilities. Due to the proximity and good road access from the manufacturing site at Rathkeale, the device will be lifted into the water in Foynes port, connected to the forward vessel via a short towing bridle and towed to the test site (2.5hrs). The device will be towed to the

deployment location on the ebb tide, the mooring system will be pulled up on the winch and connected to the device. A small support vessel will also be required for the installation. The turbine will be installed on 1 tidal cycle. Following installation, it is anticipated that the device will become operational within 7 days. Figure 3.5 shows an illustration of the installed device and mooring.

When full recovery of the device is required (anticipated to be up to 3 times over the 12-month period), a locally sourced vessel (most likely a tug or small multicat) will be used. The device will be disconnected from its mooring and towed back to Foynes and removed. This will be carried out over one tidal cycle. In the case of extreme weather, the device will be detached from its testing mooring and moored to the northeast of the site in an area of sheltered water just off Canon Island (see Figure 3.4).

In both cases, each mooring line will be buoyed off to a suitably lit and marked buoy as specified by CIL.

The deployment and recovery operations will be carried out over short timeframes and can be done with minimum to no impact on nearby harbour operations, or other vessels operating in the area. Shannon Foynes Port Company (SFPC) conducted a navigational assessment of the proposed site and determined that the proposed site will not interfere with commercial traffic. In addition, SFPC have indicated that the proposed site is a quite area for small craft activity and if the proposed site is suitably charted and marked with appropriate lights and shapes as specified by CIL, then the impact on leisure and other users will be minimised, with a low risk existing.

The technology developer's operations team will require frequent access to the device in order to inspect and maintain the on-board systems, along with providing training for same to clients. Access will be undertaken using a small crew transfer vessel from both Foynes port and Cahiracon pier.

Cahircon Pier is located less than 3.8km southwest of the device location. This pier will be the primary site for standby in the event of emergency. A shore side office/monitoring station will be installed in a brown field close to Cahiracon Pier (see Figure 3.6). The monitoring station will take the form of a container unit approximately 6mx3m and it would be slightly raised off the ground. This station will not require any services (e.g. electricity/waste facilities etc).

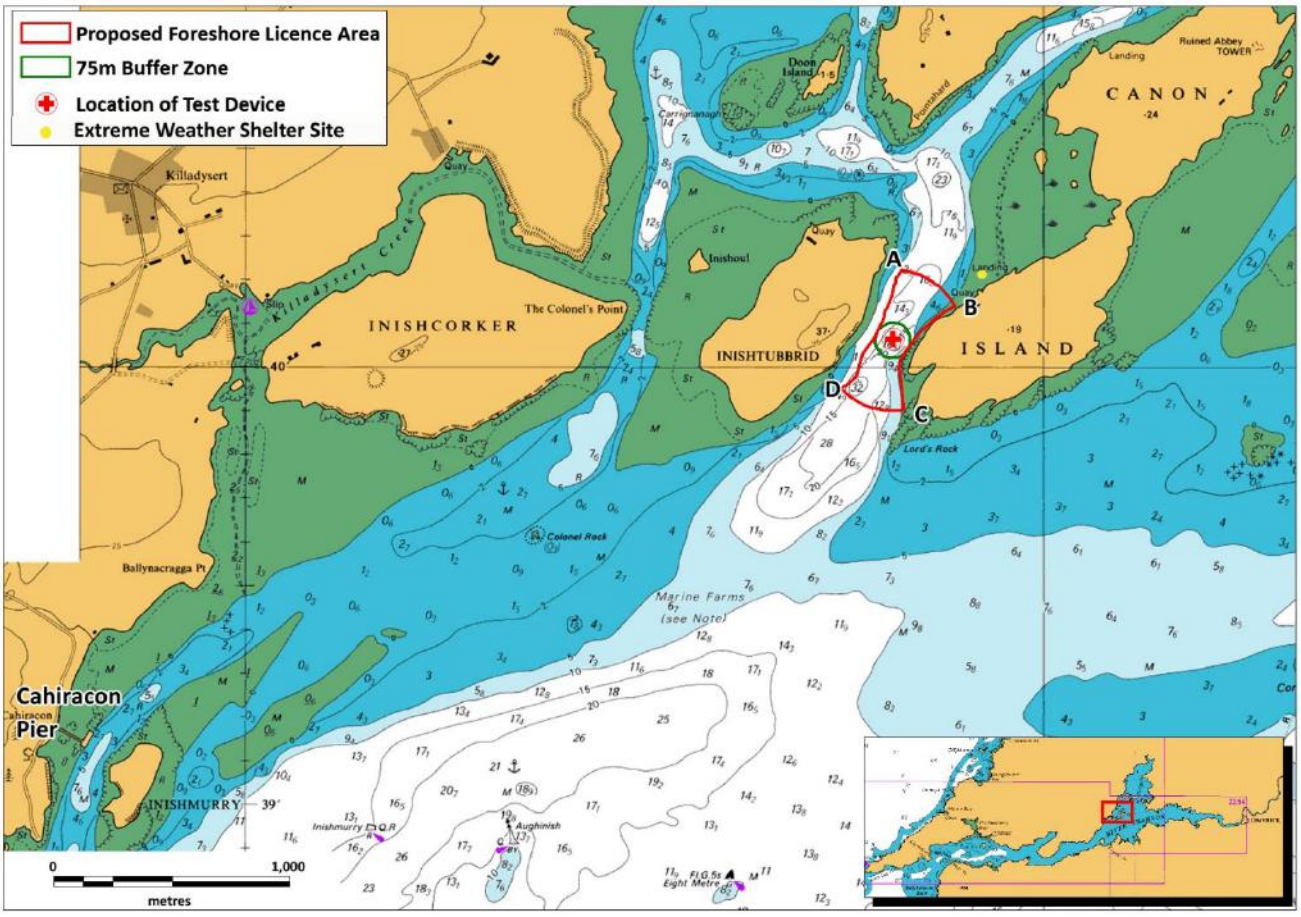

Figure 3.4: Location of test site and Foreshore Licence Area in the Shannon Estuary

Table 3.2: Coordinates of the proposed test site

Corner	Easting ITM	Northing ITM	Easting ING	Northing ING	Longitude (DMS)	Latitude (DMS)
A	528343.36	658254.56	128377.3	158211	-9° 3’ 34.13’’	52° 40’ 14.59’’
B	528563.83	658098.77	128599.56	158055.15	-9° 3’ 22.19’’	52° 40’ 9.65’’
C	528340.12	657660.58	128374.1	157616.86	-9° 3’ 33.84’’	52° 39’ 55.37’’
D	528076.33	657756.98	128110.24	157713.3	-9° 3’ 47.95’’	52° 39’ 58.36’’

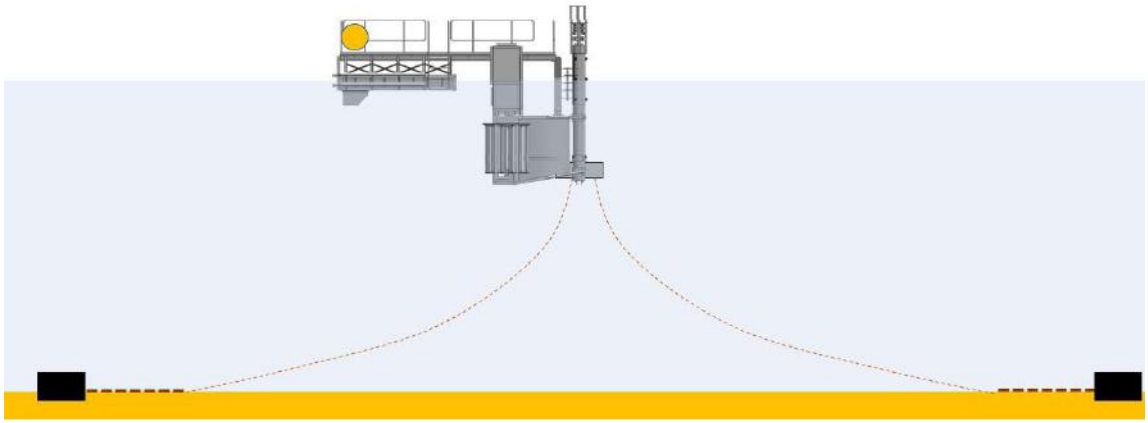

Figure 3.5: Illustration of installed device and mooring

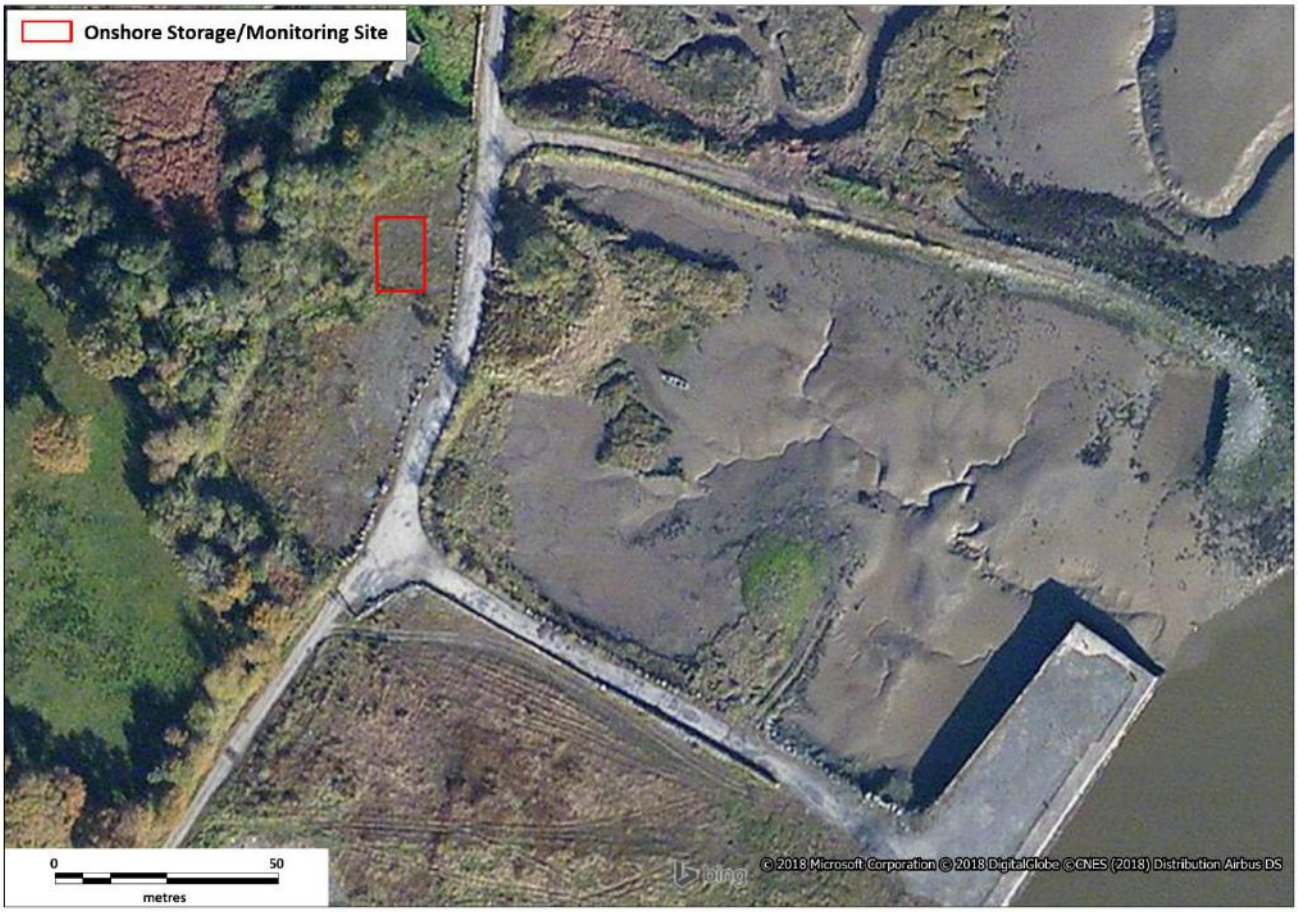

Figure 3.6: Location of shore side monitoring station.

3.1.3. Decommissioning

Decommissioning will involve the removal of the device and it's mooring from the seabed. A locally sourced tug or small multicat vessel with a winch and lifting capabilities will be required. The device will be disconnected from its mooring and lifted from the water back on to the vessel. The mooring system anchors will be removed in a separate operation.

The device will be removed on 1 tidal cycle and the moorings over 2-3 tidal cycles.

The vessel route will be from Foynes port and return.

3.2. Description of Receiving Environment

3.2.1. Annex I Habitats

The proposed test site will be located in the channel between Canon Island to the east and Inishtubbrid to the west. The device will be deployed within 75m of coordinate 528299.97E; 657957.86N (ITM) (128333.93E; 157914.2N ING) and the mooring will extend 280m to the northeast of the device location, and approximately 275m to the southeast. Water depth at the site is *c.* 20m. Figure 3.7 shows seabed topography and bathymetry in the area.

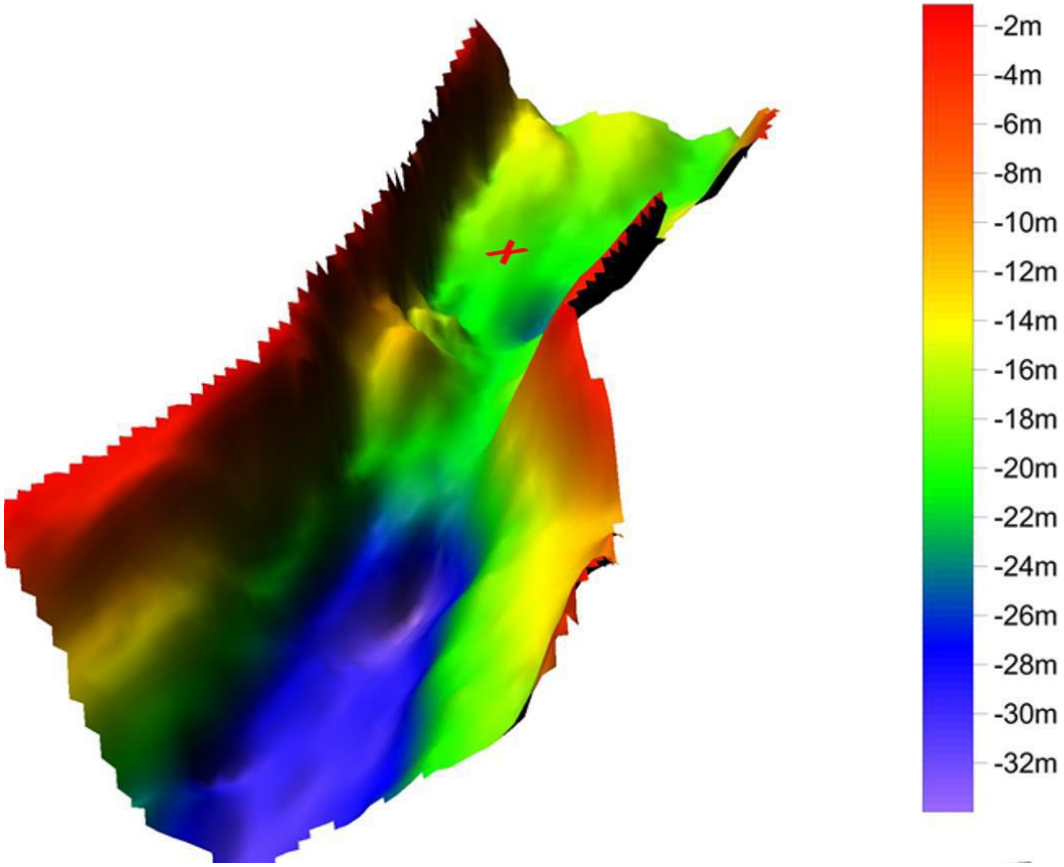

Figure 3.7: Topography and water depth at the proposed device location (AQUAFACT, 2018).

Figure 3.8 shows the marine habitats in the survey area derived from NPWS Conservation Objective mapping for Lower River Shannon cSAC (IE002165). The habitat that overlaps the proposed test site is limited to the 'subtidal sand to mixed sediment with *Nephtys* spp. community complex'.

The sediment of this complex is that of sand to mixed sediment with a great deal of variation within the sediment fractions (NPWS, 2012b). Gravel ranges from 59% to 0%, very coarse sand from 28% to 0%, coarse sand from 42.8% to 0%, medium sand from 70.6% to 0%, fine sand from 91.7% to 0.8%, very fine sand from 66.6% to 0.1% and silt-clay from 52.5% to 0%. In the upper to mid estuary the sediment is predominately mixed sediment with pockets of muddy sand. The community is distinguished by the polychaete genera *Nephtys* spp. Other distinguishing species include *Nephtys cirrosa*, *Bathyporeia elegans* and *Magelona johnstoni*. *Nephtys* sp. occurs in moderate to low abundances at the confluence of the Fergus and Shannon.

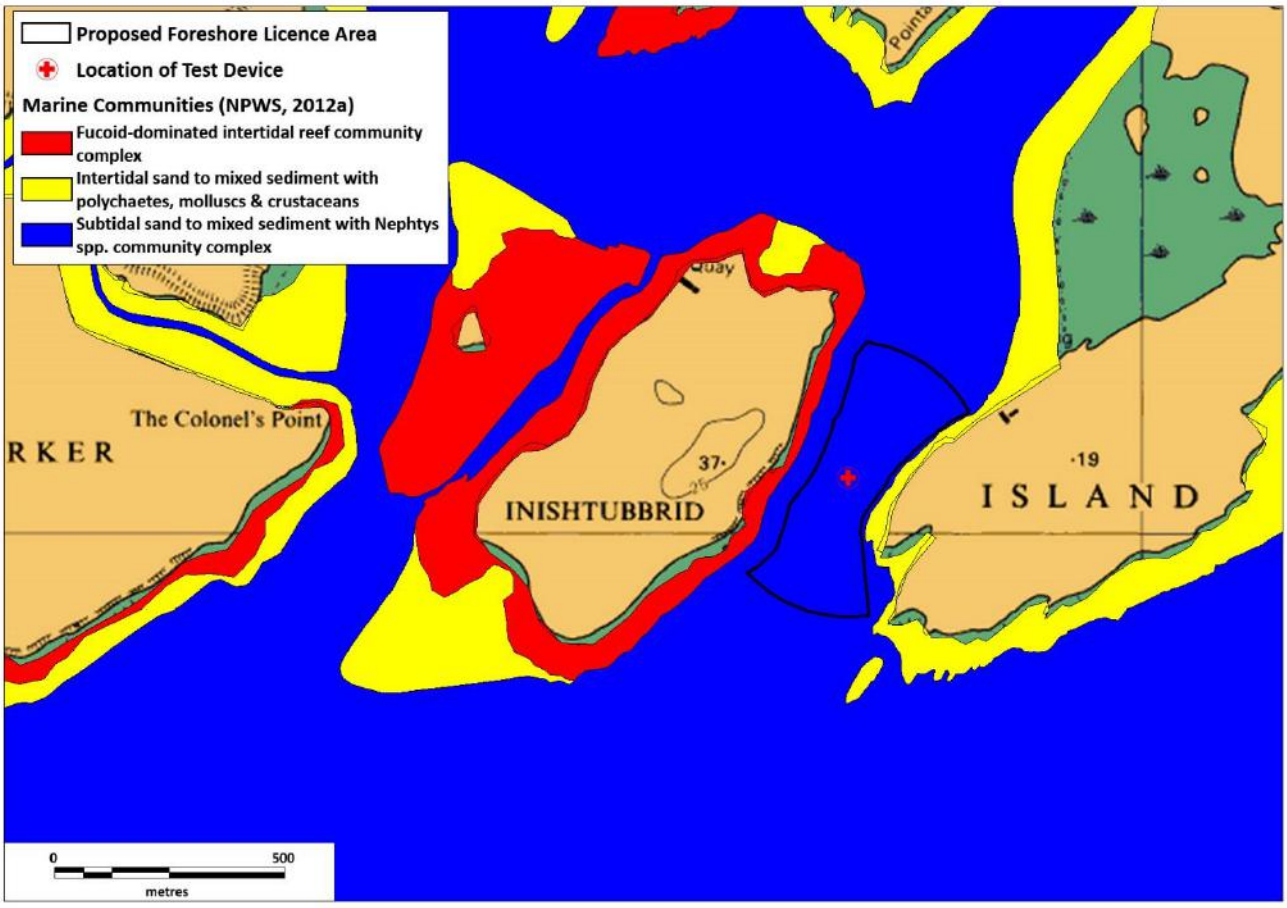

Figure 3.8: Marine habitats in the survey area (NPWS, 2012a).

AQUAFACT surveyed the proposed test site area in February 2018 to ascertain further information on the benthic communities and substrate in the footprint of the proposed test site. Appendix 2 provides methodologies and detailed results from the survey. A grab sampler was used to obtain samples where sediments allowed and a drop-down video was used to survey the areas of hard substrate. Figure 3.9 shows the locations sampled with respect to the marine habitats identified in NPWS (2012a).

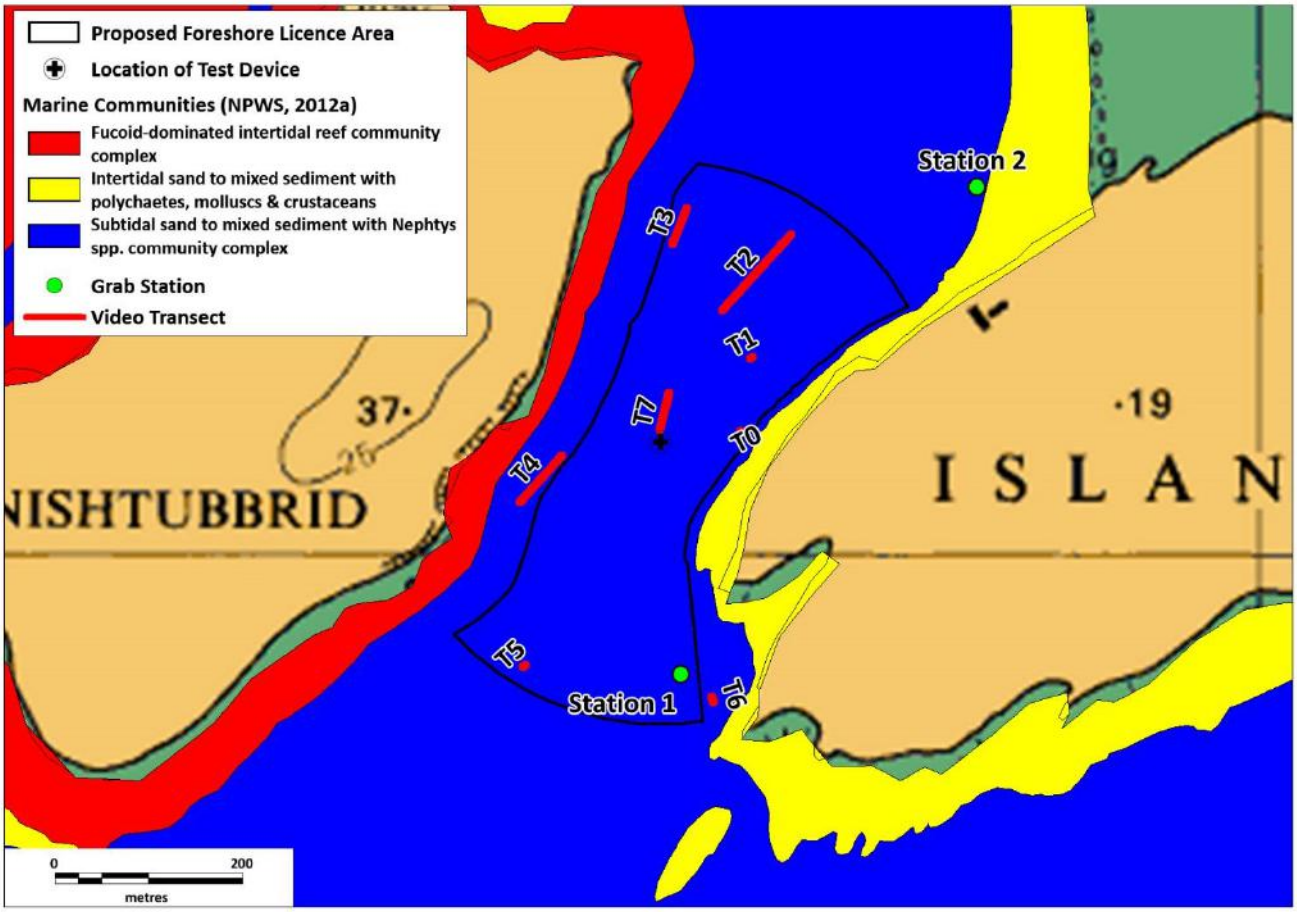

Figure 3.9: Sites surveyed in February 2018

The results from the faunal grab analysis reveals that both grab stations are located in a transition zone between the 'subtidal sand to mixed sediment with *Nephtys* spp. community complex' and the 'intertidal sand to mixed sediment with polychaetes, molluscs and crustaceans community complex'. Distinguishing species from both of these communities were found in the faunal returns; *Nephtys* spp. (including *N. hombergii*), *Corophium volutator* and *Limecola balthica* (previously known as *Macoma balthica*). Sediment type was classified as gravelly muddy sand and slightly gravelly muddy sand according to Folk (1954) with gravel ranged from 3.6 to 14%, very coarse sand from 7.9 to 15%, coarse sand from 6.9 to 10%, medium sand from 4.7 to 7.7%, fine sand from 6.6 to 6.9%, very fine sand from 16.2 to 24.2% and silt clay from 29.5 to 46.1%.

The results from the video survey revealed a hard rocky substratum dominated by boulders and cobbles with some intervening patches of sandy mud and gravel. Depths ranged from 7.4 to 29.1m. The following species were identified from the video footage: hydroids, sponges (possibly *Cliona* or *Halichondria*) and bryozoans (possibly *Alcyonidium diaphanum*). Previous efforts to sample this area of the Fergus Estuary failed to return a grab sample due to the coarse/hard nature of the seabed (AQUAFACT, 2011). A single individual of the

green shore crab *Carcinus maenas* was recovered from one grab. These findings indicate that the community type in the proposed test site area is consistent with the 'faunal turf-dominated subtidal reef community' described by NPWS (2012a) in parts of the Estuary west of Tarbert. The community is found on boulders and cobbles in exposed to moderately exposed areas and is dominated by a faunal turf comprising of hydroids, bryozoans and encrusting sponges. The remaining fauna is primarily echinoderms including ophiuroids, *Echinus esculentus*, *Asterias* sp. and *Holothuria forskali* and crustaceans including *Carcinus maenas*, *Necora puber*, *Liocarcinus* sp. and *Cancer pagurus*. Other fauna recorded here include the anemone *Urticina* sp. and the polychaete *Pomatoceros* sp. Figure 3.10 shows representative images from the area.

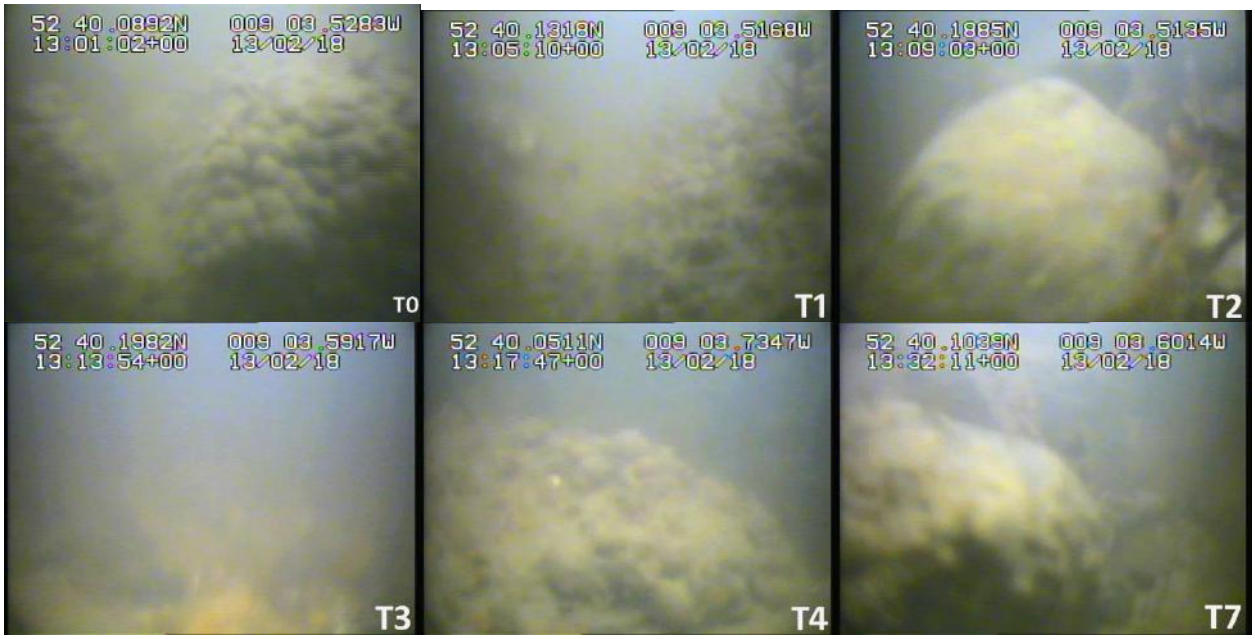

Figure 3.10: Representative images from rocky seabed within the proposed test site area

The intertidal area along the shoreline of Canon Island that borders the proposed test site consisted of bedrock and boulder substratum with a short shoreline which is steep in places. The shore is dominated by the knotted wrack *Ascophyllum nodosum* and the shoreline was backed by grassland, with an orange lichen zone in places (see Figures 3.11). This habitat is characterised as 'fucoid-dominated intertidal reef community complex' (NPWS, 2012a) typically dominated by the fucoid algae *Fucus vesiculosus*, *F. spiralis* and *F. serratus*. The associated flora includes *Ulva* sp., *Porphyra umbilicalis*, *Ralfsia* sp., *Corallina officinalis* and encrusting red algae. The associated fauna includes the gastropods *Patella* sp., *Littorina saxatilis*, *Melarhaphe neritoides* and *Nucella* sp., the polychaetes *Pomatoceros* sp. and Spirorbid spp. and barnacles including *Elminius modestus*, *Chthamalus montagui* and *C. stellatus*. In more sheltered areas east of Tarbert, *Fucus spiralis* is replaced by *Ascophyllum nodosum* as is seen in this location.

Figure 3.11: Intertidal zone along the shoreline of Canon Island

The intertidal area along the shoreline of Inishtubbrid that borders the proposed test site consisted of a bedrock and boulder substratum with a short shoreline which was steep in places. The shore is dominated by the knotted wrack *Ascophyllum nodosum* with an orange lichen and *Ulva* zone on the bedrock above (see Figures 3.12). This habitat is characterised as 'fucoid-dominated intertidal reef community complex' (NPWS, 2012a) typically dominated by the fucoid algae *Fucus vesiculosus*, *F. spiralis* and *F. serratus*. The associated flora includes *Ulva* sp., *Porphyra umbilicalis*, *Ralfsia* sp., *Corallina officinalis* and encrusting red algae. The associated fauna includes the gastropods *Patella* sp., *Littorina saxatilis*, *Melarhaphe neritoides* and *Nucella* sp., the polychaetes *Pomatoceros* sp. and Spirorbid spp. and barnacles including *Elminius modestus*, *Chthamalus montagui* and *C. stellatus*. In more sheltered areas eats of Tarbert, *Fucus spiralis* is replaced by *Ascophyllum nodosum* as is seen in this location.

Figure 3.12: Intertidal zone along the coastline of Inishtubbrid

Figure 3.13 shows the Annex 1 habitats in the vicinity of the proposed test site and tidal device. The location of the tidal device overlaps the estuary (1130) habitat only. The proposed Foreshore Licence area overlaps the estuary (1130) and reef (1170) habitats. Neither the test device of Foreshore Licence area overlaps the mud and sandflat (1140) habitat.

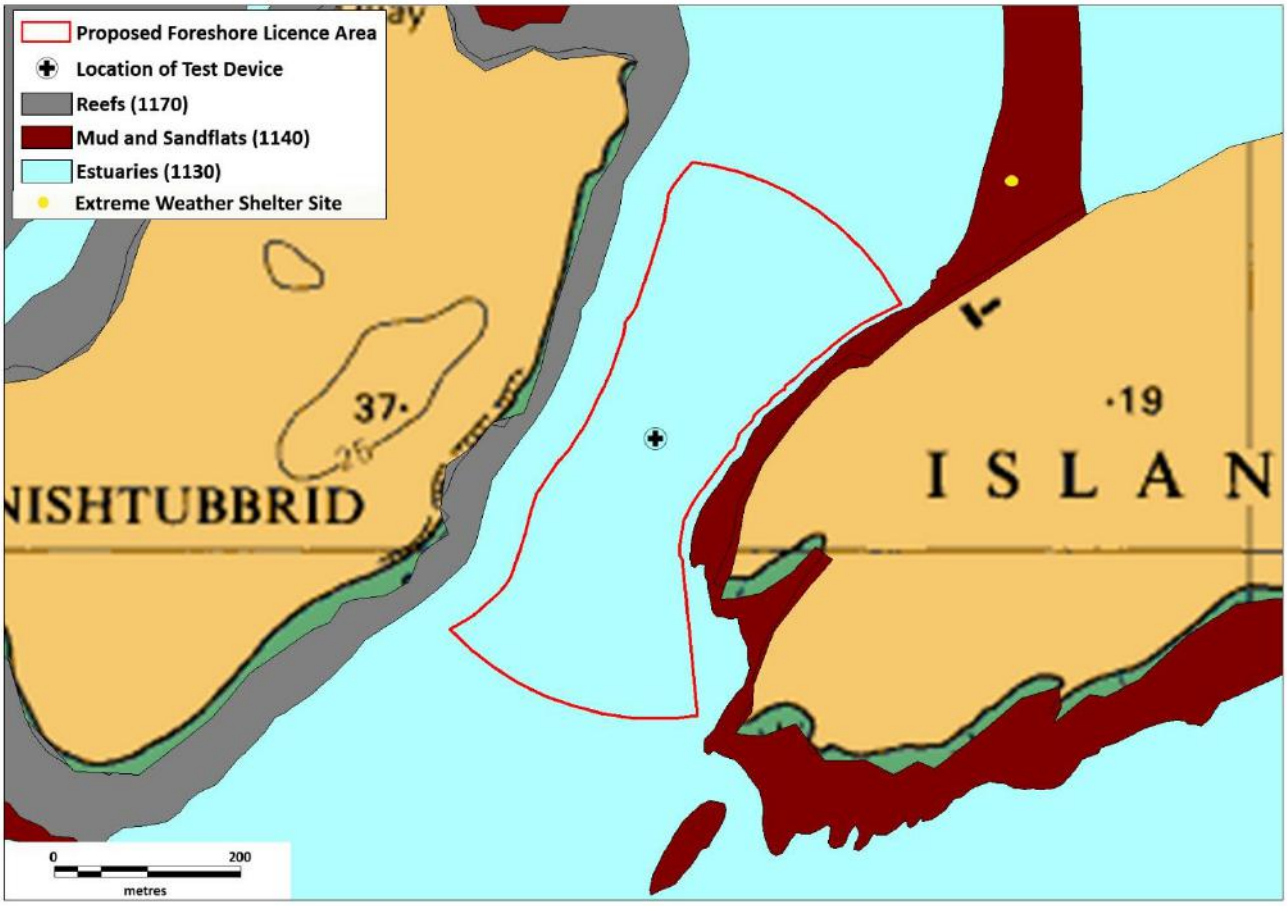

Figure 3.13: Annex 1 habitats in the vicinity of the proposed test site area.

The onshore location for the monitoring station can be seen in Figure 3.14. The site is an area that had been cleared, flattened and gravelled sometime in the past and is now slowly being recolonised by low sized, shrubby trees. Tree species recorded on the site were willow (*Salix* spp.) and alder (*Alnus glutinosa*) and shrub species included gorse (*Ulex europaeus*) and bramble (*Rubus* spp). Stands of rush (*Juncus effusus*) were noted on the water logged ground. The site is backed to the west by a fairly steep ridge of bed rock overlain by top soil with mature trees such as ash (*Fraxinus excelsior)* and alder (*Alnus glutinosa*). The site does not contain any Annex I habitats and it is of very low conservation value and the siting of the container there will therefore have no ecological impact on the area.

Figure 3.14: Representative photographs of the onshore monitoring station location.

3.2.2. Annex II Species

Only those estuarine/marine species of relevance are discussed below.

3.2.2.1. Bottlenose dolphin *Tursiops truncatus* (1349)

The Shannon Estuary is the most important site in Ireland for bottlenose dolphins (*Tursiops truncatus*) and was designated as a SAC for this species in 1999 (Berrow *et al.*, 2012a). This is one of only two sites designated for this species in Ireland and one of only about 20 in Europe. A study on genetics of bottlenose dolphins in Ireland suggested that the bottlenose dolphins in the Shannon Estuary are genetically discrete and thus of very high conservation value (Mirimin *et al.,* 2011). Bottlenose dolphins have been known to use

the estuary since at least 1835 (Knott, 1997) and probably for much longer.

The first study of the dolphins in the estuary was carried out in 1993-1994 (Berrow *et al*., 1996), which showed the dolphins were resident and calved in the estuary making it of high conservation value. A larger study carried out between 1996 and 1998 derived an abundance estimate of 113±16[2] dolphins in the estuary (95% Confident Intervals of 94-161[3]) and identified a number of critical habitats (Ingram, 2000; Ingram & Rogan, 2002). A similar abundance estimate of 121±14 was calculated in 2003 (95% Confident Intervals of 103-163) (Ingram & Rogan, 2003). These population abundance estimates were carried out again in 2006 (140) and 2008 (114) (Englund *et al.,* 2007; 2008) and most recently in 2010 (Berrow *et al.* 2010). The 2010 population assessment recorded a total of 64 dolphin groups with 547 individuals (Berrow *et al.,* 2010). Of the 547 individuals sighted, 116 were unique individuals. Group size ranged from 1-50 overall. Lone dolphins were reported on two occasions. Dolphins were located throughout the survey area (from Tarbert west to Kilbaha Bay) with concentrations off Kilcredaun Head, Kilbaha, Leck Point in the outer estuary and Carrig Buoy in the middle estuary (*c.* 25km west of the proposed survey area). Of the 116 individual dolphins recorded during this survey 47% (55 out of 116) were considered resident (*i.e.* they had been recorded previously in the Shannon Estuary) and 53% were "new" dolphins not recorded previously. The 2010 abundance estimates for bottlenose dolphins in the Lower River Shannon cSAC was within the range recorded in 2006 and 2008 and also within the 95% Confidence Intervals for all surveys carried out to date. This suggests that, within the power of the survey technique, the population of bottlenose dolphins in the Lower River Shannon cSAC is relatively stable (Berrow *et al.,* 2012b).

Bottlenose dolphins are not evenly distributed throughout the Shannon Estuary (O'Brien & Berrow, 2012), however survey effort has largely been restricted to the outer and middle estuary (Berrow *et al.,* 1996; Ingram, 2000; Ingram & Rogan, 2003; Englund *et al.,* 2007; 2008; Berrow *et al.,* 2010). Survey effort upriver of Tarbert, Co Kerry is restricted to one short winter study by Berrow (2009).

Ingram & Rogan (2002) attempted to describe the dolphins preferred habitat requirements and suggested they preferentially use areas with the greatest benthic slope and depth for foraging. These sites in the Shannon are characterised by strong currents, particularly on the ebb tide which are thought to influence the distribution and movement of fish, especially salmon (*Salmo salar*) which is believed to be a preferred prey item of the Shannon dolphins (O'Brien & Berrow, 2012).

(2) Estimate with its standard deviations is given, showing the level of uncertainty

(3) Confidence intervals means that there is 95% confidence that the real figure lies within the range presented

In 2012, as part of the Strategic Integrated Framework Plan (SIFP) for the Shannon Estuary, Berrow *et al.* (2012a) attempted to identify and rate the important areas for bottlenose dolphins in the Shannon Estuary. Figure 3.15 shows monthly sightings data throughout the Estuary over a 2 year period from 1996-1997. Figure 3.16 shows the effort corrected encounter rate of bottlenose dolphins from Shannon dolphin tour boat data between 2000 - 2010 (Berrow *et al.,* 2012a). These data allowed Berrow *et al.* (2012a) to validate their habitat scoring system which was based on current speed (faster the better), seabed slope (greater the better) and water depth (deeper the better). Figure 3.17 shows the scoring assessment for habitat suitability for bottlenose dolphins in the Shannon Estuary. The area of the proposed test site is located in an areas that has an intermediate suitability for dolphin habitat. Figure 3.18 shows bottlenose dolphin habitat and critical habitat within the Shannon Estuary (NPWS, 2012a). **The proposed test site is over 20km from the dolphin critical habitat and does not overlap it.**

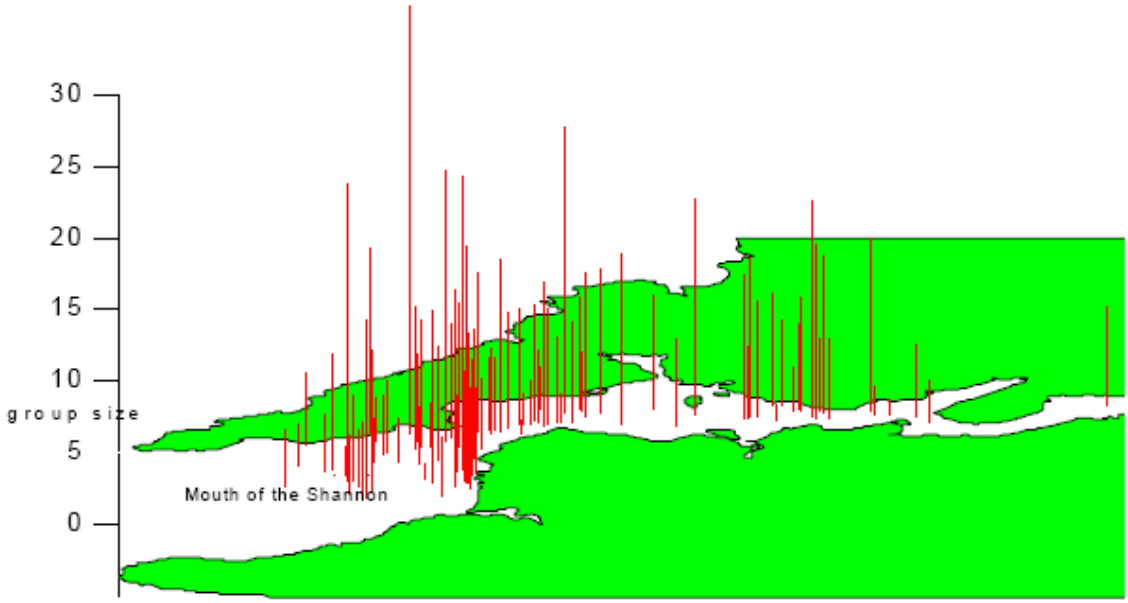

Figure 3.15: Location of sightings of dolphin groups encountered during boat surveys between 1996 and 1997 (length of line denotes group size) (Rogan *et al.,* 2000).

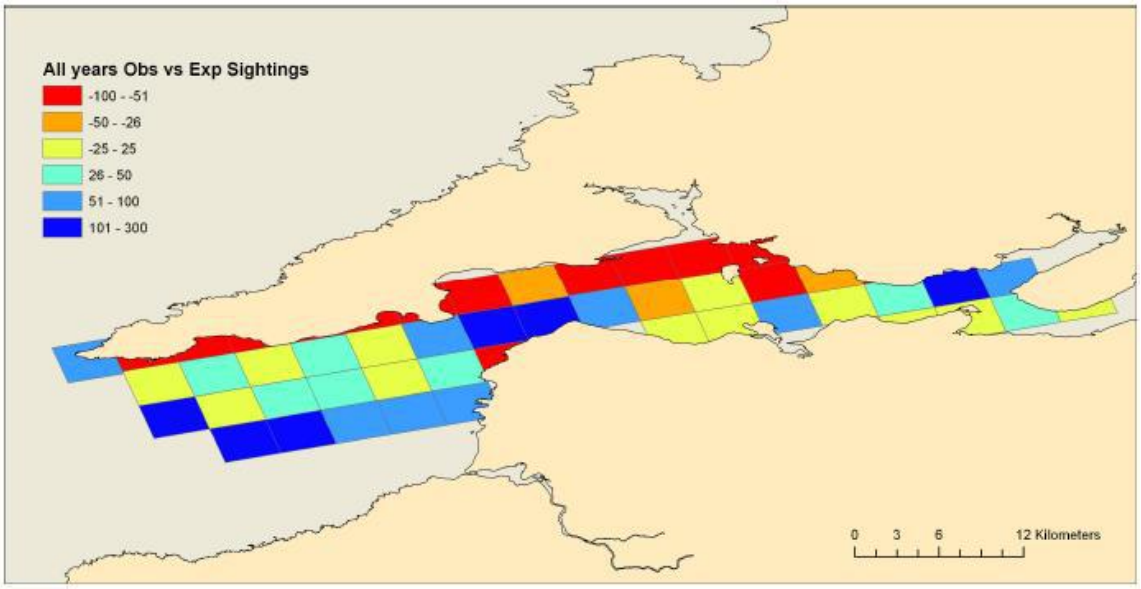

Figure 3.16: Effort corrected encounter rate of bottlenose dolphins from Shannon dolphin tour boat data between 2000-2010 (Berrow *et al.,* 2012a).

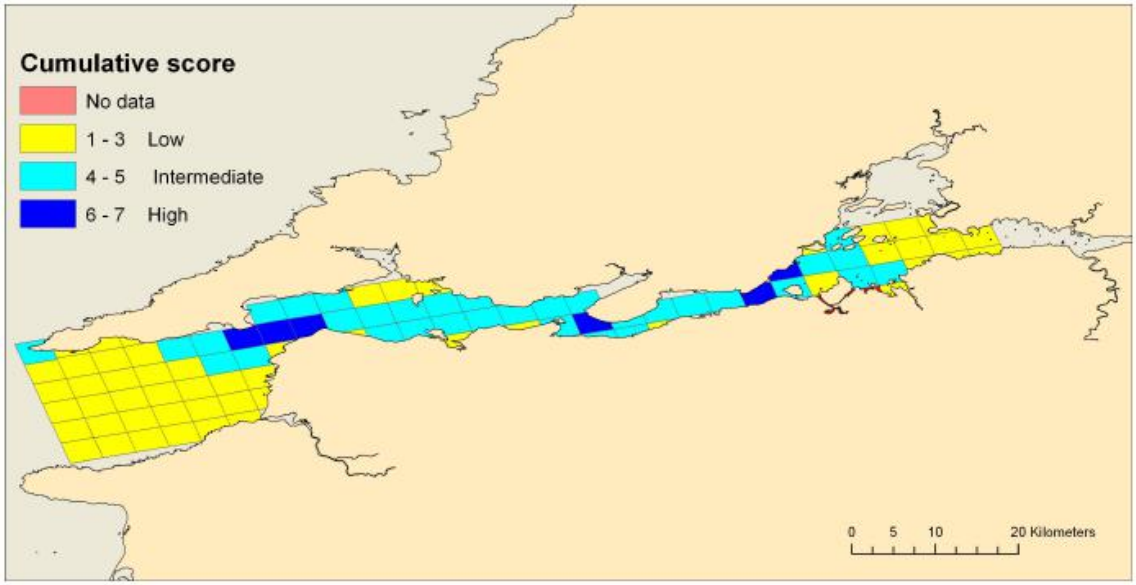

Figure 3.17: Scoring assessment for habitat suitability for bottlenose dolphins in the Shannon Estuary.

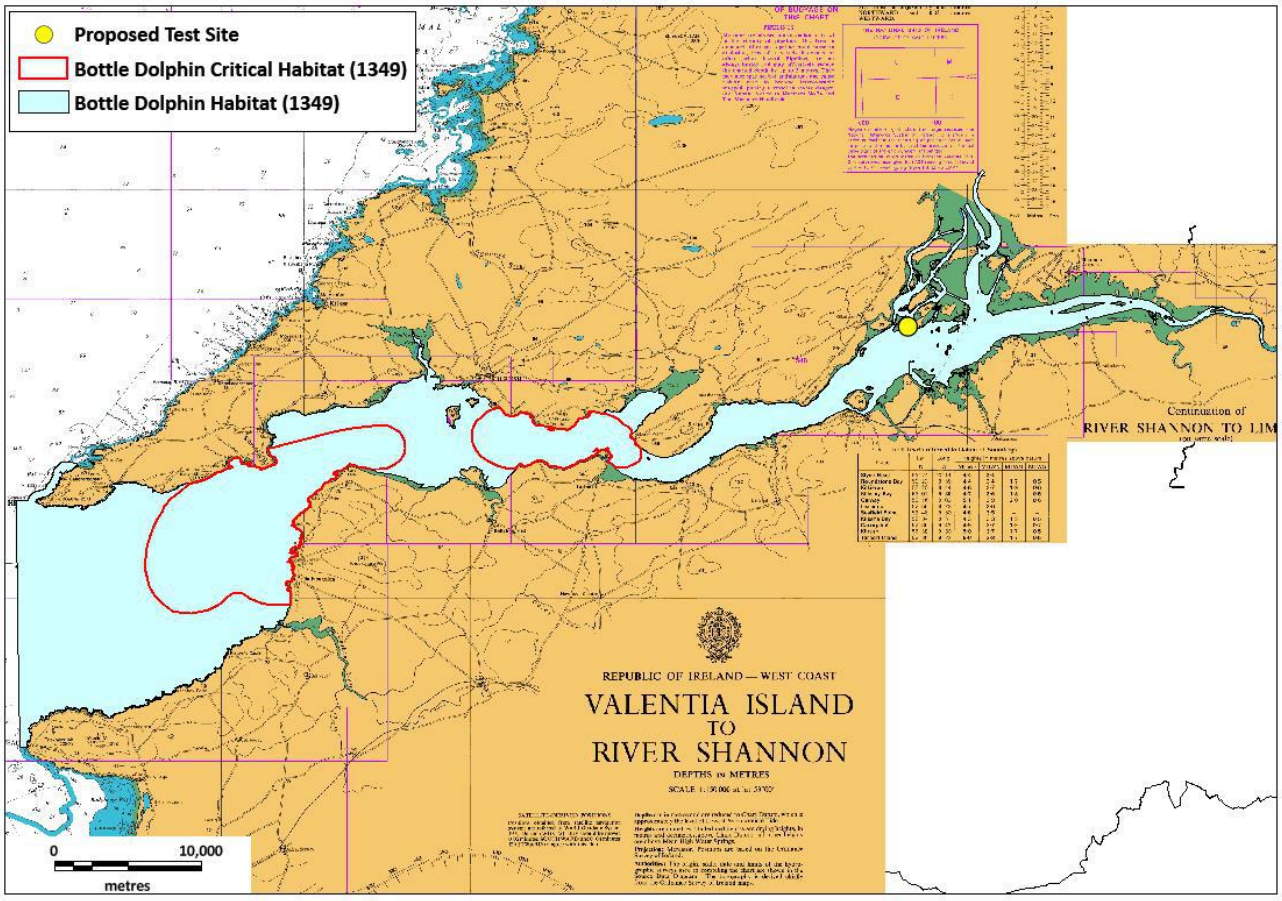

Figure 3.18: Bottlenose dolphin habitat and critical habitat in relation to the proposed test site (NPWS, 2012a).

As part of the SIFP for the Shannon Estuary, long-term Static Acoustic Monitoring (SAM) was carried out at 4 deep water jetty sites in the Shannon Estuary (O'Brien & Berrow, 2012). The closest monitoring sites to the proposed test site were Aughinish, located approximately 2km to the south and Foynes, located approximately 6km to the southwest. The two other sites were Moneypoint, 24km west of the test site and located within the critical habitat of the bottlenose dolphin and Shannon Airport, located 9.5km east of the test site. A C-POD was deployed from the jetty at Aughinish for a period of 225 C-POD days and at the jetty at Foynes for a period of 288 days from November 5th 2011 to November 4th 2012. The C-POD had a range of *c.* 800m. Bottlenose dolphins were detected on 31% of the days (70 days) at Aughinish and on 47% of the days (135 days) at Foynes. The proportion of days with dolphin detections decreased further up the estuary with 80% of days (281 days) with detection at Moneypoint compared to just 21% (77 days) of days at Shannon Airport. The mean Dolphin Positive Minutes (DPM) per day at Aughinish was 1 (minute), 4.4 (minutes at Foynes) and 1.5 (minutes) at Shannon Airport. These short durations are consistent with dolphins passing through the sites rather than using the sites as foraging areas. Season had a significant effect on dolphin presence at Foynes and Aughinish with a peak in detections during the spring (Mar-May) at Foynes and

winter at Aughinish (Dec-Feb[4]). Diel cycle was also significant at Foynes and Aughinish, with most dolphin detections recorded at night showing they are more active at the site during this period. Tidal cycle and tidal phase had a significant effect on detections at Aughinish with most detections during the flood tide.

As stated earlier, dolphins calve in the estuary. The breeding season is between May and September (Rogan *et al.,* 2000). It is also used as a nursery area for mother calf pairs. Highest numbers in the estuary tend to coincide with the breeding season. However, as stated above, highest numbers recorded around Foynes and Aughinish fall outside the breeding season.

While dolphins have been recorded further in the Fergus Estuary, there is no evidence that this is a frequent pattern (Berrow, *pers. comm.).*

3.2.2.2. Otter *Lutra lutra* (1355)

Otter incidence in the Shannon catchment was estimated at 59.3% in the 2010/2012 population assessment (Reid *et al.,* 2013), with 128 out of 216 surveyed sites showing positive signs for otter. In the previous population assessment, otter incidence in the Shannon catchment was estimated at 70.5% in the 2004/2005 population assessment (Bailey & Rochford, 2006), with 70 out of 100 surveyed sites showing positive signs for otter. Prior to this, the 1980/1981 population assessment estimated an incidence of 97.4% (Chapman & Chapman, 1982), with 515 out of 529 surveyed sites showing positive signs for otter.

Within the Shannon Estuary itself, there are no records for the Fergus Estuary (or proposed test site location and Cahiracon Pier/Inishmurray Island) from Biodiversity Ireland (see Figure 3.19). In addition, the most recent population assessment (Reid *et al.,* 2013), did not record evidence of otters at the sites surveyed within the Fergus Estuary. Along the coast, holts are often found adjacent to freshwater streams or springs as otters need to wash the salt from their fur. Couches can often be found on islands. While no records exist for otters in the area of the proposed test site, NPWS have identified a 10m terrestrial buffer along the shoreline of Canon Island and Inishtubbrid above the high water mark which is critical for otters (NPWS, 2007) and a foraging zone within 80m of the shoreline (NPWS, 2007; Kruuk, 2006). In addition, otters have the ability to commute distances of up to 500m between islands, between the mainland and islands and across an estuary (De Jongh & O'Neill, 2010). Therefore, otters do have the potential to occur within the proposed test site area for periods of time. Figure 3.20 shows the otter habitat in the vicinity of the proposed test site (NPWS, 2012a).

[4] There was no C-POD deployed at Aughinish during the autumn period

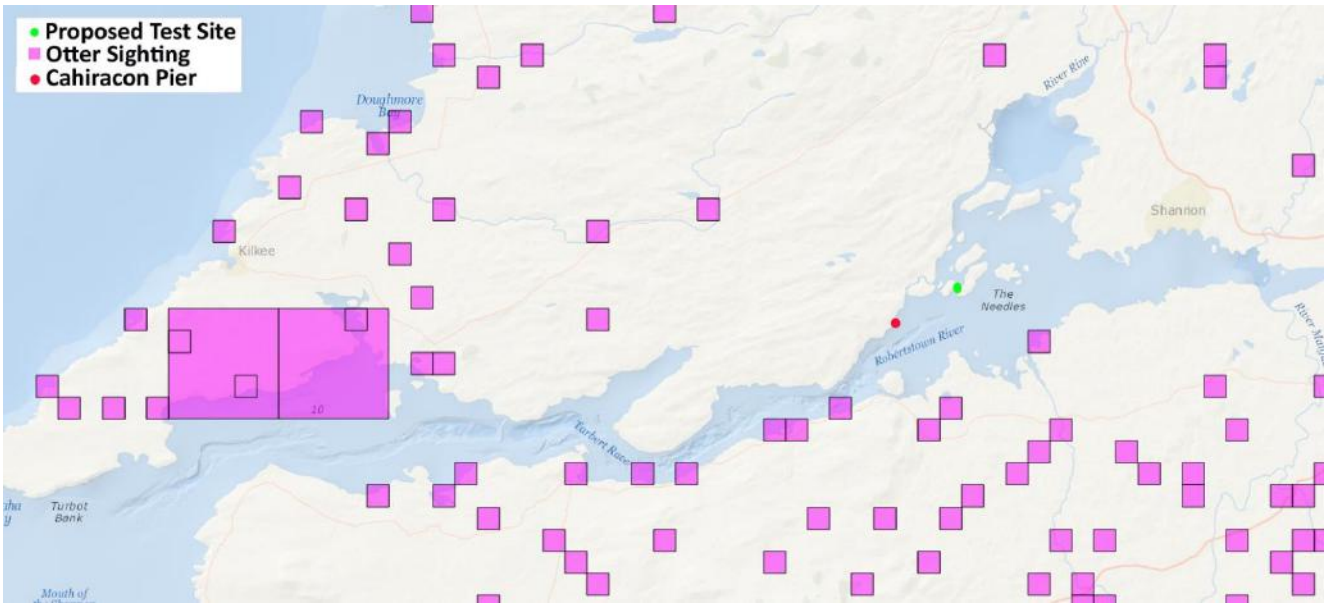

Figure 3.19: Otter records from the Shannon Estuary (Data from the Species Database held by the National Biodiversity Data Centre www.biodiversityireland.ie, [March, 2018]).

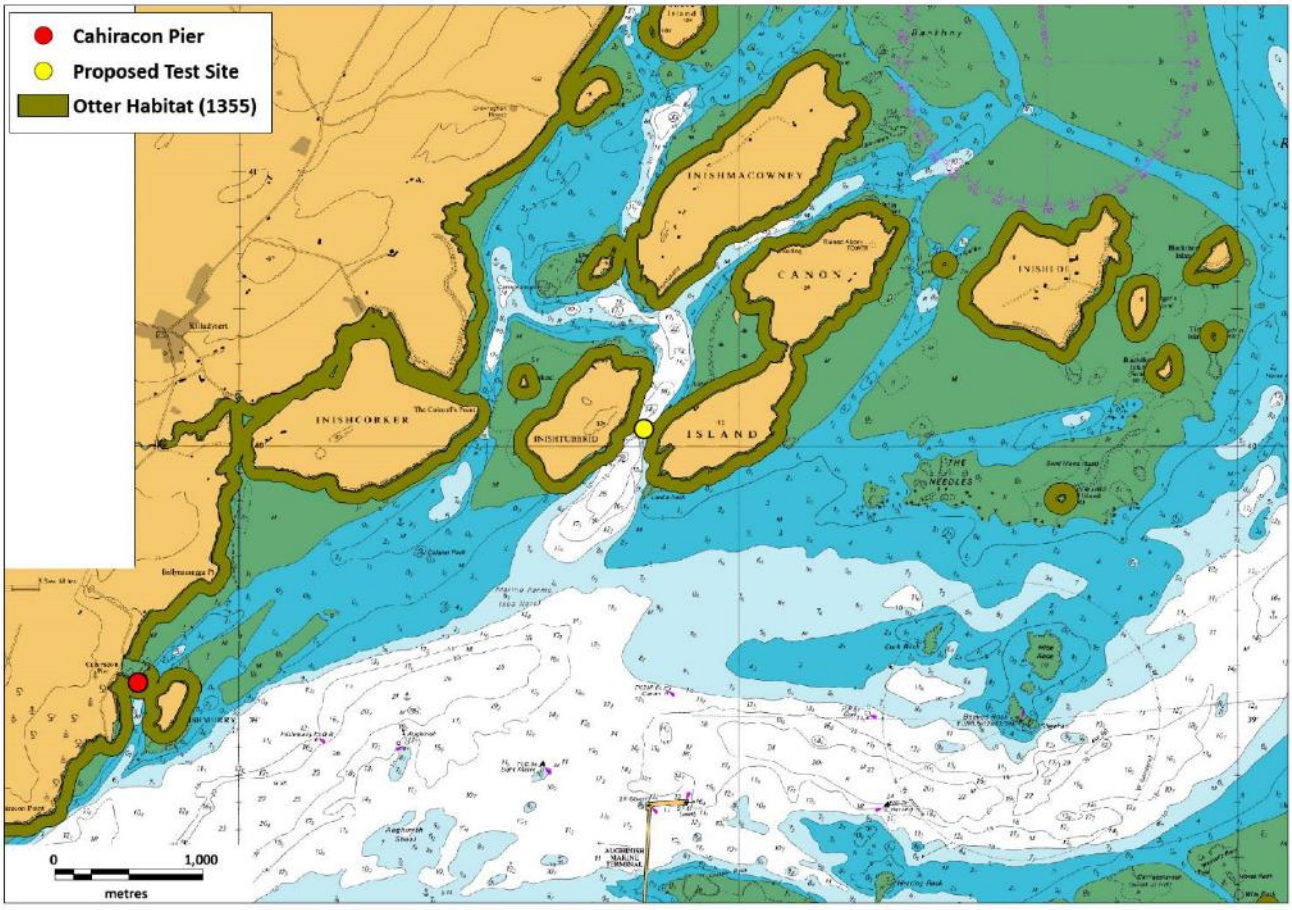

Figure 3.20: Otter habitat in relation to the proposed test site and pier access point.

3.2.2.3. Lamprey species

The sea lamprey *Petromyzon marinus* (1095) is a migratory species which grows to maturity in the sea and

migrates to freshwater to spawn. They migrate through the estuary from the sea in April and May (Hardisty, 1969) and spawn in rivers in late May or June and then return to sea. There are known records of sea lamprey throughout the Fergus Estuary and eastern half of the Shannon Estuary and as per "The Status of EU Protected Habitats and Species in Ireland, 2013" the 10km national grid squares for this area indicates the presence of sea lamprey (NPWS, 2013a).

The river lamprey (*Lampetra fluviatilis*) is a migratory species which grows to maturity in estuaries and migrates to freshwater to spawn from October to December (Maitland, 2003). Spawning occurs in the rivers in March and April. Between July and September young adults at 3-5 years of age migrate during darkness to the estuary. There are no records for this species at the proposed test site. However, it is likely that they occur in most rivers that allow access to spawning and nursery areas from the sea and as per "The Status of EU Protected Habitats and Species in Ireland, 2013" the 10km national grid squares for rivers flowing in to Estuary indicate the presence of river lamprey (NPWS, 2013a).

3.2.2.4. Atlantic Salmon *Salmo salar* (1106)

Atlantic salmon *Salmo salar* are also qualifying interests of the Lower River Shannon cSAC. There are a number of rivers, which flow into the Shannon Estuary, which are fished for salmon and sea trout (*Salmo trutta*). These include the River Fergus, Castleconnell Salmon Fishery, River Mulchair, River Maigue and River Deel. The presence of migratory fish species in the upper River Shannon indicates that there is a high likelihood that this same species may occur within the proposed test site area at some point in their life-cycle. Smolts typically head out to sea between March and June and adults return to the river between March and August.

3.2.3. Species of Conservation Interest

The proposed test site area also overlaps the River Shannon and River Fergus Estuaries SPA (IE004077). The site is of Special Conservation Interest (SCI) for the following species: Cormorant, Whooper Swan, Light-bellied Brent Goose, Shelduck, Wigeon, Teal, Pintail, Shoveler, Scaup, Ringed Plover, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew, Redshank, Greenshank and Black-headed Gull. It is also of special conservation interest for holding an assemblage of over 20,000 wintering waterbirds. The E.U. Birds Directive pays particular attention to wetlands and, as these form part of this SPA, the site and its associated waterbirds are of special conservation interest for Wetland & Waterbirds.

McCarthy Keville O' Sullivan (MKOS) was commissioned under the SIFP to carry out a bird usage survey of the River Shannon and River Fergus Estuaries SPA. Eleven 2-day surveys from May 2017 to April 2018 at high tide

and low tide were conducted to provide up-to-date seasonal data on bird usage. While the proposed test site area was not monitored, two of the monitored sites border the proposed test site area; OH534 and OH533 (see Figure 3.21). Only the results from May 2017 to February 2018 were available at the time of writing. The species recorded from both sites can be seen in Appendix 3.In total, 29 different species were recorded from the two subsites and of these 9 were recorded from the subtidal zone (common tern, cormorant, shelduck, black-headed gull, common gull, herring gull, great black-backed gull, mallard, wigeon, mute swan and great crested grebe) with an additional species (little grebe) recorded from the terrestrial zone but which has the potential to occur in the subtidal zone.

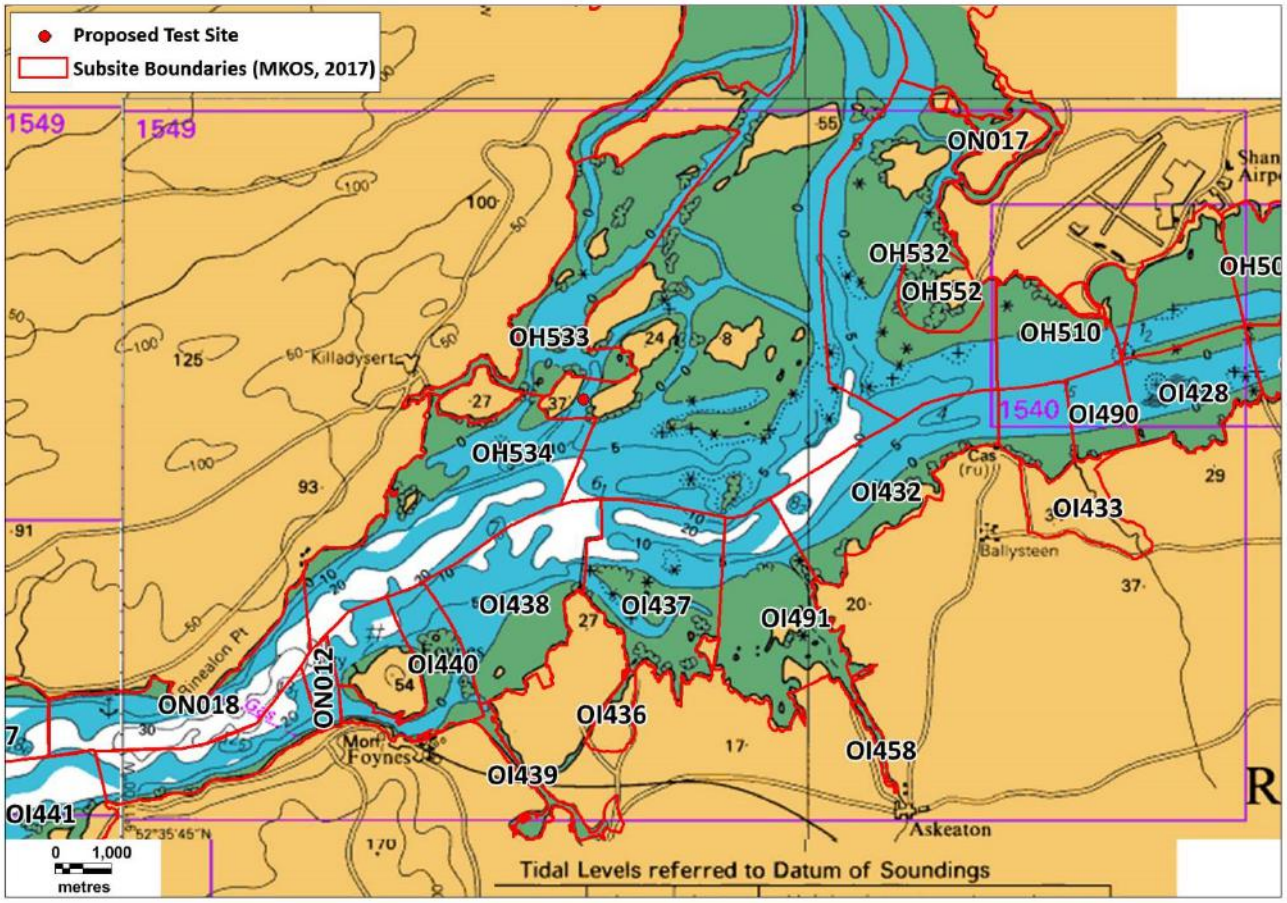

Figure 3.21: Bird sites monitored during a bird usage study in 2017/2018 in relation to the proposed test site (MKOS, 2017).

Figure 3.22 shows the significant flocks observed during the May to September 2017 survey period in the vicinity of the proposed test site. A flock of 129 black-tailed godwits was recorded feeding at high water in the intertidal zone on Inishcorker *c.* 1.8km west of the proposed test site and *c.* 2.6km northeast of Cahiracon Pier (BW006). A flock of 50 redshanks was observed feeding in the intertidal zone at high water in

Killadysert Creek, *c.* 2.3km west of the proposed test site and *c.* 2km northeast of Cahiracon Pier (RK003). A flock of 65 curlew was recorded roosting in the supratidal zone *c.* 300m northwest of Cahiracon Pier and 3.7km southwest of the proposed test site (CU006).

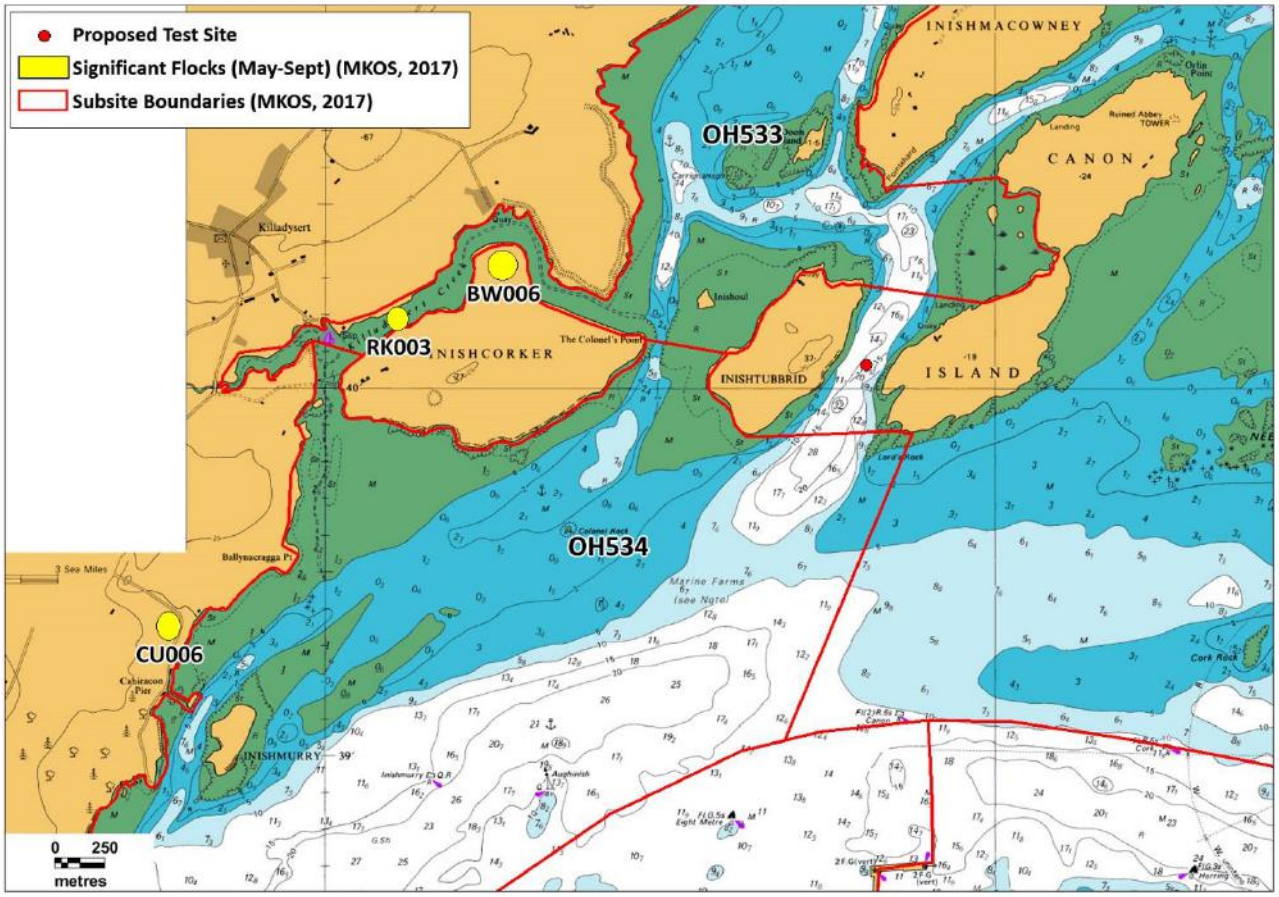

Figure 3.22: Significant flocks of birds recorded in the vicinity of the proposed test site from May to September 2017 (MKOS, 2017)

Figure 3.23 shows the significant winter flocks observed during the October 2017 to February 2018 survey period in the vicinity of the proposed test site. A flock of 1400 dunlin was recorded feeding at low water in the intertidal zone south of Inishmore *c.* 4km south of the proposed test site and *c.* 7.2km northeast of Cahiracon Pier (DN003). A flock of 218 lapwings was observed roosting in the terrestrial zone at high water, *c.* 2.5km northwest of the proposed test site and *c*. 5.1km northeast of Cahiracon Pier (L003). A flock of 155 golden plover was recorded feeding at high water in the intertidal zone on the northern shore of Inishcorker, *c.* 1.9km west of the proposed test site and 2.7kmnortheast of Cahiracon Pier (GP001). Other significant flocks consisted of 112 roosting lapwing (L001), 110 feeding lapwing (L002), 69 roosting curlew (CU007), 40 feeding lapwing (L004), 32 feeding mallard (MA001), 24 feeding curlew (CU008), 20 feeding black-headed gulls (BH004), 20 feeding redshank (RK004) and 12 feeding shelduck (SU002).

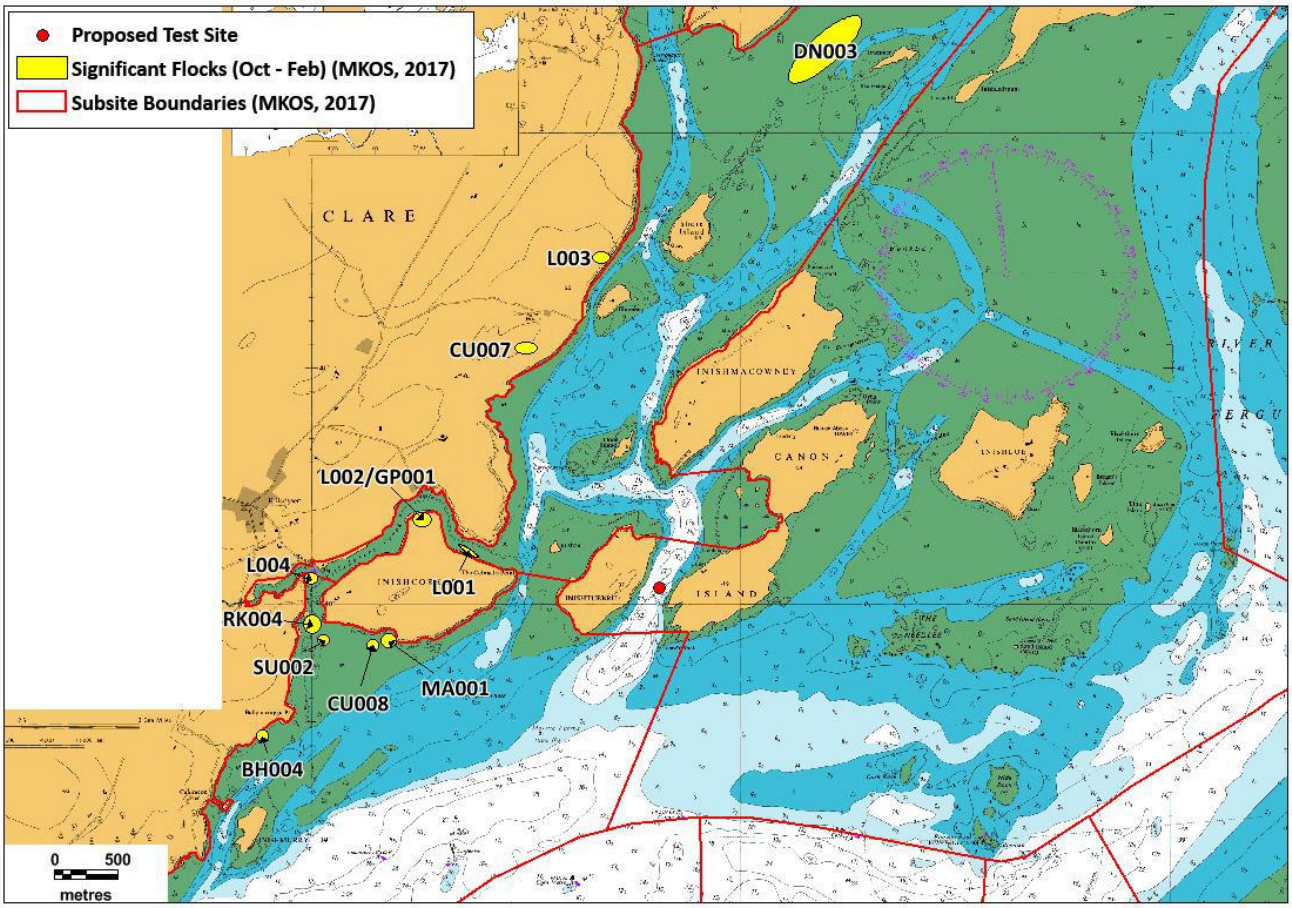

Figure 3.23: Significant flocks of birds recorded in the vicinity of the proposed test site from October 2017 to February 2017 (Data supplied by MKOS).

Despite the incomplete status of the winter surveys in the MKOS bird usage survey, the NPWS Waterbird Survey Programme of 2010/11 (NPWS, 2012d) provides results from both subsites for the winter period. Appendix 4 shows the dot density maps from October 2010 to February 2011 for those species recorded from either OH533 or OH534. In addition to the 10 species recorded during the May to September 2017 period, which have the potential to occur in the proposed test site area (common tern, cormorant, shelduck, black-headed gull, common gull, herring gull, mallard, wigeon and great crested grebe, great black-backed gull), the winter 2010/2011 survey added teal to the list of relevant species. Subsites OH533 and OH534 were ranked No. 1 in terms of their relative contribution of shelduck subtidal foraging distribution across all sub-sites surveyed. OH533 was in the top third of ranking placings in terms of its relative contribution of teal subtidal foraging distribution across all sub-sites surveyed.

Table 3.3 shows the roost summary data for subsites OH533 and OH534 from the 2010/2011 winter monitoring. Figure 3.24 shows the roost locations in subsites OH533 and OH534 in relation to the proposed test site.

Table 3.3: Roost summary table February 2010 (NPWS, 2012d).

Subsite	Count	No. Locations	No. Species	Species
OH533	678	12	9	Cormorant, redshank, wigeon, greenshank, black-headed gull, shelduck, curlew, mallard and bar-tailed godwit
OH534	116	5	6	Mallard, teal, curlew, black-headed gull, greenshank and wigeon

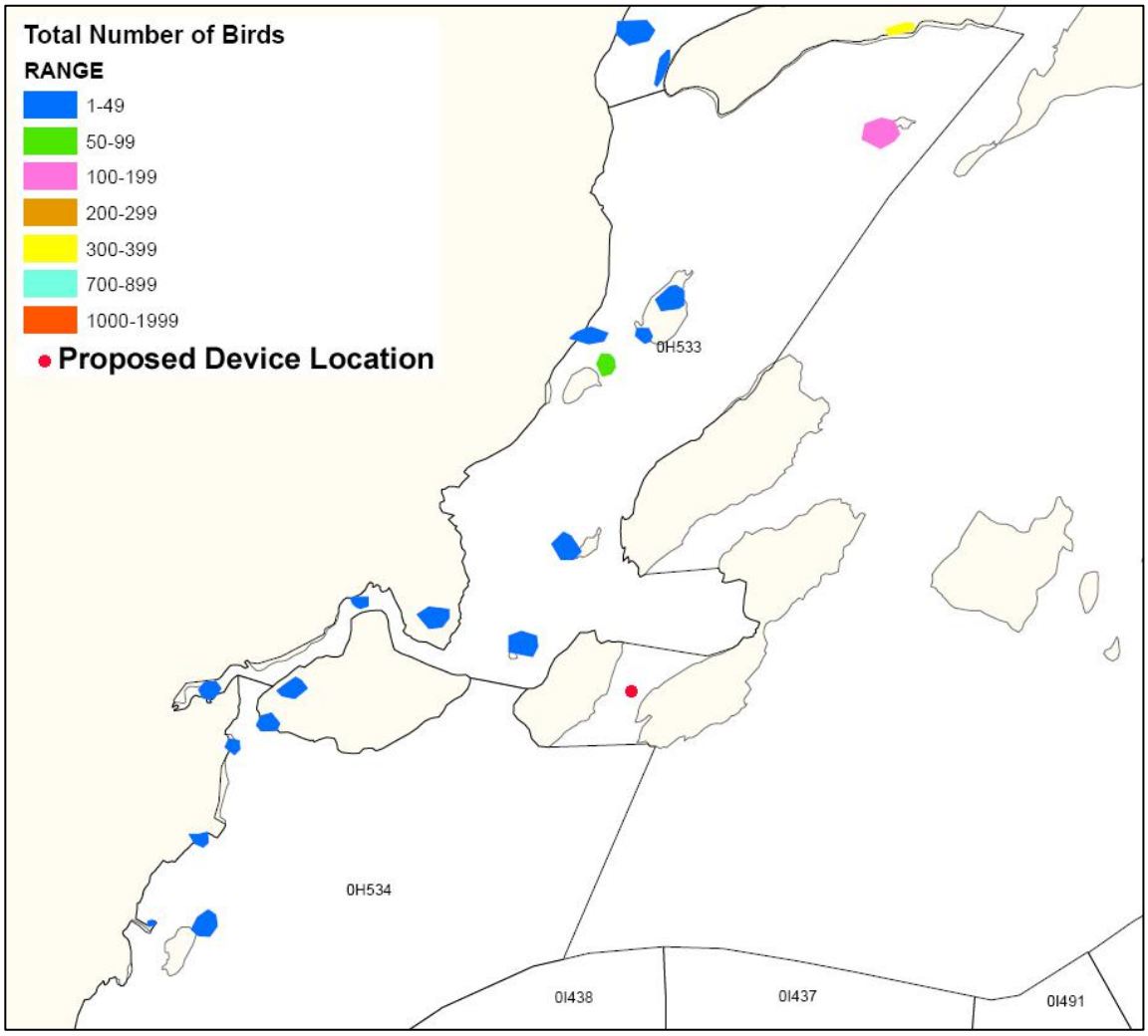

Figure 3.24: Roost location map from roost survey February 2010 (NPWS, 2012d).

3.3. Potential Impacts of the Proposal

Given the nature and scale of the current proposal a number of impacts associated with tidal energy devices can be eliminated.

- As no electricity will be generated by the operating device and the functionality of the electrical cable connection will be tested in a simulation mode (whereby the cable is not live), therefore impacts associated with **electromagnetic fields** can be eliminated.
- Changes in energy flow and energy removal from a single device have been shown to be unmeasurable compared to the natural variability in waterbodies (Nash & Phoenix, 2017; Baring-Gould *et al*. 2016), therefore **energy removal**, **changes in sediment pathways** and **water circulation patterns** can be eliminated.

The likely impacts associated with the proposed tidal energy test site can arise in a number of ways:

1. Installation of mooring system and device and
2. Operational impacts arising from the working test device interacting with the environment.

What follows is a general description of likely impacts associated with tidal devices. The impacts of this particular project are discussed with in Section 5.

3.3.1. Potential Impacts associated with Installation

3.3.1.1. Direct Physical Disturbance to the Seafloor

The lowering of objects to the seafloor will result in:

- the **disturbance of natural sediments** on the seafloor and temporarily resuspend them; and
- a **loss of substratum and disturbance to species** in the installation area.

When sediments get resuspended, the coarser fraction of the disturbed sediment tends to settle out close to the works but can remain mobile. The fine material tends to disperse widely at high energy sites and eventually settle out over wide areas.

The direct impacts from the loss of substratum and disturbance to species will include localised mortality or displacement of species where objects come into direct contact with the sediment. Any potential damage to the benthos and disruption of sediment locally could lead to changes in invertebrate fauna and fish stocks which may reduce food availability for birds at least in the short term (BirdLife International, 2003).

3.3.1.2. Contamination during Installation Works

Installation works have the potential to release contaminants into the water column if the sediments in the installation area are historically contaminated. Sediments can build up contaminants over time from industrial or domestic waste, radionuclides, munitions *etc*. While impacts on water quality would most likely be temporary, depending on the type and amount of material released, potential contaminants could be dispersed over a much wider area and persist within the environment .

3.3.1.3. Suspended Sediments

The lowering of any object (anchor, mooring chains/ropes) on to a sedimentary seafloor will result in:

- The temporary resuspension of particulate materials

Indirect impacts include **smothering and increased suspended sediment and turbidity**. The smothering of sensitive benthic species, fish spawning habitat and shellfish habitat can occur due to the subsequent settlement of the resuspended sediments. Increased suspended sediment and turbidity levels can impact on sensitive filter feeding organisms such as king and queen scallop, cockles and mussels. Fine particles can travel great distances from the disturbed area due to tidal currents and depending on the quantities of remobilised sediments this impact could be widespread. Increased turbidity could affect the foraging and predator/prey interactions of birds due to reduced visibility. In addition, herring, sprat, grey and common seals are sensitive to reduced visibility.

3.3.1.4. Noise

Noise sources during the installation works will be confined to that generated by the installation vessels. Vessel noise is a combination of tonal sounds at specific frequencies (*e.g.* propeller blade rotational frequency and its harmonics) and broadband noise (Vella *et al*., 2001). Propeller cavitation noise is the primary source of sound from underway vessels, whilst noise from propulsion machinery originates inside a vessel and reaches the water via the vessel hull. Noise from shipping is roughly related to vessel size, larger ships have larger, slower rotating propellers, which produce louder, lower frequency sounds (SMRU, 2001). Overall, vessel noise covers a wide range of frequencies from 10Hz to 10kHz. Source levels and dominant frequencies range from 152 dB re 1 µPa@1m at 6300Hz for a 5m Zodiac with an outboard motor, through 162dB re 1 µPa@1m at 630Hz for a tug/barge traveling at 18km/hr, through to a large tanker with source level around 177dB re 1 µPa@1m in the 100Hz third octave band (Richardson *et al*., 1995). The use of bow thrusters increases broadband sound levels.

There is a high level of diversity in hearing structures among fish, resulting in different auditory capabilities across species. Many fish species hear in the range of about 30Hz to 1kHz (1000Hz); however, some

investigations have demonstrated species-specific hearing capabilities in the infrasonic range of less than 20Hz (Karlsen, 1992; Knudsen *et al*., 1997; Sand & Karlsen, 2000) and in the ultrasonic range of over 20kHz (Mann *et al.* 1998, 2001; Popper *et al*., 2004). Shipping exhibits major energy below 1,000Hz and is therefore within the frequency range of hearing of most fish species (Richardson *et al*., 1995; Popper *et al*., 2003). Fish and shellfish species may be disturbed by the noise from the maintenance vessels.

Diving birds could also be affected by shipping noise causing them to become disorientated and affecting their foraging success (AECOM Ltd., 2010). Effects on surface feeding birds are likely to take the form of disturbance effects. This could cause birds to temporarily avoid the immediate area which may have implications for foraging and breeding success, stress on individuals and energy budgets.

Marine mammals use acoustics to navigate, locate prey and maintain social contact and as a result they are very sensitive to anthropogenic noise. Underwater hearing sensitivity in harbour seals indicates a fairly flat frequency response between 1kHz and about 50 kHz, with hearing threshold between 60 and 85 dB re 1 µPa (Richardson *et al.,* 1995). Toothed whales are most sensitive to sounds above about 10 kHz and below this sensitivity deteriorates. Harbour porpoises exhibit a very wide hearing range with relatively high hearing thresholds of 92 – 115 dBrms re 1 µPa below 1 kHz, good hearing with thresholds of 60 – 80 dBrms re 1µPa between 1 and 8 kHz, and excellent hearing abilities with thresholds of 32 – 46 dBrms re 1 µPa from 16 – 140 kHz (Kastelein *et al*., 2002). Behavioural audiograms for the bottlenose dolphin (Johnson, 1967; Ljungblad *et al.,* 1982; Au, 1993) indicate that hearing ranges from approximately 75Hz to 150kHz with the best sensitivity between 10kHz to 60kHz.

In essence, cetaceans have the ability to detect ship noise and it may elicit a temporary avoidance behaviour for some of the more sensitive species (larger baleen whales) whereas many toothed whales appeared to be tolerant of vessel noise and are regularly observed in areas where there is heavy traffic (Thomsen *et al.,* 2006). Disturbance of otters could also occur should maintenance works occur close to the coastal areas where they are present (AECOM Ltd., 2010).

3.3.1.5. Installation Vessels and Equipment

There is a risk of marine birds and cetaceans colliding with vessels during the installation phase.

While birds are generally more manoeuvrable than marine mammals, they are at **risk of colliding** with vessels especially at night (AECOM Ltd., 2010). Birds can typically collide with surface structures of ships or the ships can collide with birds rafting on the surface. The physical presence of vessels and installation equipment can have a temporary **disturbance effect** on birds due to physical and visual intrusion. This could cause birds to avoid the immediate area which may have implications for foraging and breeding success,

stress on individuals and energy budgets.

Shipping **collision** is a recognised cause of marine mammal mortality worldwide and the major factors influencing injury or mortality are vessel size and speed. In addition there is always a risk of corkscrew injuries to marine mammals from vessel propellers. Physical disturbance of otters could also occur should disturbing works occur close to the coastal areas where they are present (AECOM Ltd., 2010).

Fish and shellfish species may also be disturbed by the physical presence of the installation vessels and equipment.

3.3.1.6. Accidental Events

There is the potential of accidental pollution events from service and support vessels required during the installation works. These vessels will have fuel tanks and hydraulic systems for cranes and winches. These pollution events could include the release of fuel and lubricating oil, cleaning fluids, paints, specialised chemicals and litter. Any potential spillages could impact water quality and contaminate seabed sediments.

3.3.2. Potential Impacts associated with the Operation of the Test Site

The impacts of the operational phase of the test site are confined to the physical presence of the device and the mooring system.

3.3.2.1. Physical Presence

The physical presence of the devices and anchors on the seabed will result in a **direct loss of benthic habitat and sessile species** in the footprint of the infrastructure. This can also result in a loss of suitable substratum (particularly for benthic spawners) and feeding grounds for fish and shellfish species, foraging ground for birds and mammals. This infrastructure will also provide additional **hard substrate** to the environment of the test site. This hard substrata will be available to be colonised by near-by epifaunal species.

The presence of the tidal device has the potential to pose a **collision risk** for almost all species of marine finfish. The groups of fish species at risk depends on the location of the devices. Demersal species would not be impacted by the presence of a device at the sea surface but they may benefit from the habitat structure provided by the foundations and/or mooring of the device. They could however be impacted by the presence of a bottom mounted device and some species that make migrations up the water column using tidal stream transport could be impact by mid-water devices. Pelagic species make diurnal vertical migrations and have the potential to be impacted by all devices.

The tidal device can pose a collision risk to birds. Diving species are at greater risk of collision with subsurface turbines and mooring cables than surface feeding species, which are at a lower risk of interaction with

floating devices and surface structures as these do not use rotating blades (AECOM Ltd., 2010). As areas of high flow attract birds due to good foraging opportunities (Daunt *et al.,* 2006), the risk of collision can be increased if the renewable devices change the flow characteristics which may affect manoeuvrability and underwater swimming agility of birds.

Marine mammals also have the potential to collide with renewable energy devices as they must transit the water column to breath at the surface (AECOM Ltd., 2010). That said, marine mammals are highly mobile and have the ability to both avoid and evade these devices as long as they detect the object, perceive it as a threat and take appropriate action at long or short range. There are a number of factors that can interfere with this and they include detection failure, diving constraints, group effects, attraction, confusion, distraction, illogical behaviour, disease and life stage, size and season.

Mooring equipment will likely act like other natural or artificial seabed structures and pose few novel risks for vertebrates in the water column (AECOM Ltd., 2010). Cables, chains and powerlines extending up through the water column will have smaller cross sectional areas than vertical support structures and so produce reduced flow disruption and fewer sensory cues to approaching diving birds. Instead of being swept around these structures, mammals are more likely to be entangled in them. Areas of high turbidity can pose more of a risk for diving birds and marine mammals due to reduced visibility.

The presence of tidal devices may provide a **barrier to movement** which may result in avoidance behaviour by fish and shellfish species, birds and marine mammals which will ultimately result in **habitat exclusion**. While this avoidance behaviour would reduce the collision risk it may result in limiting access to feeding areas which could ultimately affect feeding and breeding success. It may also result in barriers to the usual migration and transit patterns of marine fish and birds. This could result in increased energy expenditure.

Loose lying mooring cables can affect the three dimensional structure of the seabed as they move in the current and this **disturbance to the seabed** could impact juvenile fish and a range of demersal species.

Renewable devices with surface structures have the potential to **provide roosting, nesting and/or breeding sites** for birds (AECOM Ltd., 2010). Man-made structures are regularly used by gulls, terns, cormorants and gannets as perching posts.

The metal structures deployed at the site will have sacrificial anodes attached (*e.g.* chain moorings,). Sacrificial anodes are designed to corrode in seawater in preference to these metal structures. Zinc and aluminium anodes are the most commonly used and these metals are potentially toxic to marine life if concentrations are high enough.

Some of the devices/equipment installed at the site may contain **anti-fouling compounds**, which may impact

on water and/or sediment quality, benthic communities, fish and shellfish species, birds and marine mammals. As top predators seals and cetaceans are more susceptible to various substances building up in their bodies (AECOM Ltd., 2010).

3.3.2.2. Noise

The potential noise sources from operating devices include rotating machinery, flexing joints, structural noise, moving air, moving water, moorings, electrical noise and instrumentation noise (AECOM Ltd., 2010). Noise from these devices could potentially disrupt prey location and underwater navigation in marine birds and prey location, navigation and social interaction in marine mammals or even result in temporary or permanent hearing damage. This noise also has the potential to affect fish, species in the immediate vicinity of the devices. The operational noise generated from these devices will be considerably lower than that generated by vessel noise, however it could result in avoidance behaviour and exclusion from an areas. This could result in limiting access to feeding areas which could ultimately affect feeding and breeding success.

The noise generated by maintenance vessels also has the potential to impact sensitive species in the area and this may elicit a temporary avoidance behaviour by sensitive fish, birds and mammals. This could cause birds to temporarily avoid the immediate area which may have implications for foraging and breeding success, stress on individuals and energy budgets. Disturbance of otters could also occur should maintenance works occur close to the coastal areas where they are present (AECOM Ltd., 2010). Fish and shellfish species may also be disturbed by the noise from the maintenance vessels.

3.3.2.3. Maintenance Vessels

There is a risk of marine birds and cetaceans colliding with maintenance vessels during the operational phase. While birds are generally more manoeuvrable than marine mammals they are at **risk of colliding** with vessels especially at night (AECOM Ltd., 2010). Birds can typically collide with surface structures of ships or the ships can collide with birds rafting on the surface. Shipping collision is a recognised cause of marine mammal mortality worldwide and the major factors influencing injury or mortality are vessel size and speed. In addition there is always a risk of corkscrew injuries to marine mammals from vessel propellers.

The physical presence of maintenance vessels can have a temporary **disturbance effect** on birds due to physical and visual intrusion. This could cause birds to avoid the immediate area which may have implications for foraging and breeding success, stress on individuals and energy budgets. Physical disturbance of otters could also occur should maintenance works occur close to the coastal areas where they are present (AECOM Ltd., 2010). Fish and shellfish species may also be disturbed by the physical presence of the maintenance vessels.

3.3.2.4. Accidental Events

There is the potential of accidental pollution events from service and support vessels required during routine maintenance of the device installed at the site. The device contains oil in the gearbox and the vessels will have fuel tanks and hydraulic systems for cranes and winches. These pollution events could include the release of fuel and lubricating oil, cleaning fluids, paints, specialised chemicals and litter. Any potential spillages could impact water quality and contaminate seabed sediments.

4. Appropriate Assessment Stage 1 Screening

4.1. Identification of Relevant Natura 2000 Sites

Adopting a precautionary principle, the Natura 2000 sites within 15km of the proposed test site were included in this assessment. All are listed in Table 4.1 and can be seen in Figure 4.1. Of these, the Natura 2000 sites deemed relevant and **screened in** are those which have Conservations Objectives or Qualifying Interests (QIs)/Special Conservation Interests (SCIs) which may be impacted by the proposed test site. Sites/qualifying interests that are screened in for further assessment are highlighted in Table 4.1.

Those sites or individual qualifying interests that are screened out at this stage (primarily as a result of being too great a distance away from the site and having different habitat requirements) are not assessed further.

Table 4.1: Identification of relevant Natura 2000 sites. All those screened in are highlighted.

Natura 2000 Site	Qualifying Interest/	Distance from Test Site	Potential Impacts	Screened In / Out
Lough Gash Turlough SAC (IE00051)	Turloughs[3180]	13.8km northeast	None – non-marine, no pathway for interaction	Screened Out
	Rivers with muddy banks with *Chenopodion rubri* p.p. and *Bidention* p.p. vegetation [3270]			
Curraghchase Woods SAC (E000174)	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0]	13.2km northwest	None – non-marine, no pathway for interaction	Screened Out
	Taxus baccata woods of the British Isles [91J0]			
	Rhinolophus hipposideros (Lesser Horseshoe Bat) [1303]			
Barrigone SAC (E000432)	*Juniperus communis* formations on heaths or calcareous grasslands [5130]	6.8km south	None – non-marine, no pathway for interaction	Screened Out
	Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (* important orchid sites) [6210]			
	Limestone pavements [8240]			
	Euphydryas aurinia (Marsh Fritillary) [1065]			
Newhall and Edenvale Complex SAC (IE002091)	Caves not open to the public [8310]	14.6km northeast	None – non-marine, no pathway for interaction	Screened Out
	Rhinolophus hipposideros (Lesser Horseshoe Bat) [1303]			
Lower River Shannon SAC (IE002165)	Sandbanks which are slightly covered by sea water all the time [1110]	45.5km west	None – distance too great, no pathway for interaction	Screened Out
	Estuaries [1130]	Overlap	Potential for interaction and direct effects	Screened In
	Mudflats and sandflats not covered by seawater at low tide [1140]	Overlap	Potential for interaction and direct effects	Screened In
	Coastal lagoons [1150]	5km south	None – distance too great, no pathway for interaction	Screened Out
	Large shallow inlets and bays [1160]	28.5km west	None – distance too great, no pathway for interaction	Screened Out
	Reefs [1170]	50m west	Potential for indirect effects	Screened In
	Perennial vegetation of stony banks [1220]]	26km west	None – distance too great, no pathway for interaction	Screened Out
	Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]	39.7km west	None – distance too great, no	Screened

Natura 2000 Site	Qualifying Interest/	Distance from Test Site	Potential Impacts	Screened In / Out
			pathway for interaction	Out
Lower River Shannon SAC (IE002165)	*Salicornia* and other annuals colonising mud and sand [1310]	19.4km west	None – coastal habitat above the high water mark, no pathway for interaction	Screened Out
	Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]	540m northeast	None – coastal habitat above the high water mark, no pathway for interaction	Screened Out
	Mediterranean salt meadows (*Juncetalia maritimi*) [1410]	1.4km northwest	None – coastal habitat above the high water mark, no pathway for interaction	Screened Out
	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260]	19.4km southeast	None – non-marine, no pathway for interaction	Screened Out
	Molinia meadows on calcareous, peaty or clayey-silt-laden soils *(Molinion caeruleae*) [6410]	37km east	None – non-marine, no pathway for interaction	Screened Out
	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0]	35km east	None – non-marine, no pathway for interaction	Screened Out
	Margaritifera margaritifera (Freshwater Pearl Mussel) [1029]	11km west	None – non-marine, no pathway for interaction	Screened Out
	Petromyzon marinus (Sea Lamprey) [1095]	Overlap	Potential for interaction and direct effects	Screened In
	Lampetra planeri (Brook Lamprey) [1096]	Distance unknown	No pathway for interaction due to distance and habitat type	Screened Out
	Lampetra fluviatilis (River Lamprey) [1099]	Overlap	Potential for interaction and direct effects	Screened In
	Salmo salar (Salmon) [1106]	Overlap	Potential for interaction and direct effects	Screened In
	Tursiops truncatus (Common Bottlenose Dolphin) [1349]	Overlap	Potential for interaction and direct effects	Screened In
	Lutra lutra (Otter) [1355]	Overlap	Potential for interaction and direct effects	Screened In
Askeaton Fen Complex SAC (IE002279)	Calcareous fens with *Cladium mariscus* and species of *the Caricion davallianae* [7210]	9.7km southeast	None – non-marine, no pathway for interaction	Screened Out
	Alkaline fens [7230]			

Natura 2000 Site	Qualifying Interest/	Distance from Test Site	Potential Impacts	Screened In / Out
Knockanira House SAC (IE002318)	*Rhinolophus hipposideros* (Lesser Horseshoe Bat) [1303]	3.6km north	None – non-marine, no pathway for interaction	Screened Out
River Shannon and River Fergus Estuaries SPA (IE004077)	Cormorant (*Phalacrocorax carbo*) [A017]	Within	Has the potential to forage in the test site	Screened In
	Whooper Swan (*Cygnus cygnus*) [A038]		None – due to habitat preference	Screened Out
	Light-bellied Brent Goose (*Branta bernicla hrota*) [A046]			
	Shelduck (*Tadorna tadorna*) [A048]		Have the potential to forage in the test site	Screened In
	Wigeon (*Anas penelope*) [A050]			
	Teal (*Anas crecca*) [A052]			
	Pintail (*Anas acuta*) [A054]			
	Shoveler (*Anas clypeata*) [A056]			
	Scaup (*Aythya marila*) [A062]		None – due to habitat preference	Screened Out
	Ringed Plover (*Charadrius hiaticula*) [A137]			
	Golden Plover (*Pluvialis apricaria*) [A140]			
	Grey Plover (*Pluvialis squatarola*) [A141]			
	Lapwing (*Vanellus vanellus*) [A142]			
	Knot (*Calidris canutus*) [A143]			
	Dunlin (*Calidris alpina*) [A149]			
	Black-tailed Godwit (*Limosa limosa*) [A156]			
	Bar-tailed Godwit (*Limosa lapponica*) [A157]			
	Curlew (*Numenius arquata*) [A160]			
	Redshank (*Tringa totanus*) [A162]			
	Greenshank (*Tringa nebularia*) [A164]			
	Black-headed Gull (*Chroicocephalus ridibundus*) [A179]		Has the potential to forage in the test site	Screened In
	Wetland [A999]		Potential for interaction and direct effects	Screened In
Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA (IE004161)	Hen Harrier (*Circus cyaneus*) [A082]	12.9km southwest	None – non-marine, no pathway for interaction	Screened Out

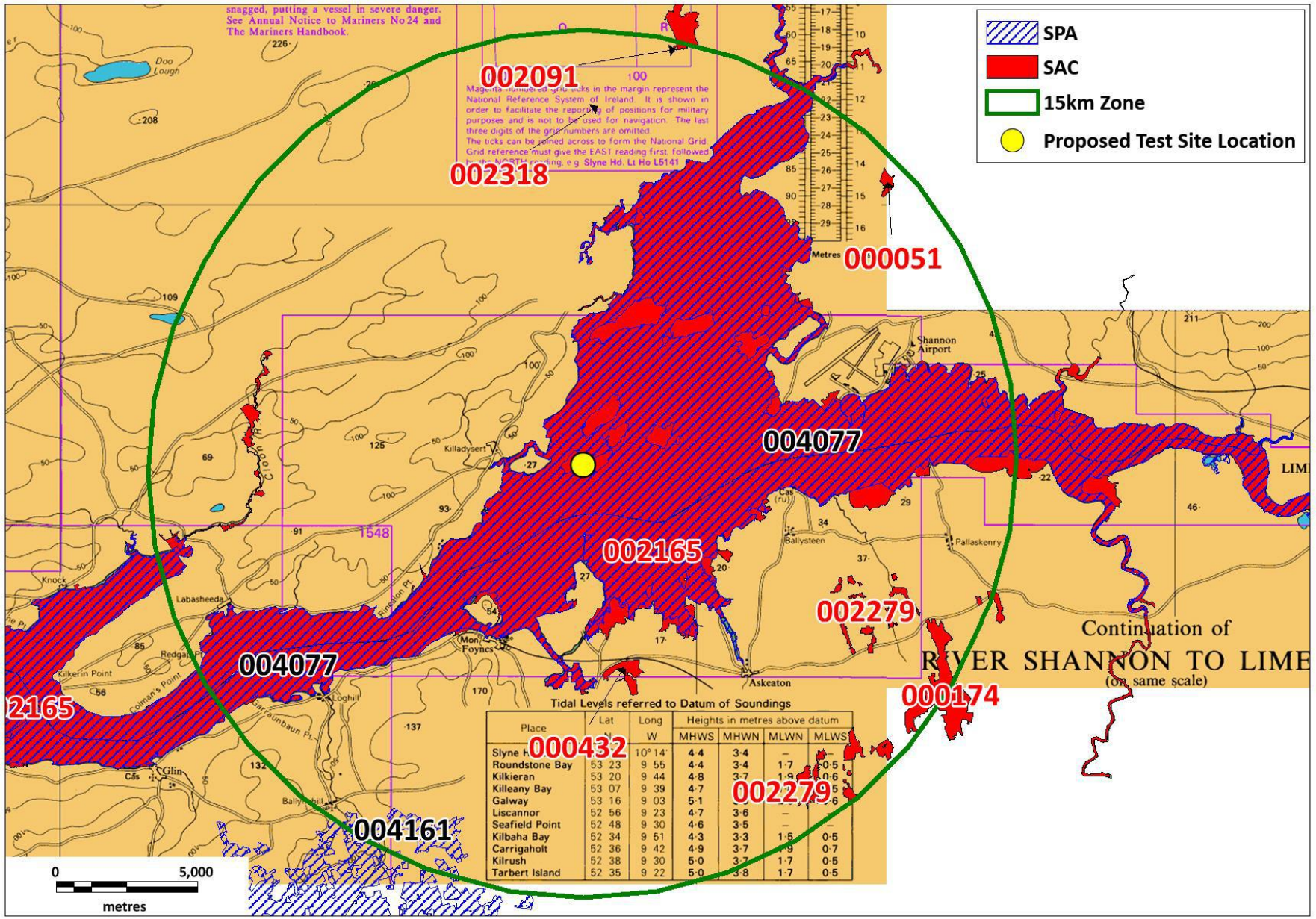

Figure 4.1: Location of all cSACs and SPAs within 15km of the test site.

4.2. Screening Assessment & Statement

After an initial review of the Natura 2000 sites listed in Table 4.1 and their QI/SCIs, it was considered that "*no pathway*" exists by which the proposed test site could impact upon the following Natura 2000 sites as the habitats and species protected in these Natura 2000 sites are not marine and are in any way connected to the marine environment:

- Lough Gash Turlough SAC (IE00051)
- Curraghchase Woods SAC (E000174)
- Barrigone SAC (E000432)
- Newhall and Edenvale Complex SAC (IE002091)
- Askeaton Fen Complex SAC (IE002279)
- Knockanira House SAC (IE002318)
- Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA (IE004161)

There is no likelihood of a significant adverse impact on the above Natura 2000 sites and therefore **Appropriate Assessment is not necessary** for these Natura 2000 sites.

In addition, there are a number of QIs and SCIs from the two remaining Natura 2000 sites in Table 4.1 (Lower River Shannon SAC [IE002165] and River Shannon and River Fergus Estuaries SPA [IE004077]) where there is also no likelihood of significant adverse impacts. It has been determined that no pathway exists by which the proposal could impact on the following QIs of the Lower River Shannon SAC due to distance:

- Sandbanks which are slightly covered by sea water all the time [1110]
- Coastal lagoons [1150]
- Large shallow inlets and bays [1160]
- Perennial vegetation of stony banks [1220]]
- Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]

Likewise, it has been determined that no pathway exists by which the proposal could impact on the following QIs of the Lower River Shannon SAC as they are not subtidal marine habitats or species:

- *Salicornia* and other annuals colonising mud and sand [1310]
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]
- Mediterranean salt meadows (*Juncetalia maritimi*) [1410]
- Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260]
- *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils *(Molinion caeruleae*) [6410]

- Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0]
- *Margaritifera margaritifera* (Freshwater Pearl Mussel) [1029]
- *Lampetra planeri* (Brook Lamprey) [1096]

It has been determined that no pathway exists by which the proposal could impact on the following SCIs of the River Shannon and River Fergus Estuaries SPA due to habitat preference (*i.e.* the bird species does not forage subtidally):

- Whooper Swan (*Cygnus cygnus*) [A038]
- Light-bellied Brent Goose (*Branta bernicla hrota*) [A046]
- Scaup (*Aythya marila*) [A062]
- Ringed Plover (*Charadrius hiaticula*) [A137]
- Golden Plover (*Pluvialis apricaria*) [A140]
- Grey Plover (*Pluvialis squatarola*) [A141]
- Lapwing (*Vanellus vanellus*) [A142]
- Knot (*Calidris canutus*) [A143]
- Dunlin (*Calidris alpina*) [A149]
- Black-tailed Godwit (*Limosa limosa*) [A156]
- Bar-tailed Godwit (*Limosa lapponica*) [A157]
- Curlew (*Numenius arquata*) [A160] Redshank (*Tringa totanus*) [A162] Greenshank (*Tringa nebularia*) [A164] Wetland and Waterbirds [A999]

There is no likelihood of a significant adverse impact on the above QIs/SCIs of the Lower River Shannon SAC (IE002165) and River Shannon and River Fergus Estuaries SPA (IE004077) and therefore **Appropriate Assessment is not necessary** for these features.

There are however a number of QIs for the Lower River Shannon SAC (IE002165), whereby the likelihood of significant adverse impacts cannot be ruled out, they are:

- Estuaries [1130]
- Mudflats and sandflats not covered by seawater at low tide [1140]
- Reefs [1170]
- *Petromyzon marinus* (Sea Lamprey) [1095]
- *Lampetra fluviatilis* (River Lamprey) [1099]
- *Salmo salar* (Salmon) [1106]
- *Tursiops truncatus* (Common Bottlenose Dolphin) [1349]
- *Lutra lutra* (Otter) [1355].

Likewise there are a number of SCIs for the River Shannon and River Fergus Estuaries SPA (IE004077) whereby the likelihood of significant adverse impacts cannot be ruled out. They are:

- Cormorant (*Phalacrocorax carbo*) [A017]
- Shelduck (*Tadorna tadorna*) [A048]
- Wigeon (*Anas penelope*) [A050]
- Teal (*Anas crecca*) [A052]
- Pintail (*Anas acuta*) [A054]
- Shoveler (*Anas clypeata*) [A056]
- Black-headed Gull (*Chroicocephalus ridibundus*) [A179]
- Wetlands [A999]

As significant adverse effects are uncertain at this stage, **Appropriate Assessment for these relevant QIs and SCIs is required**.

5. Appropriate Assessment Stage 2 Natura Impact Statement

5.1. Characteristics of Relevant Sites

5.1.1. Lower River Shannon cSAC (IE001265)

This very large site stretches along the Shannon valley from Killaloe in Co. Clare to Loop Head/Kerry Head, a distance of some 120km (NPWS, 2013b). The site thus encompasses the Shannon, Feale, Mulkear and Fergus estuaries, the freshwater lower reaches of the River Shannon (between Killaloe and Limerick), the freshwater stretches of much of the Feale and Mulkear catchments and the marine area between Loop Head and Kerry Head.

This site is of great ecological interest as it contains a high number of habitats and species listed on Annexes I and II of the E.U. Habitats Directive, including the priority habitats lagoon and alluvial woodland, the only known resident population of Bottle-nosed Dolphin in Ireland and all three Irish lamprey species. A good number of Red Data Book species are also present, most notably the thriving populations of Triangular Club-rush. A number of species listed on Annex I of the E.U. Birds Directive are also present, either wintering or breeding. The Shannon and Fergus Estuaries form the largest estuarine complex in Ireland and support more wintering wildfowl and waders than any other site in the country. Most of the estuarine part of the site has been designated a Special Protection Area (SPA), under the E.U. Birds Directive, primarily to protect the large numbers of migratory birds present in winter.

The QIs of relevance to this assessment are estuaries, mudflats and sandflats not covered by seawater at low tide, reefs, sea lamprey), river lamprey, salmon, bottlenose dolphin and otter.

Both the Fergus and inner Shannon Estuaries feature vast expanses of intertidal mudflats, often fringed with saltmarsh vegetation (NPWS, 2013b). The smaller estuaries also feature mudflats, but have their own unique characteristics, e.g. Poulnasherry Bay is stony and unusually rich in species and biotopes. Plant species are typically scarce on the mudflats, although there are some eelgrass (*Zostera* spp.) beds and patches of green algae (e.g. *Ulva* sp. and *Enteromorpha* sp.). The main macro-invertebrate community which has been noted from the inner Shannon and Fergus estuaries is a *Macoma-Scrobicularia-Nereis* community.

The intertidal reefs in the Shannon Estuary are exposed or moderately exposed to wave action and subject to moderate tidal streams (NPWS, 2013b). Known sites are steeply sloping and show a good zonation down the shore. Well developed lichen zones and littoral reef communities offering a high species richness in the sublittoral fringe and strong populations of the Purple Sea Urchin *Paracentrotus lividus* are found. The communities found are tolerant to sand scour and tidal streams. The infralittoral reefs range from sloping platforms with some vertical steps, to ridged bedrock with gullies of sand between the ridges, to ridged bedrock with boulders or a mixture of cobbles, gravel and sand. Kelp is very common to about 18m. Below this it becomes rare and the community is characterised by coralline crusts and red foliose algae.

There is a resident population of bottle-nosed dolphin in the Shannon Estuary (NPWS, 2013b). This is the only known resident population of this E.U. Habitats Directive Annex II species in Ireland. The population is estimated (in 2006) to be 140 ± 12 individuals. Otter, a species also listed on Annex II of this Directive, is commonly found on the site.

Four species of fish listed on Annex II of the E.U. Habitats Directive are found within the site. These are Sea Lamprey (*Petromyzon marinus*), Brook Lamprey (*Lampetra planeri*), River Lamprey (*Lampetra fluviatilis*) and Salmon (*Salmo salar*). The three lampreys and Salmon have all been observed spawning in the lower Shannon or its tributaries. The Fergus is important in its lower reaches for spring salmon, while the Mulkear catchment excels as a grilse fishery, though spring fish are caught on the actual Mulkear River. The Feale is important for both types. There are few other river systems in Ireland which contain all three species of lamprey.

5.1.2. River Shannon and River Fergus Estuaries SPA (IE004077)

The estuaries of the River Shannon and River Fergus form the largest estuarine complex in Ireland (NPWS, 2015). The site comprises the entire estuarine habitat from Limerick City westwards as far as Doonaha in Co. Clare and Dooneen Point in Co. Kerry.

The site is an SPA, of special conservation interest for the following species: Cormorant, Whooper Swan, Light-bellied Brent Goose, Shelduck, Wigeon, Teal, Pintail, Shoveler, Scaup, Ringed Plover, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew, Redshank, Greenshank and Black-headed Gull. It is also of special conservation interest for holding an assemblage of over 20,000 wintering waterbirds.

The site is the most important coastal wetland site in the country and regularly supports in excess of 50,000 wintering waterfowl, a concentration easily of international importance. The site has internationally important populations of Light-bellied Brent Goose, Dunlin, Black-tailed Godwit and Redshank. A further 17 species have populations of national importance, *i.e.* Cormorant, Whooper Swan, Shelduck, Wigeon, Teal, Pintail, Shoveler, Scaup, Ringed Plover, Golden Plover, Grey Plover, Lapwing, Knot, Bar-tailed Godwit, Curlew, Greenshank and Black-headed Gull. The site also supports a nationally important breeding population of Cormorant.

The SCIs of relevance to this assessment are the cormorant, black-headed gull, shelduck, wigeon, teal, pintail and shoveler.

5.2. Conservation Objectives of Relevant Sites

5.2.1. Lower River Shannon cSAC (IE001265)

The conservation objectives of the QIs of relevance can be seen below.

Conservation objectives for: Lower River Shannon SAC [002165]

1095 Sea Lamprey *Petromyzon marinus*

To restore the favourable conservation condition of Sea Lamprey in the Lower River Shannon SAC, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Distribution: extent of anadromy	% of river accessible	Greater than 75% of main stem length of rivers accessible from estuary	Artificial barriers can block or cause difficulties to lampreys' upstream migration, thereby limiting the species to lower stretches and restricting access to spawning areas. See Gargan et al. (2011). Specific barriers serve to constrain the up-river migration of sea lamprey. The upper extent of the SAC in the R. Fergus is delineated by a barrier to migration. Barriers are also present in the Mulkear and Feale
Population structure of juveniles	Number of age/size groups	At least three age/size groups present	Attribute and target based on data from Harvey and Cowx (2003) and O'Connor (2007)
Juvenile density in fine sediment	Juveniles/m^2	Juvenile density at least 1/m^2	Juveniles burrow in areas of fine sediment in still water. Attribute and target based on data from Harvey and Cowx (2003)
Extent and distribution of spawning habitat	m^2 and occurrence	No decline in extent and distribution of spawning beds	Lampreys spawn in clean gravels. Surveys by Inland Fisheries ireland (IFI) commonly indicated accumulations of redds downstream of major weirs. (See also Gargan et al., 2011)
Availability of juvenile habitat	Number of positive sites in 3rd order channels (and greater), downstream of spawning areas	More than 50% of sample sites positive	Despite observed spawning activity, sampling for ammocoetes consistently fails to find these in many samplling stations and never in any great numbers

Conservation objectives for: Lower River Shannon SAC [002165]

1099 River Lamprey *Lampetra fluviatilis*

To maintain the favourable conservation condition of River Lamprey in the Lower River Shannon SAC, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Distribution	% of river accessible	Access to all water courses down to first order streams	Artificial barriers can block or cause difficulties to river lampreys' migration, both up- and downstream, thereby possibly limiting species to specific stretches and creating genetically isolated populations (Espanhol et al., 2007)
Population structure of juveniles	Number of age/size groups	At least three age/size groups of river/brook lamprey present	Attribute and target based on data from Harvey and Cowx (2003). It is impossible to distinguish between river and brook lamprey juveniles in the field (Gardiner 2003), hence they are considered together in this target
Juvenile density in fine sediment	Juveniles/m²	Mean catchment juvenile density of river/brook lamprey at least 2/m²	Juveniles burrow in areas of fine sediment in still water. Attribute and target based on data from Harvey and Cowx (2003) who state 10/m² in optimal conditions and more than 2/m² on a catchment basis
Extent and distribution of spawning habitat	m² and occurrence	No decline in extent and distribution of spawning beds	
Availability of juvenile habitat	Number of positive sites in 2nd order channels (and greater), downstream of spawning areas	More than 50% of sample sites positive	Many sites with suitable larval attributes i.e. fine sediment in low velocity habitat, are found not to contain larval lamprey. This may be a function of chance or probability, or may be a consequence of insufficient recruitment to fill all spatial niches. Occupancy in excess of 50% of sites would be 'reasonable' for the Irish catchments examined to date (King et al., unpublished data)

Conservation objectives for: Lower River Shannon SAC [002165]

1106 Atlantic Salmon *Salmo salar* (only in fresh water)

To restore the favourable conservation condition of Salmon in the Lower River Shannon SAC, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Distribution: extent of anadromy	% of river accessible	100% of river channels down to second order accessible from estuary	Artificial barriers block salmons' upstream migration, thereby limiting the species to lower stretches and restricting access to spawning areas. The large hyrdo-electric station at Ardnacrusha and the Parteen regulating weir present considerable obstructions to upstream passage of salmon on the Shannon main channel. While both have fish passes installed, upstream migration of salmon is still problematical. Further weirs upstream on the Shannon also restrict access to spawning habitat. No such obstacles, causing significant fish passage issues for salmon are present on the Feale and Mulkear rivers
Adult spawning fish	Number	Conservation Limit (CL) for each system consistently exceeded	A conservation limit is defined by the North Atlantic Salmon Conservation Organisation (NASCO) as "the spawning stock level that produces long-term average maximum sustainable yield as derived from the adult to adult stock and recruitment relationship". The target is based on the Standing Scientific Committee of the National Salmon Commission's annual model output of CL attainment levels. See SSC (2010). Stock estimates are either derived from direct counts of adults (rod catch, fish counter) or indirectly by fry abundance counts. The salmon stocks in the Shannon above the impoundments are significantly below their Conservation Limits. Salmon stocks in the Feale and Mulkear rivers are above CL
Salmon fry abundance	Number of fry/5 minutes electrofishing	Maintain or exceed 0+ fry mean catchment-wide abundance threshold value. Currently set at 17 salmon fry/5 min sampling	Target is threshold value for rivers currently exceeding their conservation limit (CL). The abundance of salmon fry at monitored sites on the Shannon main channel, above the hydro-electric station, is significantly below this target
Out-migrating smolt abundance	Number	No significant decline	Smolt abundance can be negatively affected by a number of impacts such as estuarine pollution, predation and sea lice (*Lepeophtheirus salmonis*). On the Shannon main channel, salmon smolt abundance may be significantly affected by mortality passing through hydro-electric turbines
Number and distribution of redds	Number and occurrence	No decline in number and distribution of spawning redds due to anthropogenic causes	Salmon spawn in clean gravels. Artificial barriers are currently preventing salmon from accessing suitable spawning habitat on the Shannon main channel
Water quality	EPA Q value	At least Q4 at all sites sampled by EPA	Q values based on triennial water quality surveys carried out by the Environmental Protection Agency (EPA)

Conservation objectives for: Lower River Shannon SAC [002165]

1130 Estuaries

To maintain the favourable conservation condition of Estuaries in the Lower River Shannon SAC, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Habitat area	Hectares	The permanent habitat area is stable or increasing, subject to natural processes. See map 4	Habitat area was estimated as 24,273ha using OSi data and the Transitional Water Body area as defined under the Water Framework Directive
Community distribution	Hectares	Conserve the following community types in a natural condition: Intertidal sand to mixed sediment with polychaetes, molluscs and crustaceans community complex; Estuarine subtidal muddy sand to mixed sediment with gammarids community complex; Subtidal sand to mixed sediment with *Nucula nucleus* community complex; Subtidal sand to mixed sediment with *Nephtys* spp. community complex; Fucoid-dominated intertidal reef community complex; Faunal turf-dominated subtidal reef community; and Anemone-dominated subtidal reef community. See map 9	The likely area of these communities was derived from intertidal and subtidal surveys undertaken in 2010 (Aquafact, 2011a and c). See marine supporting document for further details

Conservation objectives for: Lower River Shannon SAC [002165]

1140 Mudflats and sandflats not covered by seawater at low tide

To maintain the favourable conservation condition of Mudflats and sandflats not covered by seawater at low tide in the Lower River Shannon SAC, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Habitat area	Hectares	The permanent habitat area is stable or increasing, subject to natural processes. See map 5	Habitat area was estimated using OSi data as 8,808ha
Community distribution	Hectares	Conserve the following community types in a natural condition: Intertidal sand with *Scolelepis squamata* and *Pontocrates* spp. community; and Intertidal sand to mixed sediment with polychaetes, molluscs and crustaceans community complex. See map 9	The likely area of these communities was derived from an intertidal survey in 2010 (Aquafact, 2011c). See marine supporting document for further details

Conservation objectives for: Lower River Shannon SAC [002165]

1170 Reefs

To maintain the favourable conservation condition of Reefs in the Lower River Shannon SAC, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Habitat distribution	Occurrence	The distribution of Reefs is stable, subject to natural processes. See map 8	Distribution is established from intertidal and subtidal reef surveys in 2010 (Aquafact, 2011b and c)
Habitat area	Hectares	The permanent habitat area is stable, subject to natural processes. See map 8	Habitat area was estimated as 21,421ha from the 2010 intertidal and subtidal reef survey (Aquafact 2011b and c)
Community distribution	Hectares	Conserve the following reef community types in a natural condition: Fucoid-dominated intertidal reef community complex; Mixed subtidal reef community complex; Faunal turf-dominated subtidal reef community; Anemone-dominated subtidal reef community; and *Laminaria*-dominated community complex. See map 9	Based on the 2010 intertidal and subtidal reef survey (Aquafact, 2011b and c). See marine supporting document for further details

Conservation objectives for: Lower River Shannon SAC [002165]

1349 Bottlenose Dolphin *Tursiops truncatus*

To maintain the favourable conservation condition of Bottlenose Dolphin in the Lower River Shannon SAC, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Access to suitable habitat	Number of artificial barriers	Species range within the site should not be restricted by artificial barriers to site use. See map 16 for suitable habitat	See marine supporting document for further details
Habitat use: critical areas	Location and hectares	Critical areas, representing habitat used preferentially by bottlenose dolphin, should be maintained in a natural condition. See map 16	Attribute and target based on Ingram and Rogan (2002), Englund et al. (2007), Englund et al. (2008), Berrow (2009), Berrow et al. (2010) and review of data from other studies. See marine supporting document for further details
Disturbance	Level of impact	Human activities should occur at levels that do not adversely affect the bottlenose dolphin population at the site	See marine supporting document for further details

Conservation objectives for: Lower River Shannon SAC [002165]

1355 Otter *Lutra lutra*

To restore the favourable conservation condition of Otter in the Lower River Shannon SAC, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Distribution	Percentage positive survey sites	No significant decline	Measure based on standard otter survey technique. FCS target, based on 1980/81 survey findings, is 88% in SACs. Current range in Shannon catchment estimated at 70.5% (Bailey and Rochford 2006)
Extent of terrestrial habitat	Hectares	No significant decline. Area mapped and calculated as 596.8ha above high water mark (HWM); 958.9ha along river banks/ around ponds	No field survey. Areas mapped to include 10m terrestrial buffer along shoreline (above HWM and along river banks) identified as critical for otters (NPWS, 2007)
Extent of marine habitat	Hectares	No significant decline. Area mapped and calculated as 4,461.6ha	No field survey. Area mapped based on evidence that otters tend to forage within 80m of the shoreline (HWM) (NPWS, 2007; Kruuk, 2006)
Extent of freshwater (river) habitat	Kilometers	No significant decline. Length mapped and calculated as 500.1km	No field survey. River length calculated on the basis that otters will utilise freshwater habitats from estuary to headwaters (Chapman and Chapman, 1982)
Extent of freshwater (lake/lagoon) habitat	Hectares	No significant decline. Area mapped and calculated as 125.6ha	No field survey. Area mapped based on evidence that otters tend to forage within 80m of the shoreline (NPWS, 2007)
Couching sites and holts	Number	No significant decline	Otters need lying up areas throughout their territory where they are secure from disturbance (Kruuk, 2006; Kruuk and Moorhouse, 1991)
Fish biomass available	Kilograms	No significant decline	Broad diet that varies locally and seasonally, but dominated by fish, in particular salmonids, eels and sticklebacks in freshwater (Bailey and Rochford, 2006) and wrasse and rockling in coastal waters (Kingston et al., 1999)
Barriers to connectivity	Number	No significant increase. For guidance, see map 17	Otters will regularly commute across stretches of open water up to 500m. e.g. between the mainland and an island; between two islands; across an estuary (De Jongh and O'Neill, 2010). It is important that such commuting routes are not obstructed

5.2.2. River Shannon and River Fergus Estuaries SPA (IE004077)

The conservation objectives of the SCIs of relevance can be seen below.

Conservation objectives for: River Shannon and River Fergus Estuaries SPA [004077]

A017 Cormorant *Phalacrocorax carbo*

To maintain the favourable conservation condition of Cormorant in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Breeding population abundance: apparently occupied nests (AONs)	Number	No significant decline	This attribute applies to breeding cormorant. Measure based on standard survey methods (see Walsh et al., 1995). Mitchell et al. (2004) provides summary population information. The Seabird Monitoring Programme (SMP) online database (JNCC, 2012) provides population data for this species
Productivity rate	Mean number	No significant decline	This attribute applies to breeding cormorant. Measure based on standard survey methods (see Walsh et al., 1995). The Seabird Monitoring Programme (SMP) online database (JNCC, 2012) provides population data for this species
Distribution: breeding colonies	Number; location; area (hectares)	No significant decline	This attribute applies to breeding cormorant. Cormorant colonies are usually sited on flat or rocky islets or sea stack tops, less often on cliffs but they can also nest in trees (Walsh et al., 1995)
Prey biomass available	Kilogrammes	No significant decline	This attribute applies to breeding cormorant. Key prey items: fish (mostly benthic), some crustaceans. Key habitats: populations use sandy areas, rocky and vegetated substrate. Foraging range: max. 50km, mean max. 31.67km, mean 8.46km (BirdLife International Seabird Database (Birdlife International, 2012))
Barriers to connectivity	Number; location; shape; area (hectares)	No significant increase	This attribute applies to breeding cormorant. Seabird species can make extensive use of the marine waters adjacent to their breeding colonies. Foraging range: max. 50km, mean max. 31.67km, mean 8.46km (BirdLife International Seabird Database (Birdlife International, 2012))
Disturbance at the breeding site	Level of impact	Human activities should occur at levels that do not adversely affect the breeding cormorant population	This attribute applies to breeding cormorant. Cormorant colonies are usually sited on flat or rocky islets or sea stack tops, less often on cliffs but they can also nest in trees (Walsh et al., 1995)
Population trend	Percentage change	Long term population trend stable or increasing	This attribute applies to non-breeding cormorant. Waterbird population trends are presented in part four of the conservation objectives supporting document
Distribution	Range, timing and intensity of use of areas	There should be no significant decrease in the range, timing or intensity of use of areas by cormorant other than that occurring from natural patterns of variation	This attribute applies to non-breeding cormorant. As determined by regular low tide and other waterbird surveys. Waterbird distribution from the 2010/2011 waterbird survey programme is discussed in part five of the conservation objectives supporting document

Conservation objectives for: River Shannon and River Fergus Estuaries SPA [004077]

A048 Shelduck *Tadorna tadorna*

To maintain the favourable conservation condition of Shelduck in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Population trend	Percentage change	Long term population trend stable or increasing	Waterbird population trends are presented in part four of the conservation objectives supporting document
Distribution	Range, timing and intensity of use of areas	There should be no significant decrease in the range, timing or intensity of use of areas by shelduck other than that occurring from natural patterns of variation	As determined by regular low tide and other waterbird surveys. Waterbird distribution from the 2010/2011 waterbird survey programme is discussed in part five of the conservation objectives supporting document

Conservation objectives for: River Shannon and River Fergus Estuaries SPA [004077]

A050 Wigeon *Anas penelope*

To maintain the favourable conservation condition of Wigeon in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Population trend	Percentage change	Long term population trend stable or increasing	Waterbird population trends are presented in part four of the conservation objectives supporting document
Distribution	Range, timing and intensity of use of areas	There should be no significant decrease in the range, timing or intensity of use of areas by wigeon other than that occurring from natural patterns of variation	As determined by regular low tide and other waterbird surveys. Waterbird distribution from the 2010/2011 waterbird survey programme is discussed in part five of the conservation objectives supporting document

Conservation objectives for: River Shannon and River Fergus Estuaries SPA [004077]

A052 Teal *Anas crecca*

To maintain the favourable conservation condition of Teal in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Population trend	Percentage change	Long term population trend stable or increasing	Waterbird population trends are presented in part four of the conservation objectives supporting document
Distribution	Range, timing and intensity of use of areas	There should be no significant decrease in the range, timing or intensity of use of areas by teal other than that occurring from natural patterns of variation	As determined by regular low tide and other waterbird surveys. Waterbird distribution from the 2010/2011 waterbird survey programme is discussed in part five of the conservation objectives supporting document

Conservation objectives for: River Shannon and River Fergus Estuaries SPA [004077]

A054 Pintail *Anas acuta*

To maintain the favourable conservation condition of Pintail in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Population trend	Percentage change	Long term population trend stable or increasing	Waterbird population trends are presented in part four of the conservation objectives supporting document
Distribution	Range, timing and intensity of use of areas	There should be no significant decrease in the range, timing or intensity of use of areas by pintail other than that occurring from natural patterns of variation	As determined by regular low tide and other waterbird surveys. Waterbird distribution from the 2010/2011 waterbird survey programme is discussed in part five of the conservation objectives supporting document

Conservation objectives for: River Shannon and River Fergus Estuaries SPA [004077]

A056 Shoveler *Anas clypeata*

To maintain the favourable conservation condition of Shoveler in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Population trend	Percentage change	Long term population trend stable or increasing	Waterbird population trends are presented in part four of the conservation objectives supporting document
Distribution	Range, timing and intensity of use of areas	There should be no significant decrease in the range, timing or intensity of use of areas by shoveler other than that occurring from natural patterns of variation	As determined by regular low tide and other waterbird surveys. Waterbird distribution from the 2010/2011 waterbird survey programme is discussed in part five of the conservation objectives supporting document

Conservation objectives for: River Shannon and River Fergus Estuaries SPA [004077]

A179 Black-headed Gull *Chroicocephalus ridibundus*

To maintain the favourable conservation condition of Black-headed Gull in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets:

Attribute	Measure	Target	Notes
Population trend	Percentage change	Long term population trend stable or increasing	Waterbird population trends are presented in part four of the conservation objectives supporting document
Distribution	Range, timing and intensity of use of areas	There should be no significant decrease in the range, timing or intensity of use of areas by black-headed gull other than that occurring from natural patterns of variation	As determined by regular low tide and other waterbird surveys. Waterbird distribution from the 2010/2011 waterbird survey programme is discussed in part five of the conservation objectives supporting document

Conservation objectives for: River Shannon and River Fergus Estuaries SPA [004077]			
A999 Wetlands			
To maintain the favourable conservation condition of the wetland habitat in the River Shannon and River Fergus Estuaries SPA as a resource for the regularly-occurring migratory waterbirds that utilise it. This is defined by the following attribute and target:			
Attribute	**Measure**	**Target**	**Notes**
Wetland habitat area	hectares	The permanent area occupied by the wetland habitat should be stable and not significantly less than the area of 32,261ha, other than that occurring from natural patterns of variation	The wetland habitat area was estimated as 32,261ha using OSi data and relevant orthophotographs. For further information see part three of the conservation objectives supporting document

5.3. Impact Assessment

5.3.1. Impact Assessment Methodology

Impact analysis involves the establishment of the impact classification criteria followed by impact analysis based on these criteria. Impact analysis tables evaluate and rank the impacts compared to each other. They form the basis for rating the likelihood (see Table 5.1) of an impact occurring and the consequence of the impact (see Table 5.2). The likelihood and consequence ratings are combined to form a score for impact evaluation. Table 5.3 shows the Impact Matrix based on likelihood and consequence and the impact scores vary between from Low, Medium and High

Table 5.1: Impact Classification Table - Likelihood

Rating	**Likelihood**	
	Category	**Description**
1	Remote	1% likelihood of impact occurring
2	Unlikely	1-20% likelihood of impact occurring
3	Possible	20-50% likelihood of impact occurring
4	Probable	50-95% likelihood of impact occurring
5	Highly Likely	>95% likelihood of impact occurring

Table 5.2: Impact Classification Table – Consequence

Rating	Consequence	
	Category	**Description**
0	None	No change due to impact occurring
1	Negligible	Individuals in the population/characterising species in a habitat affected but effect not detectable against background natural variability
2	Minor	Direct or indirect mortality or sub-lethal effects caused to individuals by the activity/up to 15% of habitat disturbed seasonally but population remains self-sustaining. Seasonal change in characterising species and community structure and function
3	Moderate	*In situ* population depleted by the activity but regularly sub-vented by immigration/over 15% of habitat disturbed seasonally. Seasonal change in characterising species and structure and function. Frequency of disturbance < recovery time. Non-cumulative
4	Major	Population depleted by impact and immigration insufficient to maintain local populations/over 15% of habitat disturbed persistently leading to cumulative impacts. Persistent change in characterising species, structure and function. Frequency of disturbance> recovery time. Cumulative
5	Severe	Population depleted and supporting habitat significantly depleted and unable to support the population. Biodiversity reduction associated with impact on key structural species. Impact is effectively permanent due to severe habitat alteration. No recovery or effectively no recovery.

Table 5.3: Risk matrix

Likelihood	**Highly Likely**	**5**						
	Probable	**4**						
	Possible	**3**						
	Unlikely	**2**						
	Remote	**1**						
			0	**1**	**2**	**3**	**4**	**5**
			None	**Negligible**	**Minor**	**Moderate**	**Major**	**Severe**
				Consequence				

5.3.2. Annex I Habitats

5.3.2.1. Estuaries

The sediment type in the area consists of boulders and cobbles in the main channel, where current speeds are strong (at least 1 m/s) and the seabed is scoured. There are some intervening patches of sandy mud and gravel in amongst the rocky material. The topography of the area gives rise to pockets either side of the channel where fine material accumulates when the current speeds drop off.

The placement of 2 concrete block anchors on the seabed in areas dominated by rocky cobbly ground will result in a minor physical disturbance to the seabed. Some boulders/cobbles may become dislodged from their resting positions and may be relocated locally. It is probable that the epifaunal species on the disturbed faces of the rock will be abraded. Any epifaunal communities directly under the anchor will be damaged or lost, however the concrete anchors themselves once in position will provide additional substrata for colonisation by epifaunal species from the surrounding area. The dimensions of the anchors are estimated at 5m x 5m, giving an area lost to each anchor of 25m^2 (0.0025ha).

The mooring chains attached to the anchors will also be attached to a mooring system which will lie across the seabed for a short period (days to weeks) until the device is installed. During this time, any movement of the chains have the potential to disturb or abrade the seabed. It is estimated that up to 5m either side of the chains could be affected. This covers an area of *c.* 2775m^2 (0.28ha).

In total it is estimated that 2850m^2 (0.29ha) of the estuarine habitat will be temporarily disturbed. This represents 0.00119% of the estuarine habitat in the SAC (24,273ha).

While the loss of habitat and species cannot be mitigated, the actual area temporarily lost is so small that the impact on the benthic community will be **negligible**. In addition, following the removal of the anchors the impacted areas will immediately begin to recover through recruitment from neighbouring undisturbed areas.

If the anchors are lowered on to a sedimentary area, the seabed sediments will be disturbed and remobilised in the immediate footprint of the anchors. This will result in a short-term (minutes), localised increase in suspended sediment levels and turbidity. Any movement of mooring chains over the sedimentary seabed would also remobilise sediments. Small localised sediment plumes are generated frequently in the marine environment by a variety of activities e.g. remote sampling, fish emerging from and burial in the seabed, dolphin and porpoise foraging and feeding, storm events etc. It is not possible to quantify the volumes of sediment that would be mobilised during the placement of the anchors on the seabed, however as the Shannon Estuary is a highly turbid environment any minor increases in suspended sediments due to will be **negligible** against background levels.

Murphy *et al.* (2012) note that as tidal devices are placed in high energy environments, it is likely that the relatively small amounts of sediment that are likely to be released into the water column during turbine and cable installation will be rapidly dispersed and accordingly have a negligible impact on background suspended sediment and turbidity levels.

The subsequent settlement of the remobilised sediment will also have no impact on the habitats and communities in the immediate vicinity of the object as volumes will be so low.

The device will occupy a surface area of 108.68m^2 (0.011ha) on the sea surface, the total under water area is 33.2m^2 (0.003ha) and the device will occupy a volume of 486.89m^3 (0.049ha) of the water column. The estuarine habitat covers an area of 24,273ha (242.73km^2). The device will occupy 0.00004% of the surface area of the estuary. The volume of the estuarine water in not known but taking a very conservative average depth of 10m, the volume would equate to 2427.3km^2, the device would occupy 0.0002% of the estuarine water body. This level of temporary loss of habitat is **negligible.**

Habitat Loss/Disturbance: Likelihood = Highly Likely; Consequence = Negligible; Impact = Low

With regards to the risk posed by the accidental release of pollutants from the installation/maintenance vessels or the device itself. All vessels employed to carry out any work onsite will have all required certification to ensure sea worthiness. In addition they will employ best practice measures to minimise any possible impacts on the marine environment and in case of an accidental event the ship's Oil Pollution Plan will be implemented and on board oil pollution control measures will be implemented to minimise any impacts on the environment. The quantities of oil/fuel involved in accidental spillages are likely to be very small and the impact on water quality would be minor. The likelihood of a spillage would be **unlikely**.

There is the potential for contamination from the use of anti-fouling compounds and the erosion of sacrificial anodes. As the quantities and toxicities associated with these are generally expected to be extremely small and therefore the potential effect will be of negligible significance (AECOM, 2010). There are no sensitive habitats in the vicinity of where these compounds may be used and as a result any impacts will be **negligible**.

As the test site is located outside of the industrial dock area, outside any of the main shipping routes, there is no historical munitions or spoil disposals at the site, the rivers that discharge into the area are not from industrialised areas and there is a rich diversity of benthic fauna at the site, it is extremely unlikely that the sediments in the test site are contaminated. As a result, the remobilisation of contaminated sediments during the installation phase is **extremely unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the Lower River Shannon SAC:

Objective: *To maintain the favourable conservation condition of Estuaries in the Lower River Shannon SAC, which is defined by the following list of attributes and targets.*

Target 1: The permanent habitat area is stable or increasing, subject to natural processes.

No activities will permanently remove habitat from the site and therefore habitat area will not be reduced.

Target 2: Conserve the following community types in a natural condition: 'Intertidal sand to mixed sediment with polychaetes, molluscs and crustaceans community complex' (8130ha); 'Estuarine subtidal muddy sand to mixed sediment with gammarids community complex' (2638ha); 'Subtidal sand to mixed sediment with *Nucula nucleus* community complex' (4196ha) and 'Subtidal sand to mixed sediment with *Nephtys* spp. community complex' (8404ha), 'Fucoid-dominated intertidal reef community complex' (678ha); 'Faunal turf-dominated subtidal reef community' (981ha); and 'Anemone-dominated subtidal reef community' (713ha).

The survey work carried out for this study indicated that the habitat type in the area of the proposal is 'Faunal turf-dominated subtidal reef community' (981ha) and not 'Subtidal sand to mixed sediment with *Nucula nucleus* community complex' (4196ha) as documented in NPWS (2013a, b). The proposed activities will cause an ongoing disturbance (for a maximum period of 12 months) to 0.28ha. This represents 0.029%[5] of the 'Faunal turf-dominated subtidal reef community' or 0.007% of the 'Subtidal sand to mixed sediment with *Nucula nucleus* community complex'. **This level of disturbance does not exceed the 15% threshold.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for estuaries.

5.3.2.2. Mudflats and sandflats not covered by seawater at low tide [1140]

The proposed test site does not overlap with the mud and sandflat habitat. The device will be located *c.* 80m from this habitat type and as a result there will be no direct impacts on this habitat type. The indirect impacts from the proposal would be limited to increases in suspended sediments/turbidity levels if the anchors/chains interact with sedimentary habitats. This would result in a short-term (minutes), localised increase in suspended sediment levels and turbidity. Small localised sediment plumes are generated frequently in the marine environment by a variety of activities e.g. remote sampling, fish emerging from and burial in the seabed, dolphin and porpoise foraging and feeding, storm events etc. It is not possible to quantify the volumes of sediment that would be mobilised during the placement of the anchors on the seabed, however, as the Shannon Estuary is a highly turbid environment any minor increases in suspended

[5] The percentage would actually be lower than this as the area identified by this report as 'Faunal turf-dominated subtidal reef community' is not included in the total habitat area of 981ha for this community type.

sediments due to will be **negligible** against background levels. The subsequent settlement of the remobilised sediment will also have no impact on the habitats and communities in the immediate vicinity of the object as volumes will be so low.

If the device is temporarily relocated to a sheltered area off Canon Island during periods of extreme weather events, the device will be moored on mud sand sandflat habitat. The dimensions of the anchors are estimated at 5m x 5m, giving an area lost to each anchor of 25m^2 (0.0025ha). While this temporary loss of habitat and species cannot be mitigated, the actual area temporarily lost is so small that the impact on the benthic community will be **negligible**. In addition, following the removal of the anchors the impacted areas will immediately begin to recover through recruitment from neighbouring undisturbed areas. As described above, any localised temporary increases in suspended sediment and turbidity levels will be **negligible** against background levels.

Habitat Loss/Disturbance: Likelihood = Highly Likely; Consequence = Negligible; Impact = Low

As described in Section 5.3.2.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the Lower River Shannon SAC:

Objective: *To maintain the favourable conservation condition of Mudflats and sandflats not covered by seawater at low tide in the Lower River Shannon SAC, which is defined by the following list of attributes and targets.*

Target 1: The permanent habitat area is stable or increasing, subject to natural processes.

No activities will permanently remove habitat from the site and therefore habitat area will not be reduced.

Target 2: Conserve the following community types in a natural condition: 'Intertidal sand with *Scolelepis squamata* and *Pontocrates* spp. community' (213ha) and 'Intertidal sand to mixed sediment with polychaetes, molluscs and crustaceans community complex' (8596ha).

No activities, once of, continuous or ongoing, will disturb the community types in this habitat. **The 15% disturbance threshold will not be exceeded.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for mudflats and sandflats not covered by seawater at low tide.

5.3.2.3. Reefs [1170]

The proposed test site does not overlap with the reef habitat. The device will be located *c.* 120m from this habitat type and as a result there will be no direct impacts on this habitat type. The indirect impacts from the

proposal would be limited to increases in suspended sediments/turbidity levels if the anchors/chains interact with sedimentary habitats. This would result in a short-term (minutes), localised increase in suspended sediment levels and turbidity. Small localised sediment plumes are generated frequently in the marine environment by a variety of activities e.g. remote sampling, fish emerging from and burial in the seabed, dolphin and porpoise foraging and feeding, storm events etc. It is not possible to quantify the volumes of sediment that would be mobilised during the placement of the anchors on the seabed, however as the Shannon Estuary is a highly turbid environment any minor increases in suspended sediments due to will be **negligible** against background levels. The subsequent settlement of the remobilised sediment will also have no impact on the habitats and communities in the immediate vicinity of the object as volumes will be so low.

Habitat Loss/Disturbance: Likelihood = Highly Likely; Consequence = Negligible; Impact = Low

As described in Section 5.3.2.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **extremely unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the Lower River Shannon SAC:

Objective: *To maintain the favourable conservation condition of Reefs in the Lower River Shannon SAC, which is defined by the following list of attributes and targets.*

Target 1: The distribution of reefs is stable, subject to natural processes.

No activities will permanently remove habitat from the site and therefore habitat range will not be reduced.

Target 2: The permanent habitat area is stable or increasing, subject to natural processes.

No activities will permanently remove habitat from the site and therefore habitat area will not be reduced.

Target 3: Conserve the following community types in a natural condition: 'Fucoid-dominated intertidal reef community complex (1294ha)'; 'Mixed subtidal reef community complex (7464ha)'; 'Faunal turf-dominated subtidal reef community (9692ha)'; 'Anemone-dominated subtidal reef community (747ha)' and 'Laminaria-dominated community complex (2224ha)'

No activities, once of, continuous or ongoing, will disturb the community types in this habitat. **The 15% disturbance threshold will not be exceeded.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for reefs.

5.3.3. Annex I Species

5.3.3.1. *Petromyzon marinus* (Sea Lamprey) [1095]

The Sea lamprey *Petromyzon marinus* (1095) may pass through the test site area when migrating to and from freshwater systems. They migrate through the estuary from the sea in April and May (Hardisty, 1969) and spawn in rivers in late May or June and then return to sea.

As stated above for the Annex I habitats, any increases in suspended sediment levels during installation will be immeasurably low and short-lived and will therefore have a **negligible** effect on migrating lamprey (if any are present in the area in September).

Habitat Loss/Disturbance: Likelihood = Highly Likely; Consequence = Negligible; Impact = Low

Studies carried out to date (although limited) provide no evidence that direct interactions of fish with tidal blades was causing harm to the animals (Copping *et al.,* 2013). Monitoring at the Verdent RITE project showed that resident and migratory fish avoided the turbine area (6 x 3 bladed full scale tidal turbines in 10m of water mounted on the seabed) preferring inshore slower moving water which indicated that behaviour appeared to be primarily influenced by natural tidal currents and secondarily by the presence of operating turbines (Copping *et al.,* 2013). Blade strike as a potential damage/injury mechanism is still under study at RITE, but no evidence through 9,000 operating hours has been observed (Smith & Adonizio, 2011). Likewise, interaction experiments around the HGE turbine indicated that sizeable fish passing through the turbine were not harmed (Normandeau Associates Inc., 2009). Video footage of fish interacting with the face of the OpenHydro turbine at the EMEC provided no indication that there would be deleterious effects on the fish because they were seen to move away from the turbine when the cut-in speed of the tidal current was reached (Copping *et al.,* 2013). A study at the ORPC's commercial scale demonstration TGU unit in Cobscook Bay showed that fish regularly approached the turbine with a higher number interacting with the turbine when it was still rather than when it was rotating and that during these interactions the predominant behaviour was fish entering the turbine (Copping *et al.,* 2013). No incidences of dead or dying fish were recorded following passage through the turbine. Large fish (older herring, mackerel) appeared to have a greater ability to avoid the turbine than small and medium sized fish (sticklebacks and juvenile herring) (Copping *et al.,* 2013). Schooling fish also seemed better able to detect and avoid the turbine than individuals. Greater numbers were observed in the wake of the turbine than entering the turbine suggesting that they may have a preference of lower energy regions of the water column. Visibility was also seen as a factor in determining behaviour as at night reaction distances were shorter with more fish entering the turbine than during the day.

The evidence to date indicates that fish would appear to be most at risk from tidal turbine blades because many species may preferentially stay in the vicinity of turbines (Copping *et al.,* 2013). However, the

OpenHydro data support the theory that the bioenergetics of swimming for prolonged periods in strong tidal flows are not advantageous to most marine animals, even though fish and other marine animals are known to use tidal currents as a means of moving through an area (Polagye *et al*. 2011; Forward *et al*. 1999; Arnold *et al*. 1994; McCleave & Kleckner 1982).

The device will occupy an area of 33.2m^2 of the water column. The channel in which the device is located has an area of 4000m^2 (200m wide x 20m deep) which is 0.83% of the navigable channel.

The turbine blades will have a slow rotational speed (in the region of 20 RPM) and is designed in such a way that the turbines will rotate in the direction opposite the flow and thereby naturally deflect objects away from the device. The risk of collision due to the presence of 1 small scale device with slow rotational speeds is considered **unlikely**.

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

The Shannon Estuary is one of Europe's premier deep water berths catering to shops up to 200,000 deadweight tonnage (O'Brien *et al.,* 2016). It has six main terminals and handles up to 1,000 ships carrying 12 million tons of cargo per annum. Additionally, a car and passenger ferry operates year-round between Killimor, Co. Clare and Tarbert, Co. Kerry and the estuary has two licensed dolphin-watching vessel operating between April and October. Fishing activity, most notably potting also occurs in the estuary. There are also an additional number of pleasure crafts year round. As a result, this is an area exposed to high levels of anthropogenic noise from a range of vessel activity. Noise monitoring results from the Shannon Estuary show that the estuary is a noisy place (O'Brien *et al.,* 2016). All results were broadband (5Hz to 20kHz) rms (root mean square) values. The mean noise level for the Shannon Estuary was calculated at 100 ± 7.5dB.

In addition to the noise levels in the Shannon from shipping, tidal streams targeted for exploitation by renewable energy converters are by their nature highly energetic environments often with high ambient sound levels (Marmo, 2017).

Lampreys are considered to be the most "primitive" of extant vertebrates and may represent the most primitive conditions in many aspects of their biology (Popper, 2005). While there have been some physiological studies of the vestibular response of the lamprey ear (Lowenstein & Osborne, 1964; Lowenstein *et al.*, 1968; Lowenstein, 1970), there have been no studies to determine the responses of the ear to sound or whether lampreys respond to sound behaviourally. While it might be argued that lamprey, as other vertebrates, may use the "auditory scene" to learn about their environment, their behavioural repertoire is generally rather limited, and so it may be possible that sound is not relevant to them at all.

Although Popper (2005) report that there is no data on hearing in lamprey, their ear is relatively simple and there is nothing within the structure of the ear or associated structures to suggest any specialisations that

would make them into anything but a hearing generalist, with maximum hearing to no more than several hundred Hz. Figure 5.1 shows an audiogram for a variety of fish species (Popper, 2005).

Of the species shown here, best hearing is the goldfish, followed by silver perch. The poorest hearing is in the plaice, a flatfish, a species that does not have a swim bladder. Both silver perch and goldfish are considered to be hearing "specialists" since they have adaptations that enhance the acoustic coupling between the swim bladder and inner ear. The other species do not have such enhancements and are considered to be hearing "generalists" or "non-specialists." (Data from Fay, 1988; Ramcharitar & Popper 2004; Ramcharitar *et al.,* 2004). As lamprey are also considered hearing generalists, the audiograms for these other species have been used to represent the lamprey.

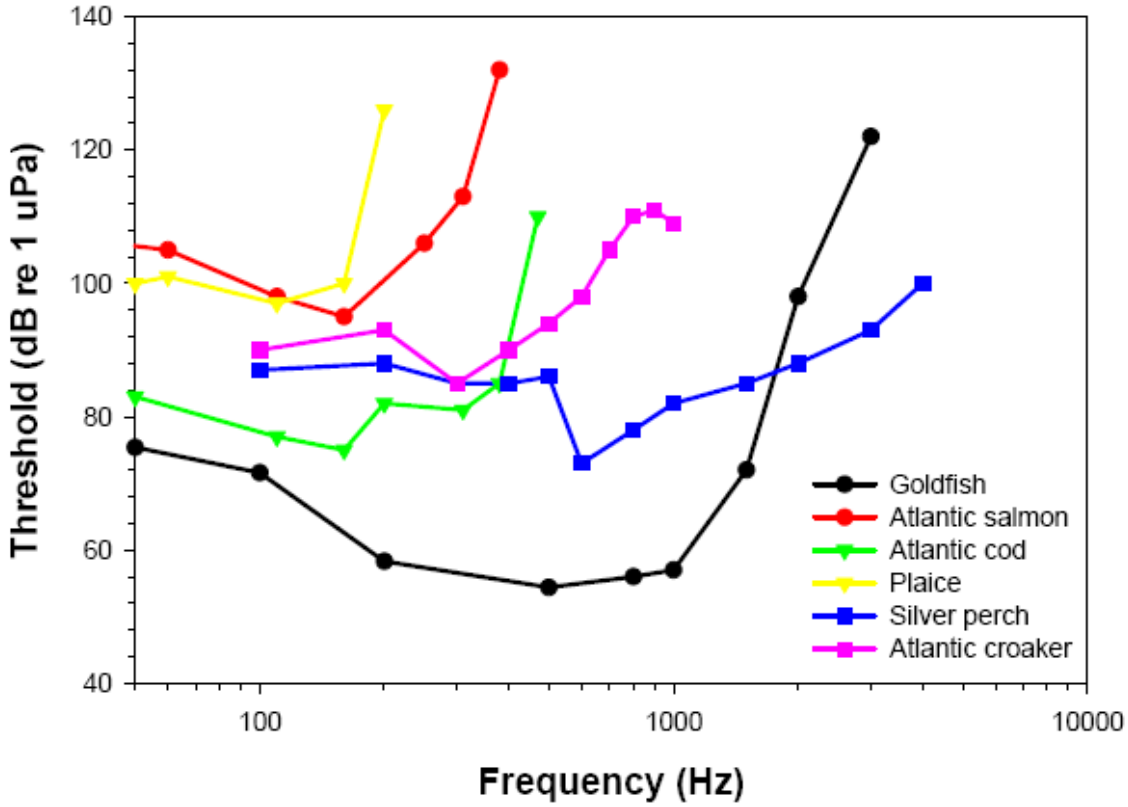

Figure 5.1: Fish species audiogram (Popper, 2005).

While no data are available on underwater noise levels from the DRP 60 device, airborne noise levels at 1m distance from the fully exposed motors (which are above the water line) of the 25kW device range from 33dB to 63dB with a frequencies ranging from 0.1 to 6.4 kHz (see Figure 5.2). In reality, these are worst-case noise levels as the motors on the DRP 60 will be fully sealed and housed. As there is no mechanical or electrical sound sources located below the waterline, the underwater noise level will be significantly lower than the airborne levels, which are significantly lower than mean background noise levels in the Shannon. The noise levels generated by the DRP 60 device in the <500Hz range are below the possible audible levels of lamprey.

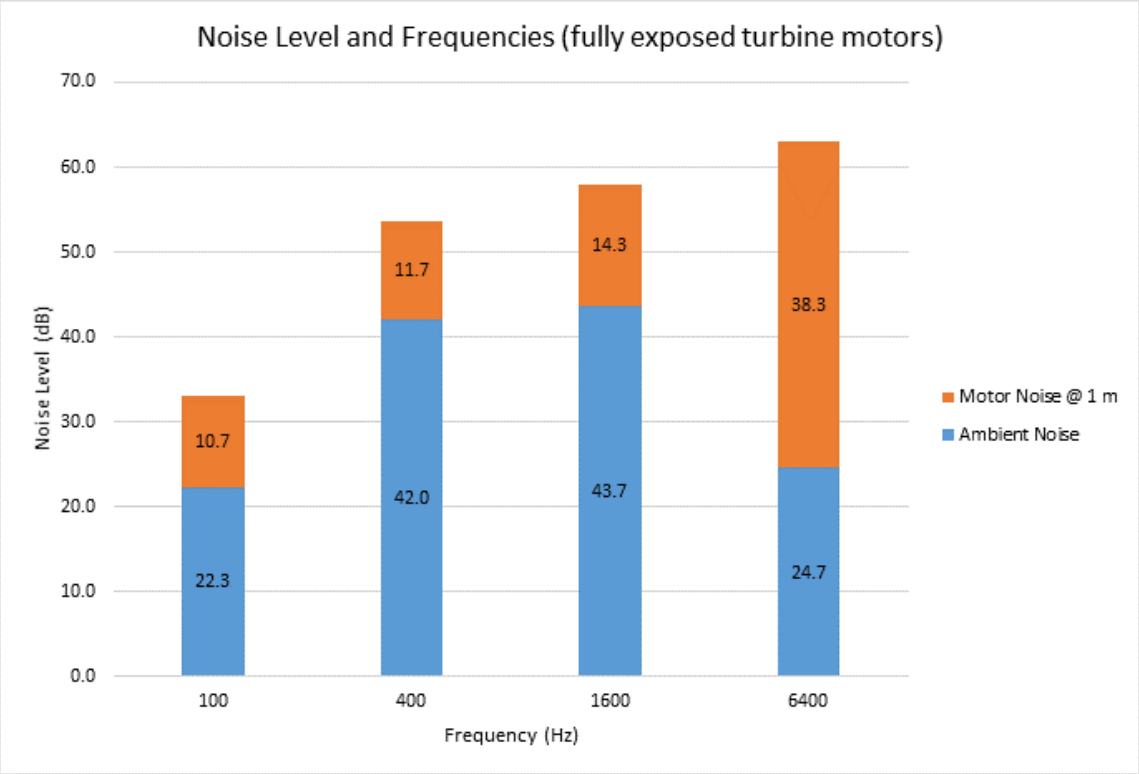

Figure 5.2: Airborne noise levels from 25kW DRP device (fully exposed motors)

The noise levels from the installation and maintenance vessels will be similar to those generated by the existing volumes of shipping traffic in the estuary. The noise from two additional vessels will not significantly impact on lamprey in the estuary.

Noise: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.1.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the Lower River Shannon SAC:

Objective: *To restore the favourable conservation condition of sea lamprey in the Lower River Shannon SAC, which is defined by the following list of attributes and targets.*

Target 1: Distribution - Greater than 75% of main stem length of rivers accessible from estuary

The device will not be located in a river channel. Adults migrating back to freshwater systems to spawn will not be impeded by the temporary presence of 1 small-scale device**. This project will not pose an obstacle to sea lamprey and will have no impact on river accessibility.**

Target 2: The population structure of juveniles should consists of at least three age/size groups

The temporary presence of 1 small-scale device will not impact individuals. **This project will not impact on the population structure of juveniles.**

Target 3: Juvenile density of at least 1/m² in fine sediment.

Juveniles are restricted to freshwater systems. **This project will not impact on juvenile density.**

Target 4: No decline in extent and distribution of spawning beds

Sea lamprey do not spawn in the area of the proposed test site. **This project will not impact on the extent and distribution of spawning beds.**

Target 5: Availability of juvenile habitat - more than 50% of sample sites positive

Juveniles are restricted to freshwater systems. **This project will not impact on juvenile habitat.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for sea lamprey.

5.3.3.2. *Lampetra fluviatilis* (River Lamprey) [1099]

The river lamprey *Petromyzon marinus* may pass through the test site area when migrating to and from freshwater systems. They migrates to freshwater to spawn from October to December (Maitland, 2003). And between July and September young adults at 3-5 years of age migrate to the estuary.

As stated above for the Annex I habitats, any increases in suspended sediment levels during installation will be immeasurably low and short-lived and will therefore have a **negligible** effect on migrating lamprey (if any are present in the area in September).

Habitat Loss/Disturbance: Likelihood = Highly Likely; Consequence = Negligible; Impact = Low

As stated above in Section 5.3.3.1 Sea lamprey, the risk of collision due to the presence of 1 small scale device with slow rotational speeds is considered **unlikely**.

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.3.1 Sea Lamprey, the impact from noise is **negligible**.

Noise: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.2.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the Lower River Shannon SAC:

Objective: *To maintain the favourable conservation condition of river lamprey in the Lower River Shannon SAC, which is defined by the following list of attributes and targets.*

Target 1: Distribution – access to all water courses down to first order streams

The temporary presence of 1 small-scale device will not impact prevent access to water courses. **This project will not pose an obstacle to river lamprey and will have no impact on river accessibility.**

Target 2: The population structure of juveniles should consists of at least three age/size groups

The temporary presence of 1 small-scale device will not impact individuals. **This project will not impact on the population structure of juveniles.**

Target 3: Mean catchment juvenile density of at least 2/m² in fine sediment.

Juveniles burrow in areas of fine sediment and still water. The test site is not suitable. **This project will not impact on juvenile density.**

Target 4: No decline in extent and distribution of spawning beds

River lamprey do not spawn in the area of the proposed test site. **This project will not impact on the extent and distribution of spawning beds.**

Target 5: Availability of juvenile habitat - more than 50% of sample sites positive

The test site is not suitable for juveniles. **This project will not impact on juvenile habitat.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for river lamprey.

5.3.3.3. *Salmo salar* (Salmon) [1106]

Atlantic salmon may pass through the test site area when migrating to and from the River Fergus. Smolts typically head out to sea between March and June and adults return to the river between March and August.

As stated above for the Annex I habitats, any increases in suspended sediment levels during installation will be immeasurably low and short-lived and will therefore have a **negligible** effect on migrating salmon (if any are present in the area in September).

Habitat Loss/Disturbance: Likelihood = Highly Likely; Consequence = Negligible; Impact = Low

As stated above in Section 5.3.3.1 Sea lamprey, the risk of collision due to the presence of 1 small scale device with slow rotational speeds is considered **unlikely**.

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.2.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

Atlantic salmon are functionally deaf above 380 Hz (Hawkins & Johnstone, 1978). This is evidenced in the audiogram shown in Figure 5.1. Given the noise levels and frequency generated by the test device, salmon will not hear it.

The noise levels from the installation and maintenance vessels will be similar to those generated by the existing volumes of shipping traffic in the estuary. The noise from two additional vessels will not significantly impact on salmon in the estuary.

Noise: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the Lower River Shannon SAC:

Objective: *To restore the favourable conservation condition of salmon in the Lower River Shannon SAC, which is defined by the following list of attributes and targets.*

Target 1: Distribution - 100% of river channels down to second order accessible from estuary

The device will not be located in a river channel. Adults migrating back to freshwater systems to spawn will not be impeded by the temporary presence of 1 small-scale device**. This project will not pose an obstacle to salmon and will have no impact on river channel accessibility.**

Target 2: Conservation Limit (CL) of adult spawning fish for each system consistently exceeded

Adults migrating back to freshwater systems to spawn will not be impeded by the temporary presence of 1 small-scale device. **This project will not impact on conservation limits of adult spawning fish.**

Target 3: Maintain or exceed 0+ fry mean catchment-wide abundance threshold value. Currently set at 17 salmon fry/5 min sampling.

Salmon fry are confined to freshwater systems and will not interact with the tidal device. **This project will not impact on salmon fry abundance.**

Target 4: No significant decline in out-migrating smolt abundance

The tidal device will not be located in the freshwater systems that smolts migrate from**. This project will not impact on out-migrating smolt abundance**

Target 5: No decline in number and distribution of spawning redds due to anthropogenic causes

Salmon redds are confined to freshwater systems and will not interact with the tidal device**. This project will not impact on the number and distribution of salmon redds.**

Target 6: Water quality of at least Q4 at all sites sampled by EPA

These water quality assessments are confined to freshwater systems and the quality of these waterbodies will not be impacted by the proposed project. **This project will not impact on water quality.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for salmon.

5.3.3.4. *Tursiops truncatus* (Common Bottlenose Dolphin) [1349]

Bottlenose dolphins have the potential to occur in the test site area and the tidal device has the potential to disturb or displace dolphins through their physical presence or operational noise or to incur collisions or entanglements.

The device will occupy an area of 33.2m^2 of the water column. The channel in which the device is located has an area of 4000m^2 (200m wide x 20m deep) which is 0.83% of the navigable channel. In addition, this channel is only one of four leading into the Fergus Estuary and in a worst-case-scenario of the presence of the device deterring mammals progressing up the estuary at this point there are three other access routes including the main channel which is more likely to be used if any. It will therefore not permanently prevent access to the upper reaches.

Displacement: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

The turbine blades will have a slow rotational speed (in the region of 20 RPM) and is designed in such a way that the turbines will rotate in the direction opposite the flow and thereby naturally deflect objects away from the device. In addition, the distance between the blade shafts is 334mm and poses no direct mortality risk. The risk of collision and subsequent injury due to the presence of 1 small scale device with slow rotational speeds is considered **unlikely**.

The device was reviewed by the Shannon Dolphin & Wildlife Foundation/Irish Whale & Dolphin Group and was deemed not to pose a collision risk and the probability of entanglement in mooring lines was very unlikely. They concluded that the short-term deployment of the proposed device should have no long term impacts on dolphins if they use the site or on the conservation objectives of the site, but they did recommend Static Acoustic Monitoring (SAM) before, during and after installation. This recommendation has been incorporated in to the proposed mitigation for the project (Section 6). One of the broad objectives of the SIFP is "*to establish an evidence-based approach to identifying areas for future development to ensure that proposals will work in harmony with the designated European sites*". In addition objective SIFP ENV 1.1 seeks to "*explore the potential for cooperation between public and private sector agencies in identifying and addressing critical gaps in baseline environmental information relating to the Shannon Estuary*".

The proposed location of this tidal test site satisfies the requirements of the overarching plan for the estuary (The SIFP) in that it is located in an area which avoids sensitive habitats, will not negatively impact on any of the qualifying interest features of the SAC and will accommodate a device which has been designed specifically to have a negligible impact on the environment.

The testing of this tidal device at this location provides an the opportunity to obtain key baseline information across all stages of the annual cycle within the estuary through the application of Static Acoustic Monitoring in the knowledge that the device does not have the potential for significant negative effects on the conservation objectives or on site integrity.

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

The Shannon Estuary is one of Europe's premier deep water berths catering to shops up to 200,000 deadweight tonnage (O'Brien *et al.,* 2016). It has six main terminals and handles up to 1,000 ships carrying 12 million tons of cargo per annum. Additionally, a car and passenger ferry operates year-round between Killimor, Co. Clare and Tarbert, Co. Kerry and the estuary has two licensed dolphin-watching vessel operating between April and October. Fishing activity, most notably potting also occurs in the estuary. There are also an additional number of pleasure crafts year round. As a result, this is an area exposed to high levels of anthropogenic noise from a range of vessel activity. Noise monitoring results from the Shannon Estuary show that the estuary is a noisy place (O'Brien *et al.,* 2016). All results were broadband (5Hz to 20kHz) rms (root mean square) values. The mean noise level for the Shannon Estuary was calculated at 100 ± 7.5dB.

In addition to the noise levels in the Shannon from shipping, tidal streams targeted for exploitation by renewable energy converters are by their nature highly energetic environments often with high ambient sound levels (Marmo, 2017).

Bottlenose dolphins have developed a sonar system whereby they use echolocation to detect objects by sensing echoes from those objects (Harley *et al.,* 2003). Their echolocation clicks are broadband, with a frequency range of between 0.2 kHz and 150 kHz, with a peak of 30-60 kHz and a source level of between 40 and 80 dB re 1mbar @1m (Evans, 1973). Bottlenose dolphins hear in the mid frequency range (0.15 kHz to 160 kHz) (DAHG, 2014), with the best sensitivity between 10 kHz and 60 kHz (Johnson, 1967; Ljungblad *et al.,* 1982; Au, 1993). Figure 5.3 shows an audiogram for bottlenose dolphins (Nedwell *et al.,* 2004).

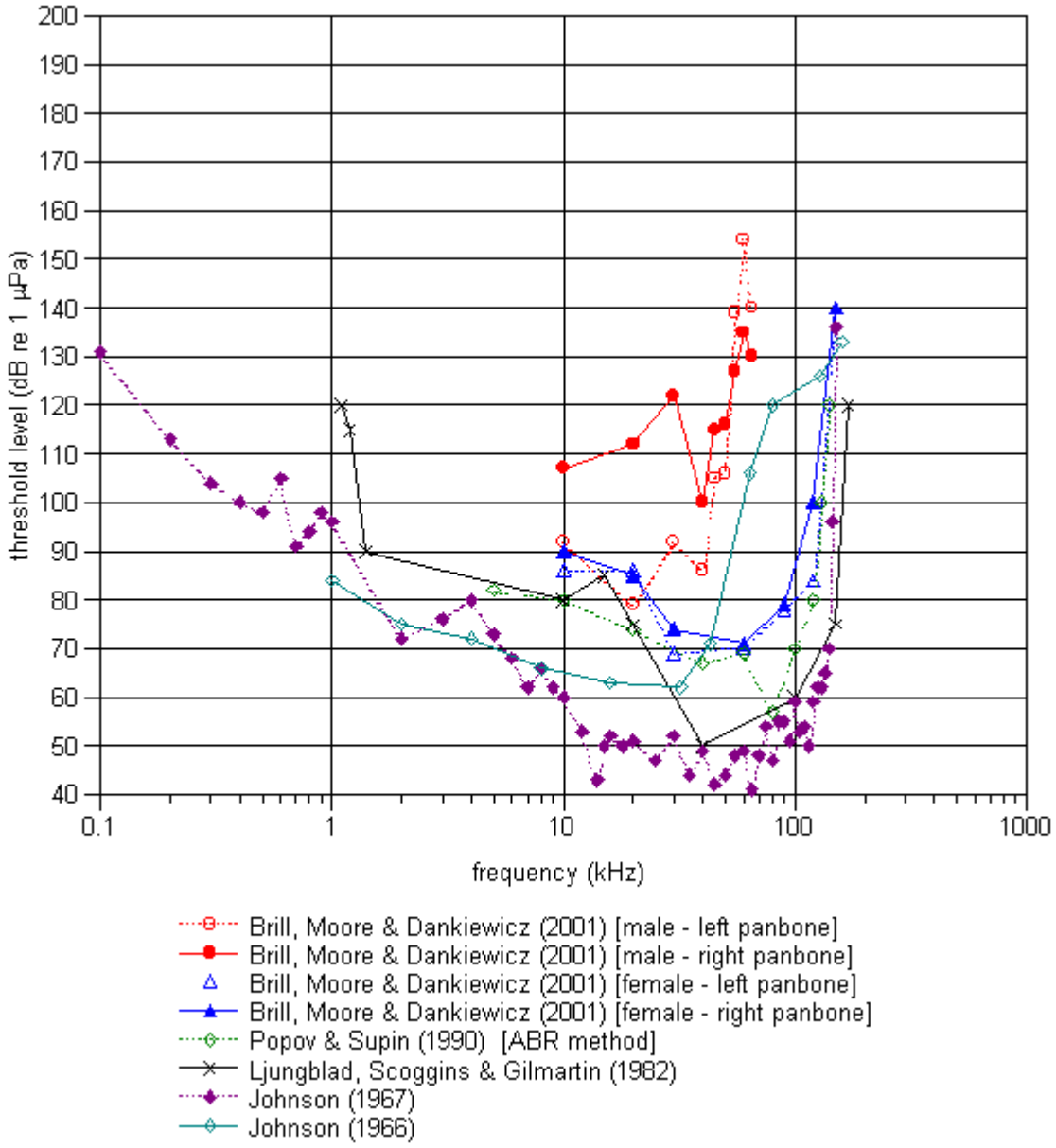

Figure 5.3: Bottlenose dolphin audiogram (Nedwell *et al.*, 2004).

While no data is available on underwater noise levels from the DRP 60 device, airborne noise levels at 1m distance from the fully exposed motors (which are above the water line) of the 25kW device range from 33dB to 63dB with a frequencies ranging from 0.1 to 6.4 kHz (see Figure 5.2). In reality, these are worst-case noise levels as the motors on the DRP 60 will be fully sealed and housed. As there is no mechanical or electrical sound sources located below the waterline, the underwater noise level will be significantly lower than the airborne levels, which are significantly lower than mean background noise levels in the Shannon. The levels generated by the DRP 60 device are below the peak sensitivity ranges of bottlenose dolphins. When these noise levels are compared with the audiogram it can be seen that the noise level generated in the 6.4 kHz range will be barely audible to the bottlenose dolphin while the other levels will be inaudible.

The noise levels from the installation and maintenance vessels will be similar to those generated by the existing volumes of shipping traffic in the estuary. The noise from two additional vessels will not significantly impact on bottlenose dolphins in the estuary.

Noise: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As stated above for the Annex I habitats, any increases in suspended sediment levels during installation will be immeasurably low and short-lived and will therefore have a **negligible** effect on bottlenose dolphins (if they are in the area).

Habitat Disturbance: Likelihood = Highly Likely; Consequence = Negligible; Impact = Low

As described in Section 5.3.1.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the Lower River Shannon SAC:

Objective: *To maintain the favourable conservation condition of bottlenose dolphin in the Lower River Shannon SAC, which is defined by the following list of attributes and targets.*

Target 1: Species range within the site should not be restricted by artificial barriers to site use

The device will only be installed for a period of 12 months. **This project will not permanently exclude the bottlenose dolphin from part of its range or permanently prevent access to suitable habitat.**

Target 2: Critical areas, representing habitat used preferentially by bottlenose dolphin, should be maintained in a natural condition

The proposed test site is not located in critical areas used preferentially by bottlenose dolphins. **This project will not impact on critical areas for this species.**

Target 3: Human activities should occur at levels that do not adversely affect the bottlenose dolphin population at the site

The proposal will not introduce noise at levels that could result in significant negative impacts on individuals and/or the population. The proposal will also not cause a collision risk or barrier to movement to individuals and/or the population. The proposal will not impact on key resources upon which the bottlenose dolphins depend.

This proposal will not adversely affect the bottlenose dolphin population at the site.

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for bottlenose dolphins.

5.3.3.5. *Lutra lutra* (Otter) [1355]

Otters have the potential to occur in the test site area. They are a curious species and may investigate the presence of the device. The device will occupy an area of 33.2m^2 of the water column. The channel in which the device is located has an area of 4000m^2 (200m wide x 20m deep) which is 0.83% of the navigable channel. As a result the likelihood of displacement is unlikely.

Displacement: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

Otters spend much of their time in water, but underwater sounds have not been studied (Galway Harbour Company, 2014). Airborne sounds of adults include whines, whistles, growls, soft cooing sounds, chuckles and snarls. When stressed otters may utter harsh screams. The sounds produced are in the human range of audibility, with sounds in the range 3-5kHz. There are no published data on the hearing of a eurasian otter, but as they spend less time in the water than pinnipeds, it can be assumed that their hearing underwater is unlikely to be as sensitive as that of a pinniped. Figure 5.4 shows an audiogram for the harbour seal in water which shows that the frequency and noise levels emitted by the device will be inaudible to harbour seals and therefore inaudible to otters.

In addition, the noise levels in air will be lower than that from existing shipping and will not significantly impact on otters in the estuary

The noise levels from the installation and maintenance vessels will be similar to those generated by the existing volumes of shipping traffic in the estuary. The noise from two additional vessels will not significantly impact on otters in the estuary. In addition, installation and maintenance operations will to be carried out in daylight hours. The interaction with the otter is likely to be minimal given that otter are considered to be mainly nocturnal and are mainly active after dusk and before dawn (Hayden & Harington, 2000).

Noise: Likelihood = Unlikely; Consequence = Minor; Impact = Low

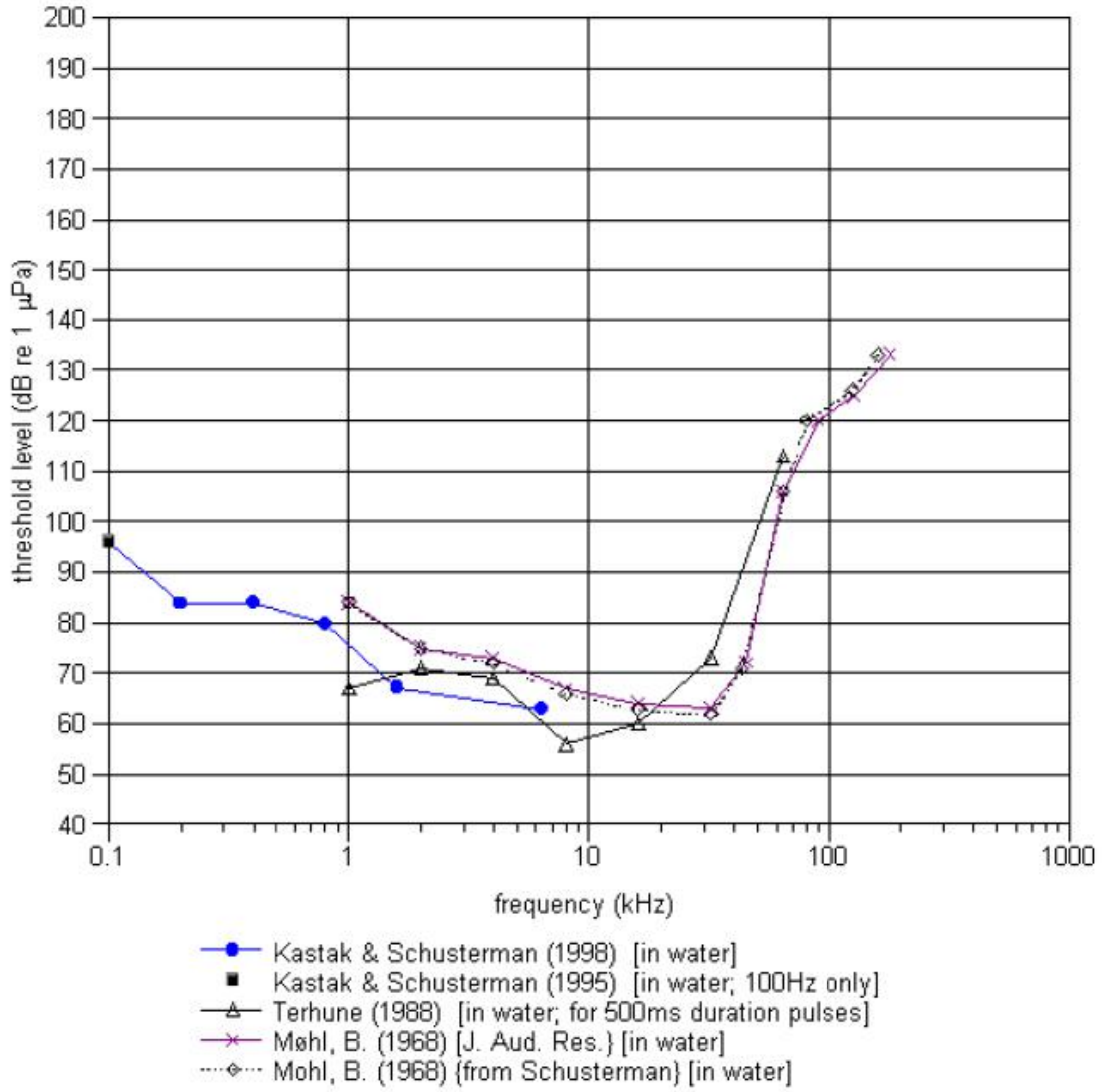

Figure 5.4: Harbour seal audiogram (Nedwell *et al.,* 2004).

The turbine blades will have a slow rotational speed (in the region of 20 RPM) and is designed in such a way that the turbines will rotate in the direction opposite the flow and thereby naturally deflect objects away from the device. In addition, the distance between the blade shafts is 334mm and poses no direct mortality risk. The risk of collision and subsequent injury due to the presence of 1 small scale device with slow rotational speeds is considered **unlikely**.

While otters are known to get entangled in fishing gear and drown (Benjamins *et al*., 2014), the mooring lines associated with the proposed test device will not have loose ends or sufficient slack to create loops in which animals can become entangled (Johnson *et al*. 2005; Baring-Gould *et al*. 2016).

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.1.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the Lower River Shannon SAC:

Objective: *To restore the favourable conservation condition of bottlenose dolphin in the Lower River Shannon SAC, which is defined by the following list of attributes and targets.*

Target 1: No significant decline in distribution

The presence of the device will not cause a barrier to movement or exclusion. **This project will not cause a significant decline in distribution.**

Target 2: No significant decline in the extent of terrestrial habitat

The proposal will not interact with any terrestrial habitats. **This project will not impact on the terrestrial habitat of otters.**

Target 3: No significant decline in the extent of marine habitat

The presence of the device will not cause a barrier to movement or exclusion. **This project will not impact on the marine habitat of otters.**

Target 4: No significant decline in the extent of freshwater (river) habitat

The proposal will not interact with any freshwater habitats. **This project will not impact on the freshwater (river) habitat of otters.**

Target 5: No significant decline in the extent of freshwater (lake/lagoon) habitat

The proposal will not interact with any freshwater habitats. **This project will not impact on the freshwater (lake/lagoon) habitat of otters.**

Target 6: No significant decline in couching sites and holts

The proposal will not interact with any habitats where couching sites and holts occur. **This project will not impact on the couching sites and holts of otters.**

Target 7: No significant decline in the availability of fish biomass

The proposal will not impact on fish species by way of slow turbine rotation speeds and the natural deflection of animals from the blades, therefore fish species will not be impacts. **This project will not impact on the availability of fish biomass for otters.**

Target 8: No significant increase in barriers to connectivity.

The proposal will only occupy 0.83% of the navigable channel and will therefore not be a barrier to connectivity. **This project will not increase barriers to connectivity.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for otters.

5.3.4. Special Conservation Interests

5.3.4.1. Cormorant (*Phalacrocorax carbo*) [A017]

Cormorants from the River Shannon and River Fergus Estuaries SPA feed in the area of the test site.

The presence of 1 small surface platform (108.68m^2) is extremely unlikely to deter cormorants from feeding in waters in the immediate vicinity of the device. The surface platform will be similar visually to a pontoon or deck of a tug boat and may act as a roost for the cormorant.

Habitat Loss/Disturbance: Likelihood = Highly Likely; Consequence = Negligible; Impact = Low

Due to the slow rotational speed of the device and the capacity of the bird to see and avoid the device under water, the impact on the cormorant population is considered to be extremely low.

As cormorants fly at a range of heights, there is also the potential risk that cormorants may collide with installation or service vessels or be disturbed by their presence. However, the risk is likely to be low (Daunt *et al.,* 2006) and the collision risk and disturbance level during construction is likely to be lower than that posed by commercial shipping traffic (AECOM, 2010).

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.2.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the River Shannon and River Fergus Estuaries SPA:

Objective: *To maintain the favourable conservation condition of cormorant in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets.*

Target 1: No significant decline in breeding population abundance

The temporary presence of 1 small-scale device will not significantly impact on breeding population abundance. **This project will not result in a decline in breeding population abundance.**

Target 2: No significant decline in the productivity rate

The temporary presence of 1 small-scale device will not significantly impact on the productivity rate of the breeding population. **This project will not result in a decline in productivity rate of the breeding population.**

Target 3: No significant decline in the distribution of breeding colonies

Cormorants do not breed in the test site. **This project will not impact on the distribution of breeding colonies.**

Target 4: No significant decline in the availability of prey biomass

The proposal will not significantly impact on fish species or benthic macroinvertebrates. **This project will not impact on the availability of prey biomass.**

Target 5: No significant increase in barriers to connectivity

The presence of a surface platform resembling the deck of a tug boat will not cause a barrier to movement. **This project will not increase barriers to connectivity.**

Target 7: Human activities should occur at levels that do not adversely affect the breeding cormorant

The presence of the device and installation/maintenance vessels will not adversely affect breeding birds. **This project will not impact on breeding birds.**

Target 8: Long term population trend stable or increasing

The presence of the device and installation/maintenance vessels will not decrease the long-term population trend. **This project will not impact on long-term population trend.**

Target 9: There should be no significant decrease in the range, timing or intensity of use of areas by cormorant other than that occurring from natural patterns of variation

The presence of the device and installation/maintenance vessels will not result in a significant decrease in the range, timing or intensity of use of areas. **This project will not impact on cormorant distribution.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for cormorant.

5.3.4.2. Shelduck (*Tadorna tadorna*) [A048]

Shelduck can only dabble in waters shallow enough for them to reach the seabed and therefore they will not feed the area of the test site. They will fly through the site but any risk of collision with the surface platform (or installation/maintenance vessels) is extremely is likely to be lower than that posed by commercial shipping traffic (AECOM, 2010).

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.3.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the River Shannon and River Fergus Estuaries SPA:

Objective: *To maintain the favourable conservation condition of shelduck in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets.*

Target 1: Long term population trend stable or increasing

The presence of the device and installation/maintenance vessels will not decrease the long-term population trend. **This project will not impact on long-term population trend.**

Target 2: There should be no significant decrease in the range, timing or intensity of use of areas by shelduck other than that occurring from natural patterns of variation

The presence of the device and installation/maintenance vessels will not result in a significant decrease in the range, timing or intensity of use of areas. **This project will not impact on shelduck distribution.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for shelduck.

5.3.4.3. Wigeon (*Anas penelope*) [A050]

Wigeon can only dabble in waters shallow enough for them to reach the seabed and therefore they will not feed the area of the test site. They will fly through the site but any risk of collision with the surface platform (or installation/maintenance vessels) is extremely is likely to be lower than that posed by commercial shipping traffic (AECOM, 2010).

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.2.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the River Shannon and River Fergus Estuaries SPA:

Objective: *To maintain the favourable conservation condition of wigeon in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets.*

Target 1: Long term population trend stable or increasing

The presence of the device and installation/maintenance vessels will not decrease the long-term population trend. **This project will not impact on long-term population trend.**

Target 2: There should be no significant decrease in the range, timing or intensity of use of areas by wigeon other than that occurring from natural patterns of variation

The presence of the device and installation/maintenance vessels will not result in a significant decrease in the range, timing or intensity of use of areas. **This project will not impact on wigeon distribution.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for wigeon.

5.3.4.4. Teal (*Anas crecca*) [A052]

Teal can only dabble in waters shallow enough for them to reach the seabed and therefore they will not feed the area of the test site. They will fly through the site but any risk of collision with the surface platform (or installation/maintenance vessels) is extremely is likely to be lower than that posed by commercial shipping traffic (AECOM, 2010).

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.2.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the River Shannon and River Fergus Estuaries SPA:

Objective: *To maintain the favourable conservation condition of teal in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets.*

Target 1: Long term population trend stable or increasing

The presence of the device and installation/maintenance vessels will not decrease the long-term population trend. **This project will not impact on long-term population trend.**

Target 2: There should be no significant decrease in the range, timing or intensity of use of areas by teal other than that occurring from natural patterns of variation

The presence of the device and installation/maintenance vessels will not result in a significant decrease in the range, timing or intensity of use of areas. **This project will not impact on teal distribution.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for teal.

5.3.4.5. Pintail (*Anas acuta*) [A054]

Pintail can only dabble in waters shallow enough for them to reach the seabed and therefore they will not feed the area of the test site. They will fly through the site but any risk of collision with the surface platform (or installation/maintenance vessels) is extremely is likely to be lower than that posed by commercial shipping traffic (AECOM, 2010).

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.2.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the River Shannon and River Fergus Estuaries SPA:

Objective: *To maintain the favourable conservation condition of pintail in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets.*

Target 1: Long term population trend stable or increasing

The presence of the device and installation/maintenance vessels will not decrease the long-term population trend. **This project will not impact on long-term population trend.**

Target 2: There should be no significant decrease in the range, timing or intensity of use of areas by pintail other than that occurring from natural patterns of variation

The presence of the device and installation/maintenance vessels will not result in a significant decrease in the range, timing or intensity of use of areas. **This project will not impact on pintail distribution.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for pintail.

5.3.4.6. Shoveler (*Anas clypeata*) [A056]

Shoveler can only dabble in waters shallow enough for them to reach the seabed and therefore they will not feed the area of the test site. They will fly through the site but any risk of collision with the surface platform (or installation/maintenance vessels) is extremely is likely to be lower than that posed by commercial shipping traffic (AECOM, 2010).

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.2.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the River Shannon and River Fergus Estuaries SPA:

Objective: *To maintain the favourable conservation condition of shoveler in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets.*

Target 1: Long term population trend stable or increasing

The presence of the device and installation/maintenance vessels will not decrease the long-term population trend. **This project will not impact on long-term population trend.**

Target 2: There should be no significant decrease in the range, timing or intensity of use of areas by shoveler other than that occurring from natural patterns of variation

The presence of the device and installation/maintenance vessels will not result in a significant decrease in the range, timing or intensity of use of areas. **This project will not impact on shoveler distribution.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for shoveler.

5.3.4.7. Black-headed Gull (*Chroicocephalus ridibundus*) [A179]

Black-headed gulls from the River Shannon and River Fergus Estuaries SPA feed and roost in the area of the test site. These gulls feed at the surface and do not dive and therefore they will have no interaction with the submerged structures (turbines and moorings).

The presence of 1 small surface platform (108.68m^2) is extremely unlikely to deter black-headed gulls from feeding in waters in the immediate vicinity of the device. The surface platform will be similar visually to a pontoon or deck of a tug boat and may act as a roost for the gull.

Habitat Loss/Disturbance: Likelihood = Highly Likely; Consequence = Negligible; Impact = Low

As black headed gulls fly at a range of heights, there is also the potential risk that black-headed gulls may collide with installation or service vessels or be disturbed by their presence. However the risk is likely to be low (Daunt *et al.,* 2006) and the collision risk and disturbance level during installation is likely to be lower than that posed by commercial shipping traffic (AECOM, 2010).

Collision Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

As described in Section 5.3.2.1 Estuaries, the risk of contamination from accidental events and release of contaminated sediments is **unlikely**.

Contamination Risk: Likelihood = Unlikely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the River Shannon and River Fergus Estuaries SPA:

Objective: *To maintain the favourable conservation condition of black-headed gull in the River Shannon and River Fergus Estuaries SPA, which is defined by the following list of attributes and targets.*

Target 1: Long term population trend stable or increasing

The presence of the device and installation/maintenance vessels will not decrease the long-term population trend. **This project will not impact on long-term population trend.**

Target 2: There should be no significant decrease in the range, timing or intensity of use of areas by black-headed gull other than that occurring from natural patterns of variation

The presence of the device and installation/maintenance vessels will not result in a significant decrease in the range, timing or intensity of use of areas. **This project will not impact on black-headed gull distribution.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for black-headed gull.

5.3.4.8. Wetlands [A999]

The wetland habitat as identified by NPWS occupies the full extent of the SPA. Using the logical applied above for estuaries, the temporary presence of anchors and mooring lines could disturb up to 0.00089% of the wetland seabed habitat and potentially 0.00003% of the surface area of the wetland habitat and 0.00015% of the wetland water body. This level of temporary loss of habitat is **negligible.** In addition, bird usage surveys have shown no evidence of foraging hotspots or resting areas within the test site area.

Habitat Loss/Disturbance: Likelihood = Highly Likely; Consequence = Negligible; Impact = Low

In terms of the conservation objectives of the River Shannon and River Fergus Estuaries SPA:

Objective: *To maintain the favourable conservation condition of the wetland habitat in the River Shannon and River Fergus Estuaries SPA as a resource for the regularly occurring migratory waterbirds that utilise it, which is defined by the following list of attributes and targets.*

Target 1: Permanent area occupied should be stable and not significantly less than the area of 32,261ha, other than from natural patterns of variation.

The temporary presence of the device and installation/maintenance vessels will not permanently reduce the area of wetland habitat as a resource for regularly occurring migratory waterbirds. **This project will not impact on habitat area.**

Given the above, it is concluded that the proposed test site in the River Shannon will not significantly impact on the conservation objectives for wetlands.

5.3.5. Cumulative Impacts

As the proposed test site will not have any significant impacts on any of the qualifying interests or special conservation interests of the nearby Natura 2000 sites, it cannot have any cumulative impact with any other proposals planned or on-going in those Natura 2000 sites.

6. Best-Practice Mitigation and Monitoring

Table 6.1 below lists the suggested project level mitigation measures for the renewable energy theme from the SIFP NIS. Table 6.1 also indicates the relevance or not of that measure to the current proposal.

Interested Features	Potential Effect	SIFP Suggested Project Level Mitigation	Adopted for Current Proposal
Habitats RE MM 1	Direct physical loss / damage to habitats	Careful site selection within areas of opportunity avoiding sensitive features for devices and export cables within the Shannon Estuary	- Device sited outside of sensitive features - No export cables required
		Habitat surveys to characterise the seabed and identify sensitive habitat and species within the area of opportunity	Carried out as part of NIS
		Avoid installation during sensitive seasons	No sensitive seasons for habitats in question
	Indirect disturbance or loss of habitats	Avoid device / infrastructure placement within 500m of areas of known sediment contamination	Sensitive site selection away from industrial ports and disposal sites has ensured this
		Habitat surveys to characterise the seabed and identify sensitive habitat and species	Carried out as part of NIS
	Toxic effects	Design devises to minimise risk of leakage of pollutants	All oils/fluids housed above the water line in sealed units housed in a steel hull
		Risk assessment and contingency planning	Developed by Dare Technologies for this project (see Appendix 5)
		Implementation of SOPEP (Shipboard Oil and Pollution Energy Plan) in line with MARPOL 73/78 on all vessels associated with the development of this theme.	Will be required on all vessels involved in the project
		Incorporation and up-dating of the equipment held and operations deployed by the Shannon Estuary Anti-Pollution Team to combat any potential incidents associated with the investigation, research, construction, operation and decommissioning of renewable energy devices in the Shannon Estuary.	Following the completion of a training exercise, simulated event and testing of the response capabilities of the Shannon Estuary Anti-Pollution Team (SEA-PT) hosted by Clare County Council in April 2017 all equipment and operations are currently up to date in terms of dealing with any potential incident which may arise from the deployment of such a tidal device.
	Biological Disturbance	Careful site selection avoiding sensitive features for devices and export cables	- Device sited outside of sensitive features

Interested Features	Potential Effect	SIFP Suggested Project Level Mitigation	Adopted for Current Proposal
Habitats RE MM 1 (cont'd)	Biological Disturbance (cont'd)	within the areas of opportunity	- No export cables required
		Habitat surveys to characterise the seabed & identify sensitive habitat & species	Carried out as part of NIS
Marine Mammals RE MM 2	Direct physical damage to mobile species	Detailed surveys would be required to examine the marine mammal (primarily Bottlenose Dolphin) distribution and use around, and within, the areas of opportunity identified in the Plan in order to fully understand and mitigate for this risk	While the proposed site for deployment is not located within an Area of Opportunity for Renewable Energy, site specific Static Acoustic Monitoring commenced in April 2018 in order to provide definitive evidence for this location. In addition CPODs were deployed at the deep water berths within the estuary in December 2017 which will provide further information in addition to what has been analysed in this report at locations in close proximity to the site e.g. Foynes Port and Aughinish Alumina.
		Avoid sites for sensitive species	Area of critical habitat for bottlenose dolphins has been avoided
		Avoid installation during sensitive seasons	Sensitive breeding season is between May and September for Bottlenose Dolphins there are no known critical areas, breeding sites or feeding areas in association with the proposed deployment location. However, as a precaution a Marine Mammal Observer will be employed during deployment and decommissioning in order to ensure no potential disturbance to any calving mothers or to mothers and young calves.
		Design device for minimal impact	Device has been designed to naturally deflect animals away from it
		Avoid siting devices in sensitive areas such as feeding and breeding areas	No evidence that the selected site is a sensitive feeding and breeding site
		Increase device visibility	Not warranted for this device

Interested Features	Potential Effect	SIFP Suggested Project Level Mitigation	Adopted for Current Proposal
Marine Mammals RE MM 2 (cont'd)	Direct physical damage to mobile species (cont'd)	Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals during research associated with the investigations for the potential development of the renewable industry, construction and activities together with any long term decommissioning activities. This code of conduct should also apply to vessels in transit to construction area if entering areas of high abundance	This code of conduct will be established for this project
		Use of protective netting or grids	Given the nature and design of the device it does not warrant the use of such protective netting or grids. This is based on the blades being designed to not travel faster than the water moving around them and a rotation which operates anti-clockwise.
		Seasonal restrictions on the operation of devices to avoid impacting on marine mammals at vulnerable times of the year	Not warranted
		Consider the use of acoustic deterrents such as pingers or acoustic harassment devices.	Given the nature and design of the device acoustic deterrents are not required as there is no risk of direct physical damage to any mobile species. In addition, the use of deterrents associated with such a device could cause other displacement impacts
		Soften collision by adding smooth edges or padding	Given the nature and design of the device it does not warrant the use of such protective netting or grids. This is based on the blades being designed to not travel faster than the water moving around them and a rotation which operates anti-clockwise.
		Protect against entrapment by incorporating escape hatches into device design.	Design does not warrant this
		No marine mammal mortalities occur as a consequence of physical interaction with the tidal device components	There is no potential for marine mammal mortalities to occur as a consequence of physical interaction with the

Interested Features	Potential Effect	SIFP Suggested Project Level Mitigation	Adopted for Current Proposal
Marine Mammals RE MM 2 (cont'd)	Direct physical damage to mobile species (cont'd)		tidal device components. The majority of the components will be contained in housing such as the motor housing the only components which will be open to the water are the blades which have been designed to rotate anti-clockwise are to deflect approaching material away from the turbine. The turbine blades are designed to not travel faster than the water moving around them, further reducing risk of damage to marine life.
		The tidal device operates in such a way as to stop when marine mammals are within 50m of the device	Design does not warrant this
		Prior to the introduction of this measures further research would be required as to its effects on marine mammals in terms of noise impact. Establishment of an active sonar system which detects marine mammals at sufficient range from the turbine to a precautionary shut-down to occur automatically. The use of active sonar systems have been incorporated into trials such as SeaGen in Strangford Lough. The results for the SeaGen EMP and other such programmes should be reviewed to assess the potential effects prior to the adoption of this mitigation measure.	
		Any device should not present a barrier effect to the free passage of marine mammals within the estuary.	The device will not act as a barrier for passage up the Fergus Estuary. Three alternative passages are present directly adjacent to this channel. Specifically in relation to the proposed channel for deployment the swept area of the device that captures power is 22.8m^2. The blades will be moving slower than the surrounding water. The device will occupy a surface area of 108.68m^2 on the sea surface, the total under water area is 33.2m^2 and the device will occupy a volume of 486.89m^3 of the water column. This area will not represent the entire width of the channel at this location and will therefore allow for

Interested Features	Potential Effect	SIFP Suggested Project Level Mitigation	Adopted for Current Proposal
Marine Mammals RE MM 2 (cont'd)	Direct physical damage to mobile species (cont'd)		free passage of marine mammals along the eastern side of the channel.
		Relative abundance, or use of the site, of marine mammals in the Shannon Estuary should not be significantly modified by the operation of any tidal energy device.	Given the location and channel for the proposed deployment is not within a known critical habitat area for Bottlenose Dolphins as per Map 16 of the NPWS Lower River Shannon Conservation Objectives and given the extremely small footprint of the device within this large complex it is not possible for the device to significantly affect the relative abundance or use of the site (The site being the overall Lower River Shannon SAC) by Marine Mammals.
		Sub-surface noise generated by any tidal energy device should not cause a level of disturbance to marine mammals sufficient to displace them from areas important for foraging and social activities.	Noise levels from the device will not cause a disturbance
	Indirect disturbance or loss of species	Minimise the use of high noise emission activities such as impact pilling and blasting	These activities are not required
		Avoid installation during sensitive periods	Sensitive breeding season is between May and September
		Soft starting pilling activities / passive acoustic deterrents – gradually increasing noise produce do allow mammals to move away from activities	These activities are not required
		Underwater noise during the operation may be beneficial in alerting species to the presence of the device, reducing the risk of collisions. However, this requires further research as to the potential negative effects on marine mammals within the area	Not warranted
		Noise from operating turbines can be reduced by using isolators. However this has not been tested in the long term and to account for cumulative effects and therefore will need to be first considered and appropriately mitigated.	Noise levels are low enough that this is not required.
		Use of bubble curtains (this may only be effective in shallow water)	Such a mitigation measure is not required in this instance as

Interested Features	Potential Effect	SIFP Suggested Project Level Mitigation	Adopted for Current Proposal
Marine Mammals RE MM 2 (cont'd)	Indirect disturbance or loss of species (cont'd)		pile driving or other noise emitting activities will not be undertaken for which bubble curtains would be appropriate.
		Prior to the introduction of this measures further research would be required as to its effects on marine mammals in terms of noise impact. The use of prototype devices which don't move could be considered to assess these effects. Use of acoustic deterrent or disturbance devices to scare sensitive species away	
		Use of mammal observers and passive acoustic monitoring to facilitate implementation of exclusion area during noisy activities	While no noisy activities are proposed as part of the deployment or operation e.g. pile driving etc as a precautionary measures marine mammal observers and Static Acoustic Monitoring will be utilised during deployment and decommissioning.
		Adherence to the risk assessment and menu of management options outlined in the NPWS Draft Guidance to manage the risk to Marine Mammals from Man-Made Sound Sources in Irish Waters	Guidance will be adhered to
		Development of similar guidance to the draft NPWS Guidance on Man-Made sounds specifically for the Shannon Estuary which can be used across all sectors.	
	EMF	Cable configuration and orientation can reduce field strength	No live cables
		Cable burial, where possible to minimise field effect at the seabed	No live cables
Fish and Freshwater RE MM 3	Direct physical damage to mobile species	Design device for minimal impact	Device has been designed to naturally deflect animals away from it
		Do not site devices in particularly sensitive sites e.g. migratory routes feeding and breeding areas	Main channel into the Fergus Estuary has been avoided.
Otters RE MM 4	Direct physical loss / damage to habitats	Detailed otter surveys would be required in order to fully understand and mitigate for this risk	The presence of otters at the site is acknowledged
		Avoid sensitive habitat areas	Device located outside foraging area
		Design device for minimal impact on habitat	Device is outside habitat but within commuting area. Device will occupy 0.83% of the channel

Interested Features	Potential Effect	SIFP Suggested Project Level Mitigation	Adopted for Current Proposal
Otters RE MM 4 (cont'd)	Direct physical damage to mobile species (cont'd)	Detailed otter surveys would be required in order to fully understand and mitigate for this risk	The presence of otters at the site is acknowledged
		Underwater noise during the operation may be beneficial in alerting species to the presence of the device, reducing the risk of collisions. However, this requires further research	Not warranted
		Avoid installation during the sensitive seasons	Commonly breed in spring or early summer, installation is planned for September
		Increase device visibility, or use of acoustic deterrent devices	Not warranted
		Use of protective netting or grids	Given the nature and design of the device it does not warrant the use of such protective netting or grids. This is based on the blades being designed to not travel faster than the water moving around them and a rotation which operates anti-clockwise.
		Protect against entrapment by incorporating escape hatches into device design.	Design does not warrant this
		Seasonal restrictions on the operation of devices to avoid impacting on otters at vulnerable times of the year	Not warranted
		Soften collision by adding smooth edges or padding	Given the nature and design of the device it does not warrant the use of such protective netting or grids. This is based on the blades being designed to not travel faster than the water moving around them and a rotation which operates anti-clockwise.
	Indirect disturbance or loss of habitats	Avoid siting devices in sensitive areas such as feeding and breeding areas	Device is outside sensitive areas but within commuting area. Device will occupy 0.83% of the channel
		Minimise the use of high noise emission activities e.g. impact pilling and blasting	These activities will not be used

Interested Features	Potential Effect	SIFP Suggested Project Level Mitigation	Adopted for Current Proposal
Otters RE MM 4 (cont'd)	Indirect disturbance or loss of habitats (cont'd)	Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to otters both during construction activities and in transit to construction area if entering areas of high abundance	This code of conduct will be established for this project
		Avoid installation during sensitive periods	Commonly breed in spring or early summer, installation is planned for September
		Use of sound insulation on equipment	Noise levels low enough and therefore insulation not required
		Soft starting pilling activities / passive acoustic deterrents – gradually increasing noise produce do allow otters to move away from activities	These activities are not required
	Toxic effects	Design devises to minimise risk of leakage of pollutants	All oils/fluids housed above the water line in sealed units housed in a steel hull
		Risk assessment and contingency planning	Developed by Dare Technologies for this project (see Appendix 5)
		Implementation of SOPEP (Shipboard Oil and Pollution Energy Plan)	Will be required on all vessels involved in the project
Birds RE MM 6	Direct physical damage to mobile species	Avoid siting the devices within sensitive sites	No know foraging hotspots or resting areas have been identified through the NPWS 2010/2011 waterbird survey or through the current Bird Usage Survey being undertaken on behalf of the SIFP.
		Avoid installation during sensitive seasons (i.e. breeding and moulting)	Breeding season is in spring, installation is in September
		Site specific surveys at project level to identify the presence of key foraging hotspots and / or resting areas and to aid site selection within the area of opportunity	No know foraging hotspots or resting areas have been identified through the NPWS 2010/2011 waterbird survey or through the current Bird Usage Survey being undertaken on behalf of the SIFP.
		Appropriate siting of developments e.g. away from breeding colonies, important feeding and roosting areas, near shore areas and migration corridors	Both the NPWS 2010/2011 waterbird survey and the Bird Usage Survey 2017/2018 for the Shannon Estuary have been reviewed for the presence of breeding colonies, important feeding and roosting areas and near shore

Interested Features	Potential Effect	SIFP Suggested Project Level Mitigation	Adopted for Current Proposal
Birds RE MM 6 (cont'd)	Direct physical damage to mobile species (cont'd)		areas and migration routes to ensure the chosen location does not impede on these areas.
		No construction of devices between resting and foraging areas	No know foraging hotspots or resting areas have been identified through the NPWS 2010/2011 waterbird survey or through the current Bird Usage Survey being undertaken on behalf of the SIFP.
		Shut down of devices at night with bad weather / visibility and high migration intensity	Not warranted
		Avoiding large-scale continuous illuminations	Minimal lighting for navigation only
		Measures to make wind turbines more recognisable to birds	Not relevant
	Indirect disturbance or loss of species	Minimise the use of high noise emission activities such as impact piling or blasting	No requirement for these activities
		Avoid installation during sensitive periods	Breeding season is in spring, installation is in September
		Review and consideration of noise reduction techniques (e.g. bubble curtains around the pile)	Such a mitigation measure is not required in this instance as pile driving or other noise emitting activities will not be undertaken for which bubble curtains would be appropriate.
		Use of sound insulation on plant equipment and device design	Motors above water level are housed and sealed

7. Summary

The proposal which has been subject to Appropriate Assessment due to its location within the the Lower River Shannon cSAC (Site Code: IE001265) and the River Shannon and River Fergus Estuaries SPA (Site Code: IE004077) consists of the flowing salient features:

- Short-term deployment (12 months maximum);
- Single small scale device (11.5m in length, x 9.5m wide and 8.5m in height [*c.* 4.5m submerged and 4m above the surface], with a dry weight of *c.* 20T – will resemble a tug on site;

- The device will occupy a surface area of 108.68m^2 on the sea surface, the total under water area is 33.2m^2 and the device will occupy a volume of 486.89m^3 of the water column – the device will occupy 0.83% of the navigable channel;
- The turbine blades are 334mm apart and will have a slow rotational speed (in the region of 20 RPM)
- Device is designed to avoid collisions, it is designed in such a way that the turbines will rotate in the direction opposite the flow and thereby naturally deflect objects away from the device;
- Footprint on the seabed is limited to 2 mooring blocks (c. 5m x 5m);
- No electricity will be generated;
- No connection to the shore;
- Noise levels for the most part will be imperceptible;
- All electrical components, gearboxes and motors will be sealed and housed in a steel hull.

The location of the device was selected for the following reasons:

- There is no known usage of the area by Bottlenose Dolphins;
- It is located outside the foraging area of otters;
- It is located outside important bird usage areas;
- Benthic habitats are not sensitive to temporary disturbance by mooring systems;
- It is not the main migration channel up the Fergus River.

Given the above and following a detailed screening and NIS assessment, it is the finding of this assessment that there will be no significant effects due to displacement, collision, habitat loss/disturbance, noise and contamination on the nearby Natura 2000 sites, their qualifying interests/special conservation interests, conservation objectives or on the integrity of the associated European Sites. As the tidal energy industry is in its infancy and the device being deployed is a test device, it is considered good practice to monitor interactions with the environment to inform the tidal energy industry going forward. The testing of this tidal device at this location provides an the opportunity to obtain key baseline information across all stages of the annual cycle within the estuary through the application of Static Acoustic Monitoring for Marine Mammals in the knowledge that the device does not have the potential for significant negative effects on the conservation objectives or on site integrity. A CPOD was deployed at the site on April 5th 2018 and data will be downloaded regularly to provide pre-installation baseline data with monitoring continuing during installation and operation.

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Appendix 1

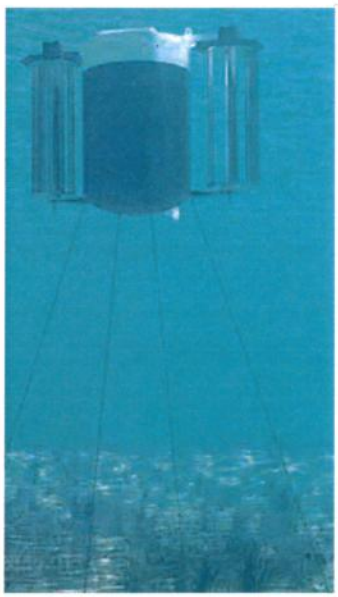
Consultation

AQUAFACT
INTERNATIONAL SERVICES LTD.

The Manager,
Development Applications Unit,
Department of Arts, Heritage and the Gaeltacht,
Newtown Road,
Wexford
Our Ref: JN1468
06/02/2018

Dear Sir/Madam,

RE: Foreshore Licence Application for Tidal Energy Test Site in the Shannon Estuary



AQUAFACT have been appointed by DesignPro Ltd. in partnership with GKinetic and Clare County Council to carry out an Appropriate Assessment to accompany a Foreshore Licence application for the deployment of a 60kW floating platform with submerged turbines extending to a depth of 3.6m. The tidal energy device is composed of twin, vertical-axis turbines mounted either side of a teardrop shaped bluff body that will be moored to the seabed with 4 small anchors. It is intended to deploy the device for 9 months starting from September 2018 and it will be removed from the water mid - way through 2019. No connection/cabling along the foreshore to land is required.

The unique concept is made up of two vertical axis turbines placed on either side of a buoyant deployment vessel, the "bluff body". The shape of the vessel accelerates the flow of water into the turbines. The combination of this accelerated flow and the "blade Pitch Control System" allows for significant energy to be generated in low flows. The device is designed in such a way so as to exploit flow acceleration, it naturally diverts objects away from the device thereby removing the collision

risk with marine mammals or fish, it is easy to deploy and recover using a floating deployment system and can self-start and generate power in velocities as low as 0.5m/s.

The proposed test site (20.59ha) is located in the Fergus Estuary, which forms part of the Lower River Shannon SAC (Site Code: IE002165) and the River Shannon and River Fergus Estuaries SPA (Site Code: IE04077) (see attached map). The proposed test site is located in the channel west of Canon Island and east of Inishtubbrid. Water depths in the area range from to 2 to 32m and benthic habitats and substrate type consists of sand and mixed sediments with intertidal reef on Inishtubbrid (NPWS, 2012[1]). The proposed test site covers 20.59ha (205,900m^2) and is 200m wide at its narrowest point and 740m in length. It is anticipated that the device will be located in waters a distance of 50-100m from shore, which would allow a 100m minimum passage for other craft. The device will be deployed in waters of *c.* 8m depth and will occupy a very small portion of the proposed test site (the total device under water swept area is 23.8m^2). The mooring system which will consist of 4 small anchors is currently being designed.

As part of the Appropriate Assessment, AQUAFACT are proposing to carry out benthic grab sampling and a drop-down video survey to inform the baseline data and resultant impact assessment. In addition, consultations are also taking place with IWDG and IFI.

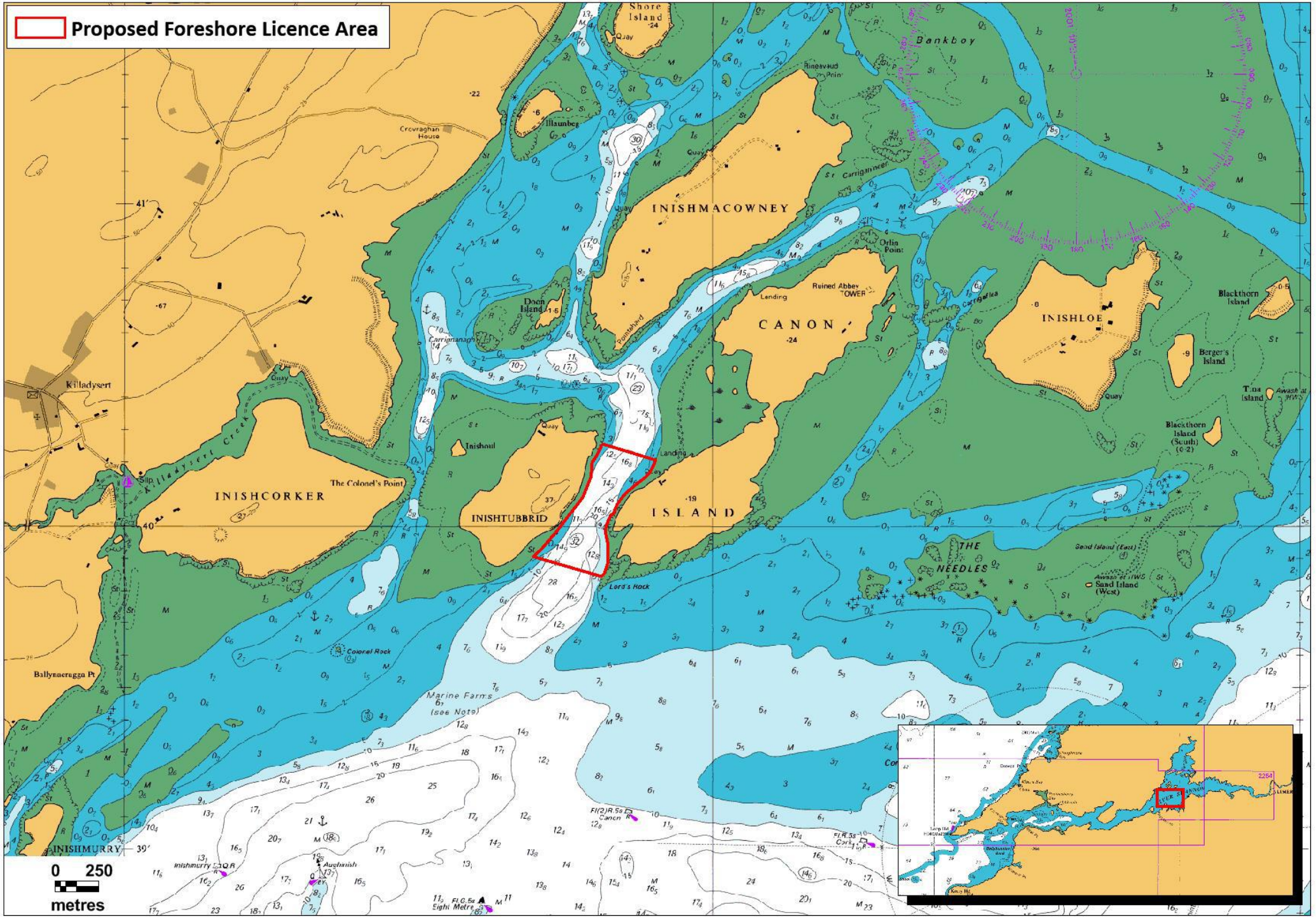
AQUAFACT would like to take this opportunity to request the scoping opinion of the Department on the proposed test site application and we welcome any advice or commentary that you may have.

If you require any additional information please do not hesitate to contact me,

Yours sincerely,

Dr. Caroline Roche
caroline@aquafact.ie
091-756812

[1] NPWS (2012) Lower River Shannon SAC (site code: 2165) Conservation objectives supporting document marine habitats and species. Version 1 March 2012.


Proposed Foreshore Licence Area
INISHMACOWNEY
CANON
INISHLOE
INISHCORKER
INISHTUBBRID
ISLAND
Killadysert
Killadysert Creek
Inishoul
Doon Island
Carrignanagh
Crovraghan House
Illaunbeg
Shore Island
Bankboy
Ringavaud Point
St Carrignaneer
Orlin Point
Ruined Abbey "OWER"
Lending
Blackthorn Island
Berger's Island
Tuna Island
Blackthorn Island (South)
Landing
The Colonel's Point
Slip
Quay
Lord's Rock
THE NEEDLES
Sand Island (East)
Sand Island (West)
Awash at MWS
Colonel Rock
Ballynacragga Pt
Marine Farms (see Note)
INISHMURRY
Inishmurry LtHO R
Aughnish
Eighi Metre
Fl(2)R.5s Canon R
Fl.R.5s Cork
Fl.G.5s
0 250
metres

From: Julie Fossitt [mailto:Julie.Fossitt@chg.gov.ie]
Sent: 14 February 2018 14:43
To: caroline@aquafact.ie
Cc: Manager Dau
Subject: Tidal device in the Fergus Estuary - G Pre00024/2018

Dear Caroline

I refer to your recent scoping request concerning the development/deployment of a test tidal device in the Fergus Estuary, and within the European sites, Lower River Shannon SAC (site code 002165) and River Shannon and River Fergus Estuaries SPA (004077).

As you may not be aware, the proposed location is within the plan area of the Strategic Integrated Framework Plan (SIFP) for the Shannon Estuary, which has been given effect by Clare County Council as part of Clare County Development Plan. The current proposal appears to come within the remit of the SIFP by virtue of its location, the type of activity (tidal energy generation, albeit on a test basis), and the involvement of the Council. The location, however, is not an 'area of opportunity' site for tidal energy within the SIFP. At this early stage, it would be advised to confirm with the Council whether the proposal is in accordance with the SIFP and, accordingly, with the County Development Plan.

You should also note that there is specified plan-level mitigation for tidal energy developments in the Shannon Estuary, and within the European sites. You are advised to consult the SIPF (section 5.6) and the associated volume of mitigation measures (volume 2) to establish which apply in this case and which are of relevance to the scope of the assessments required.

When the mitigation measures have been reviewed, and the Council/developer is satisfied that the proposal is consistent with the SIFP, NPWS can be consulted further about specific aspects of assessments that may be required (noting that it seems likely that AquaFact will be producing an NIS and that DHPLG will be carrying out the appropriate assessment). The case reference allocated by DAU - G Pre00024/2018 – should be quoted in all correspondence.

Kind regards,
Julie

Julie Fossitt BA, PhD, MCIEEM
Divisional Ecologist, Ecological Assessment Unit
National Parks and Wildlife Service
Department of Culture, Heritage and the Gaeltacht
2nd Floor, Custom House, Druid Lane, Flood Street, Galway H91 XV2C
Direct line: 0761 002608; extn 8608. Mobile: 087 9223330

_____

From: Caroline [mailto:caroline@aquafact.ie]
Sent: 08 February 2018 09:32
To: Manager Dau
Subject: JN1468 Scoping Request

Dear Sir/Madam,

Please find attached a scoping request for the deployment of a test tidal device in the Shannon Estuary for a period of approximately 9 months. AQUAFACT have been commissioned by DesignPro Ltd. in partnership with Clare Co. Co. and GKinetic Ltd. to prepare an Appropriate Assessment to accompany their foreshore licence application. Also included is a site location map.

If you require any further information please do not hesitate to contact me,

Dr. Caroline Roche,
Senior Manager

AQUAFACT International Services Ltd.,
12 Kilkerrin Park, Liosbaun, Tuam Rd.,
Galway,
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AQUAFACT
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Julie Fossitt,

Divisional Ecologist, Ecological Assessment Unit

National Parks and Wildlife Service

Department of Culture, Heritage and the Gaeltacht

2nd Floor, Custom House, Druid Lane, Flood Street, Galway H91 XV2C

Our Ref: JN1468

Your Ref: G Pre00024/2018

21/02/2018

Dear Julie,

Many thanks for your response. I have been in contact with Sheila Downes in Clare County Council in relation to your observations which you emailed to me on the 14th February 2018.

As you have correctly indicated the proposed location for the testing of this tidal energy device is within the remit of the Strategic Integrated Framework Plan for the Shannon Estuary which has been afforded statutory backing through its adoption into the Clare County Development Plan 2017-2023.

Policy support for Renewable Energy Development within the Shannon Estuary

Clare County Council is fully supportive of the setting up of a tidal energy test site at this location on the Fergus Estuary for a limited period of time. The Government Integrated Marine Plan for Ireland '*Harnessing Our Ocean Wealth*' (HOOW) estimates that the national asset that is the ocean could support a diverse marine economy with vast potential to tap into a €1.2 billion global marine market across a wide range of sectors. The recently established Marine Development Team, a Government initiated taskforce focused on maximising marine growth opportunities together with development agencies with a marine interest, Enterprise Ireland, the IMDO and the IDA Ireland are working together to achieve targets for the development of the sector set out in HOOW. The Shannon Estuary is strategically placed to exploit this potential with the Strategic Integrated Framework Plan (SIFP) providing it with a distinct advantage to other locations in Ireland and across Europe. Goal I of the Integrated Marine Plan is to harness market opportunities to deliver a thriving maritime economy built around the concept of sustainable development of the marine resource. The Shannon Estuary is one of Ireland's premier maritime resources that already host a number of long-established and successful marine enterprises including ports and nationally significant industries and economic centres. The challenge for all users and the key statutory agencies, who act as custodians of the Estuary, is how to nurture and cultivate a place where local, regional and international activities dependant on it, can grow and expand to sustain its local communities and its economy, whilst protecting and enhancing the environmental qualities which underpin its exceptional and internationally valued ecological status.

Consistency with the SIFP and the Clare County Development Plan

As you correctly indicate the current proposed location within the Shannon Estuary is not within one of the four areas of opportunity identified for renewable energy under the SIFP. This is primarily down to the specification of the device. The four sites identified in the SIFP arose from the SEAI Report '*Tidal & Current Energy Resource in Ireland*' which identified these sites as having tidal flows on a commercially viable scale. The Islands at the mouth of the River Fergus Estuary have several advantages as a demonstration site for this specific tidal energy device in comparison to the four areas of opportunity identified in the SIFP. In particular, they provide sheltered stretches of water with fairly high flow speeds. The testing of this device relates primarily to the demonstration of its functionality as opposed to a commercial scale device. The device is aimed at developing countries where there is a lack of grid infrastructure which requires distributed energy solutions this is particularly relevant for supplying remote island communities around the world with energy.

The device would be similar to a mooring, would have 4 small anchors and does not require a connection to the foreshore. The unique concept is made up of two vertical axis turbines placed on either side of a buoyant deployment vessel, the "bluff body". The shape of the vessel accelerates the flow of water into the turbines. The combination of this accelerated flow and the "blade Pitch Control System" allows for significant energy to be generated in low flows. The device is designed in such a way so as to exploit flow acceleration, it naturally diverts objects away from the device there by removing the collision risk with marine mammals or fish, it is easy to deploy and recover using floating deployment system and can self start and generate power as low as 0.5m/s.

Other key elements of design relating to environmental impact include:

1. Low blade tip speed, the rotational speed and aspect of the turbine blades is such that the blades do not travel faster than the water moving around them. This reduces risk of damage to both the equipment and marine life.
2. All immersed bearing are manufactured from specialised plastic bush's. No lubricants are used in immersed components. This eliminated the risk of pollution from such lubricants. The only lubricant used on the device is in the gearbox. This gearbox is a sealed unit with an IP 68 rating. The gearbox is itself housed in a protective housing and sealed housing that separates it from the marine environment.
3. An approved anti-fouling paint system specified by "Jotun Paints" will be applied to the required standards.

To date Limerick Docks have been used as a test site. The shipping area of the dock is operated by Shannon Foynes Port Company, while the test site itself is operated by GKinetic and is located on the banks of the River Shannon in Limerick City. The testing is carried out in a secure, enclosed wet dock facility with controlled water levels maintained at a minimum of 5 meters. GKinetic are partly funded by the Sustainable Energy Authority of Ireland to carry out testing in the Limerick Docks facility.

The Clare County Development Plan 2017-2023 contains specific economic development objectives for the Marine Related Industry site at Cahiracon which seeks to harness the economic potential of the Estuary at this location and to capitalise on its natural deepwater characteristics for enhanced maritime activity. The proposed location of this tidal energy device for testing lies adjacent to the zoned Marine Related Industry site with a substantial public pier at Cahircon (3 km away) that will allow a shore side office/ monitoring station as well as storage of equipment. Foynes harbour (7 km away), a tier one port, has a multicat vessel and substantial cranage facilities in quite close proximity and this can be used for the launching of turbine. The favourable location utilising the existing infrastructure in place will negate the requirement for any construction and/or associated impacts to the environment.

The SIFP contains a specific objective in relation to Research and Development (SIFP RD 1.1) which seeks to explore the potential sustainable development and promotion of the Shannon Estuary as a centre of excellence in research and development of renewable energy technologies. In addition, SIFP objective RE 1.8 looks to support and facilitate the sustainable development of renewable energy developments within and along the Shannon Estuary, in supporting Ireland's legally binding obligations under EU Directives. Lastly, objective RE 1.9 looks to explore the potential of tidal energy as a viable renewable energy resource within the estuary.

Clare County Development Plan

Development Plan Objective: Renewable Energy	
CDP8.40	**It is an objective of the development plan:** a) To encourage and to favourably consider proposals for renewable energy developments and ancillary facilities in order to meet national, regional and County renewable energy targets, and to facilitate a reduction in CO_2 emissions and the promotion of a low carbon economy; b) To assess future renewable energy-related development proposals having regard to the Clare Renewable Energy Strategy 2017-2023; c) To assess proposals for wind energy development and associated infrastructure having regard to the Clare Wind Energy Strategy and the associated SEA and AA, or any subsequent updated adopted strategy; d) To prepare an updated Wind Energy Strategy for County Clare during the lifetime of this development plan; e) To strike an appropriate balance between facilitating renewable and wind energy-related development and protecting the residential amenities of neighbouring properties; f) To support and facilitate the development of new alternatives and technological advances in relation to renewable energy production and storage, that may emerge over the lifetime of this Plan; g) To ensure that all proposals for renewable energy developments and ancillary facilities in the County are in full compliance with the requirements of the SEA and Habitats Directives and Objective CDP2.1; h) To promote and market the County as a leader of renewable energy provision; i) To support the implementation of 'Ireland's Transition to a Low Carbon Energy Economy 2015-2030'.

Development Plan Objective: Strategic Integrated Framework Plan (SIFP) for the Shannon Estuary	
CDP11.2	**It is an objective of the development plan:** a) To support and implement the inter-jurisdictional Strategic Integrated Framework Plan (SIFP) for the Shannon Estuary in conjunction with the other relevant local authorities and agencies. All proposed developments shall be in accordance with the Birds and Habitats Directive, Water Framework Directive and all other relevant EU Directives. All proposed developments shall incorporate the Mitigation Measures as contained in the SIFP – Volume 7 of this Plan - for ensuring the integrity of the Natura 2000 Network; b) To proactively market the Strategic Development Locations in County Clare at Inishmurry/Cahiracon and Moneypoint as potential locations for future economic development.

Development Plan Objective: Marine-Related Industry/Large-Scale Industry on the Estuary	
CDP11.3	**It is an objective of the development plan:** To capitalise on the natural deep water potential and existing port and maritime infrastructure, by facilitating and proactively encouraging the environmentally-sustainable development of maritime industries at appropriate locations within the Shannon Estuary, while seeking to improve and promote the road and rail connectivity of the deepwater ports in the County. All proposed developments shall be in accordance with the Birds and Habitats Directive, Water Framework Directive and all other relevant EU Directives; All development associated with marine-related industry shall incorporate the sector and site specific Mitigation Measures as contained in the SIFP – Volume 7 of this plan - for ensuring the integrity of the Natura 2000 Network.

Development Plan Objective: Strategic Development Locations	
CDP11.4	**It is an objective of the development plan:** a) To safeguard the role and function of the Strategic Development Locations, which are identified on Map 11A and Map 11B; b) To support economic development by encouraging the sustainable growth, development and appropriate diversification of Strategic Development Locations; All proposed developments shall be in accordance with the Birds and Habitats Directive, Water Framework Directive and all other relevant EU Directives.

This clearly demonstrates the correlation of the proposal at this location with the SIFP and the Clare County Development Plan.

Application of Mitigation Measures as identified through the SIFP

Tidal Energy Mitigation Measures (arising from the SEA)

While the proposed location for testing of the tidal device does not lie within one of the areas of opportunity as identified through the SIFP, in assessing the applicability of the measures associated with those four sites to this proposal we have ascertained that the following apply.

BFF MM 21 (SEA)

The FLOWBEC project aims to improve the understanding of how the physical behaviour of the water such as currents, waves and turbulence at tide and wave energy sites influences the behaviour of marine wildlife, and how tide and wave energy devices might alter the behaviour of such wildlife. The output from these site investigations which are being undertaken by DEFRA and the Natural Environment Research Council should inform the locating of such a device within the site together with the type of device.

Renewable Energy Mitigation Measures (arising from the SIFP NIR)

In line with the requirements under the SIFP, the current assessment will determine, what (if any), direct and indirect impacts are likely from the short-term deployment of a uniquely designed test tidal device on the Qualifying Interests of the Natura 2000 sites. Table 6.4 documents the renewable

energy mitigation measures arising from the SIFP NIR which will be utilised to inform the current assessment. Habitat surveys to characterise the seabed and identify sensitive habitats and species within the area will be undertaken as part of the initial assessments.

Table 6.4 Theme - Renewable Energy Mitigation Measures

Interested Features	Potential Effect	Suggested Project Level Mitigation Measures
Habitats **RE MM 1**	Direct physical loss / damage to habitats	- Careful site selection within areas of opportunity avoiding sensitive features for devices and export cables within the Shannon Estuary - Habitat surveys to characterise the seabed and identify sensitive habitat and species within the area of opportunity - Avoid installation during sensitive seasons
	Indirect disturbance or loss of habitats	- Avoid device / infrastructure placement within 500m of areas of known sediment contamination - Habitat surveys to characterise the seabed and identify sensitive habitat and species
	Toxic effects	- Design devises to minimise risk of leakage of pollutants - Risk assessment and contingency planning - Implementation of SOPEP (Shipboard Oil and Pollution Energy Plan) in line with MARPOL 73/78 on all vessels associated with the development of this theme. - Incorporation and up-dating of the equipment held and operations deployed by the Shannon Estuary Anti-Pollution Team to combat any potential incidents associated with the investigation, research, construction, operation and decommissioning of renewable energy devices in the Shannon Estuary.
	Biological disturbance	- Careful site selection avoiding sensitive features for devices and export cables within the areas of opportunity - Habitat surveys to characterise the seabed and identify sensitive habitat and species
Marine Mammals **RE MM 2**	Direct physical damage to mobile species	- Detailed surveys would be required to examine the marine mammal (primarily Bottlenose Dolphin) distribution and use around, and within, the areas of opportunity identified in the Plan in order to fully understand and mitigate for this risk - Avoid sites for sensitive species - Avoid installation during sensitive seasons - Design device for minimal impact - Avoid siting devices in sensitive areas such as feeding and breeding areas - Increase device visibility - Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals during research associated with the investigations for the potential development of the renewable industry, construction and activities together with any long term decommissioning activities. This code of conduct should also apply to vessels in transit to construction area if entering areas of high abundance - Use of protective netting or grids - Seasonal restrictions on the operation of devices to avoid impacting on marine mammals at vulnerable times of the year - Consider the use of acoustic deterrents such as pingers or acoustic harassment devices. - Soften collision by adding smooth edges or padding - Protect against entrapment by incorporating escape hatches into device design. - No marine mammal mortalities occur as a consequence of physical interaction with the tidal device components - The tidal device operates in such a way as to stop when marine mammals are within 50m of the device - Prior to the introduction of this measures further research would be

Interested Features	Potential Effect	Suggested Project Level Mitigation Measures
		required as to its effects on marine mammals in terms of noise impact. Establishment of an active sonar system which detects marine mammals at sufficient range from the turbine to a precautionary shut-down to occur automatically. The use of active sonar systems have been incorporated into trials such as SeaGen in Strangford Lough. The results for the SeaGen EMP and other such programmes should be reviewed to assess the potential effects prior to the adoption of this mitigation measure. - Any device should not present a barrier effect to the free passage of marine mammals within the estuary. - Relative abundance, or use of the site, of marine mammals in the Shannon Estuary should not be significantly modified by the operation of any tidal energy device. - Sub-surface noise generated by any tidal energy device should not cause a level of disturbance to marine mammals sufficient to displace them from areas important for foraging and social activities.
	Indirect disturbance or loss of species	- Minimise the use of high noise emission activities such as impact pilling and blasting - Avoid installation during sensitive periods - Soft starting pilling activities / passive acoustic deterrents – gradually increasing noise produce do allow mammals to move away from activities - Underwater noise during the operation may be beneficial in alerting species to the presence of the device, reducing the risk of collisions. However, this requires further research as to the potential negative effects on marine mammals within the area - Noise from operating turbines can be reduced by using isolators. However this has not been tested in the long term and to account for cumulative effects and therefore will need to be first considered and appropriately mitigated. - Use of bubble curtains (this may only be effective in shallow water) - Prior to the introduction of this measures further research would be required as to its effects on marine mammals in terms of noise impact. The use of prototype devices which don't move could be considered to assess these effects. Use of acoustic deterrent or disturbance devices to scare sensitive species away - Use of mammal observers and passive acoustic monitoring to facilitate implementation of exclusion area during noisy activities - Adherence to the risk assessment and menu of management options outlined in the NPWS Draft Guidance to manage the risk to Marine Mammals from Man-Made Sound Sources in Irish Waters[12] - Development of similar guidance to the draft NPWS Guidance on Man-Made sounds specifically for the Shannon Estuary which can be used across all sectors.
	EMF	- Cable configuration and orientation can reduce field strength - Cable burial, where possible to minimise field effect at the seabed
Fish and Freshwater	Direct physical damage to	- Design device for minimal impact - Do not site devices in particularly sensitive sites e.g. migratory

[12] http://www.npws.ie/media/npwsie/content/files/Guidance_Consultation%20Draft.pdf

Interested Features	Potential Effect	Suggested Project Level Mitigation Measures
RE MM 3		routes feeding and breeding areas
Otters **RE MM 4**	Direct physical loss / damage to habitats	- Detailed otter surveys would be required in order to fully understand and mitigate for this risk - Avoid sensitive habitat areas - Design device for minimal impact on habitat
	Direct physical damage to mobile species	- Detailed otter surveys would be required in order to fully understand and mitigate for this risk - Underwater noise during the operation may be beneficial in alerting species to the presence of the device, reducing the risk of collisions. However, this requires further research. - Avoid installation during the sensitive seasons - Increase device visibility, or use of acoustic deterrent devices - Use of protective netting or grids - Protect against entrapment by incorporating escape hatches into device design. - Seasonal restrictions on the operation of devices to avoid impacting on otters at vulnerable times of the year - Soften collision by adding smooth edges or padding
	Indirect disturbance or loss of habitats	- Avoid siting devices in sensitive areas such as feeding and breeding areas - Minimise the use of high noise emission activities such as impact pilling and blasting - Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to otters both during construction activities and in transit to construction area if entering areas of high abundance - Avoid installation during sensitive periods - Use of sound insulation on equipment - Soft starting pilling activities / passive acoustic deterrents – gradually increasing noise produce do allow otters to move away from activities
	Toxic effects	- Design devises to minimise risk of leakage of pollutants - Risk assessment and contingency planning - Implementation of SOPEP (Shipboard Oil and Pollution Energy Plan)
Bats **RE MM 5**	Direct physical damage to mobile species	- Avoid siting the devices within sensitive sites - Site specific surveys at project level to identify the presence of key commuting/foraging flightlines to aid site selection - Appropriate siting of developments e.g. away from roost sites and commuting/foraging flightlines - Avoiding large-scale continuous illuminations and only use appropriate sensitive lighting suitable for bats
	Indirect disturbance or loss of species	- Avoid installation during sensitive periods
Birds **RE MM 6**	Direct physical damage to mobile species	- Avoid siting the devices within sensitive sites - Avoid installation during sensitive seasons (i.e. breeding and moulting) - Site specific surveys at project level to identify the presence of key foraging hotspots and / or resting areas and to aid site selection within the area of opportunity - Appropriate siting of developments e.g. away from breeding colonies, important feeding and roosting areas, near shore areas

Interested Features	Potential Effect	Suggested Project Level Mitigation Measures
		and migration corridors - No construction of devices between resting and foraging areas - Shut down of devices at night with bad weather / visibility and high migration intensity - Avoiding large-scale continuous illuminations - Measures to make wind turbines more recognisable to birds
	Indirect disturbance or loss of species	- Minimise the use of high noise emission activities such as impact piling or blasting - Avoid installation during sensitive periods - Review and consideration of noise reduction techniques (e.g. bubble curtains around the pile) - Use of sound insulation on plant equipment and device deign.

As there are no infrastructural requirements, dredging, maintenance or dumping at sea requirements or the location of underwater features such as shipwrecks at this location all other mitigation measures under this heading are not deemed to be relevant. In addition, as there are no requirements other than to launch a small boat from the existing pier at Chairacon the mitigation measures identified for the Strategic Development Location at Inishmurry do not apply.

Following consultation with Clare County Council and an analysis of the proposal against the objectives and mitigation measures of the SIFP we are satisfied that the proposal is consistent with the ethos and requirements of the SIFP.

Finally, since issuing my initial consultation letter, a revision to the project plan has been made and the deployment duration is now expected to be 12 months as opposed to 9 months in the initial letter. There may be periods of time within this 12 month window where the device will be removed from the water, however 12 months will cover all stages of the testing as required by the Horizon 2020 funding.

We trust that this satisfies your concerns, however should you require any further information please do not hesitate to contact me at any time,

Yours sincerely,

Caroline Roche

Dr. Caroline Roche

From: Julie Fossitt [Julie.Fossitt@chg.gov.ie]
Sent: 20 March 2018 13:52
To: Caroline
Cc: Manager Dau; Sheila Downes; David Lyons
Subject: RE: G Pre00024/2018

Caroline

Thank you for your response.

You may be aware that I spoke to Sheila Downes, Clare County Council, about the matters raised regarding the relationship of your proposal with the SIFP, including, in particular, the details of SIFP mitigation measures which require review and/or apply in the case of the type of development and location in question. In this case, the proposed development is located within two European sites and within:

1. habitats which are qualifying interests of the SAC
2. habitats of species which are qualifying interests of the SAC
3. habitats of bird species which are special conservation interests of the SPA
4. wetlands which is a special conservation interest of the SPA

The point I was making in my original email was that the SIFP and associated mitigation measures, and other key information, should be reviewed and taken into account to inform and optimise consultations with this Department, and so that more focused matters or queries can be raised, e.g. in relation to 'scoping opinions' or the scope of the NIS, if required. In this case, the SAC and SPA have site specific conservation objectives which, together with supporting documents and data on certain habitats and species, are available on the NPWS website.

I note that you are meeting David Lyons tomorrow in relation to the proposal and certain marine ecology issues. If you have any other queries about specific aspects of assessments that may be required, please feel free to direct these to me, quoting the reference number above.

Regards,
Julie

From: Caroline [caroline@aquafact.ie]
Sent: 21 March 2018 16:37
To: David Lyons
Cc: Sheila Downes
Subject: Meeting minutes

Hi Dave,
Thanks for meeting with us earlier. Here are a few notes on our understanding of things.
Any additions/amendments, just let me know,
All the best,
Caroline

Summary of Meeting with David Lyons NPWS, Sheila Downes Clare Co. Co. and Caroline Roche AQUAFACT re Shannon Tidal NIS

SD summarised the project and the relevance to SIFP and its mitigation measures.

CR explained the workings of the device.
DL asked about the spacings between the blades in the rotor. SD to confirm.

DL raised concerns in relation to otter and their use of the site and their possible interactions with the device. Suggested survey effort before application is made.

DL had concerns about the bottlenose dolphin and the lack of empirical data on their usage of the site. SD/CR referred to letter from Simon Berrow indicating no collision risk and no evidence of frequent use of the Fergus Estuary by dolphins. SD indicated that SAM would be carried out before, during and after deployment of the device to log dolphin occurrence and explore potential effect of any device. DL suggested SAM throughout the summer and into autumn prior to submitting the application. Concerned about their interaction and displacement due to the device.

A discussion was undertaken in relation to the potential approach within the screening for appropriate assessment which is currently being undertaken by Aquafact on behalf of DesignPro to accompany the Foreshore Licence Application. DL outlined that the assessment should look at the conservation objectives and how they may be impacted by the deployment of the tidal test device. SD proposed that through the use of the existing data relating to Bottlenose Dolphin use within the SAC it could be shown that there is little to no usage of this area of the estuary by Bottlenose Dolphins and that in addition there is no potential for impact through the deployment of the device that subsequently it may be possible to prove that there are no implications for the conservation objectives of the European Site, and in addition that there will be no adverse effects on the integrity of that site.

DL indicated that it would be up to the applicants to prove this within the assessment as part of the application.

SD highlighted the timing issues involves (device has to be in the water in September 2018 for H2020 funding). DL did not see this timeline as realistic for MLVC and Foreshore Unit decisions.

DL raised the issue of fish species. SD said she had consultation with Mike Fiitzsimmons and Dr. Jimmy King (IFI) who had no concerns about impacts on fish.

DL had no concerns about the impact on benthic communities from the temporary placement of moorings on the seabed.

DL asked about the noise level and frequency of the device. SD to confirm.

Dr. Caroline Roche,
Marine Ecologist

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Appendix 2

Subtidal Survey February 2018

1. Materials & Methods

All survey work was carried out on the 13th February 2018 from AQUAFACT's 6.8m Lencraft RIB. A drop-down video survey was carried out initially to identify locations suitable for grab sampling.

Figure 1 shows the locations where successful faunal samples were obtained and the locations of the drop-down video transects.

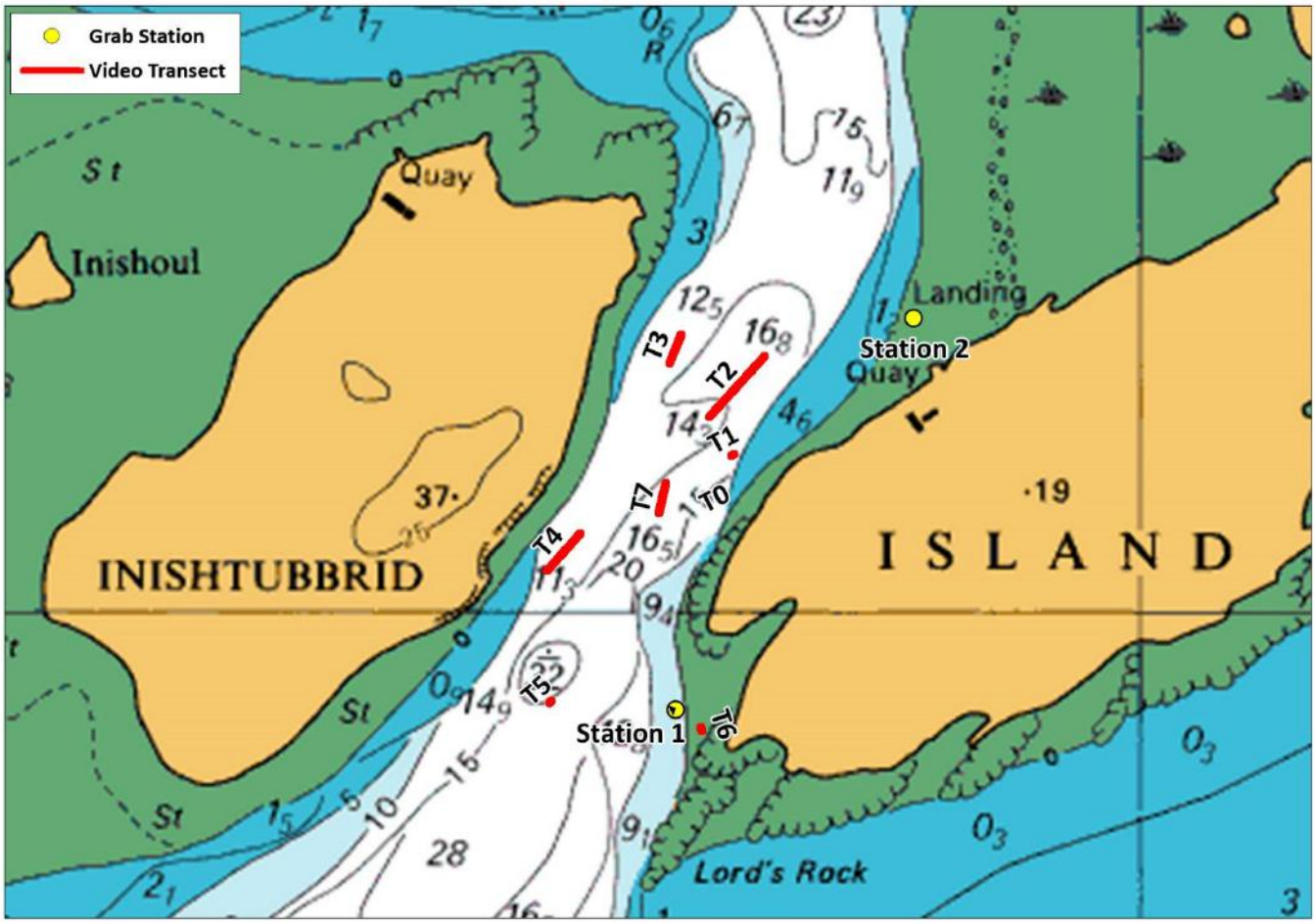


Figure 1: Location of grab stations and video transects within the survey area

1.1. Drop-down Video Survey

A total of 8 video transects of varying lengths were surveyed throughout the channel between Canon Island and Inishtubbrid. The start and end coordinates and depths of each transect are presented in Table 1. A LH-Camera video camera connected to a surface unit was used for this survey. This is an upgraded version of their standard unit and its specification include a high resolution, 560 line colour PAL camera with 0.1 lux sensitivity. Footage was digitized and captured using a Getac B300 rugged notebook and

backed up to writeable DVD media. A video overlay unit allowed position (dGPS) to be inserted and recorded continually on screen.

Table 1: Video transect coordinates

Transect	Start		End		Depth (m)
	Latitude	Longitude	Latitude	Longitude	
T0	52.66815	-9.05881	52.66815	-9.05881	8.1
T1	52.66885	-9.05865	52.66887	-9.05861	17.2
T2	52.66931	-9.05909	52.67004	-9.058	21.3
T3	52.66995	-9.05987	52.67029	-9.05965	16.1
T4	52.66748	-9.06228	52.66792	-9.06163	12.3
T5	52.6659	-9.06223	52.66592	-9.0622	29.1
T6	52.66561	-9.05926	52.66556	-9.05923	7.4
T7	52.66817	-9.06008	52.66852	-9.05994	19.3

1.2. Grab Survey

AQUAFACT has in-house standard operational procedures for benthic sampling and these were followed for this project. Additionally, the MESH report on "Recommended Standard methods and procedures" was adhered to

A 0.1m^2 van Veen grab was used to sample the grab sites. On arrival at each sampling station, the vessel location was recorded using DGPS (latitude/longitude). Additional information such as date, time, site name, sample code and depth were recorded in a data sheet. Table 2 shows the coordinates and depths of the grab stations.

Three replicate grab samples were taken at each of the stations for faunal analysis and a fourth sample was collected for sediment grain size analysis. The grab deployment and recovery rates did not exceed 1 metre/sec. This was to ensure minimal interference with the sediment surface as the grab descended. Upon retrieval of the grab a description of the sediment type and redox depth was noted in the sample data sheet. Notes were also made on colour, texture, smell and presence of animals.

The samples collected for faunal analysis were carefully and gently sieved on a 1 mm mesh sieve as a sediment water suspension for the retention of fauna. Great care was taken during the sieving process in order to minimise damage to taxa such as spionids, scale worms, phyllodocids and amphipods. The sample residue was carefully flushed into a pre-labelled (internally and externally) container from below. Each label contained the sample code and date. The samples were stained with Eosin-briebrich scarlet and fixed in 4% w/v buffered formaldehyde solution upon returning to the laboratory. These samples were ultimately preserved in 70% alcohol prior to processing.

Table 2: Station coordinates and depths at the grab stations

Station	Longitude	Latitude	Depth (m)
1	-6.97647	52.24701	9.1
2	-6.96934	52.24496	4.5

All faunal samples were placed in an illuminated shallow white tray and sorted first by eye to remove large specimens and then sorted under a stereo microscope (x 10 magnification). Following the removal of larger specimens, the samples were placed into Petri dishes, approximately one half teaspoon at a time and sorted using a binocular microscope at x25 magnification.

The fauna was sorted into four main groups: Polychaeta, Mollusca, Crustacea and others. The 'others' group consisted of echinoderms, nematodes, nemerteans, cnidarians and other lesser phyla. The fauna were maintained in stabilised 70% industrial methylated spirit (IMS) following retrieval and identified to species level where practical using a binocular microscope, a compound microscope and all relevant taxonomic keys. After identification and enumeration, specimens were separated and stored to species level. The faunal restuens from each replicate were combined and a community type assigned to the station.

The sediment granulometric analysis was carried out by AQUAFACT using the traditional granulometric approach. Traditional analysis involved the dry sieving of approximately 100g of sediment using a series of Wentworth graded sieves. The process involved the separation of the sediment fractions by passing them through a series of sieves. Each sieve retained a fraction of the sediment, which were later weighed and a percentage of the total was calculated. Table 3 shows the classification of sediment particle size ranges into size classes. Sieves, which corresponded to the range of particle sizes (Table 3), were used in the analysis. Appendix 2-1 provides the detailed granulometric methodology.

Table 3: The classification of sediment particle size ranges into size classes (adapted from Buchanan, 1984)

Range of Particle Size	Classification	Phi Unit
<63µm	Silt/Clay	>4 Ø
63-125 µm	Very Fine Sand	4 Ø, 3.5 Ø
125-250 µm	Fine Sand	3 Ø, 2.5 Ø
250-500 µm	Medium Sand	2 Ø, 1.5 Ø
500-1000 µm	Coarse Sand	1 Ø, 1.5 Ø
1000-2000 µm (1 – 2mm)	Very Coarse Sand	0 Ø, -0.5 Ø
2000 – 4000 µm (2 – 4mm)	Very Fine Gravel	-1 Ø, -1.5 Ø
4000 -8000 µm (4 – 8mm)	Fine Gravel	-2 Ø, -2.5 Ø
8 -64 mm	Medium, Coarse & Very Coarse Gravel	-3 Ø to -5.5 Ø

Range of Particle Size	Classification	Phi Unit
64 – 256 mm	Cobble	-6 Ø to -7.5 Ø
>256 mm	Boulder	< -8 Ø

2. Results

2.1. Drop-down Video Survey

The drop-down video survey revealed a hard rocky substratum dominated by boulders and cobbles with some intervening patches of sandy mud and gravel. Visibility on the survey day was poor due to high turbidity levels and strong current speeds, however the following species were identified from the video footage: hydroids, sponges (possibly *Cliona* or *Halichondria*) and bryozoans (possibly *Alcyonidium diaphanum*). Figure 2 shows some representative images from the rocky seabed.

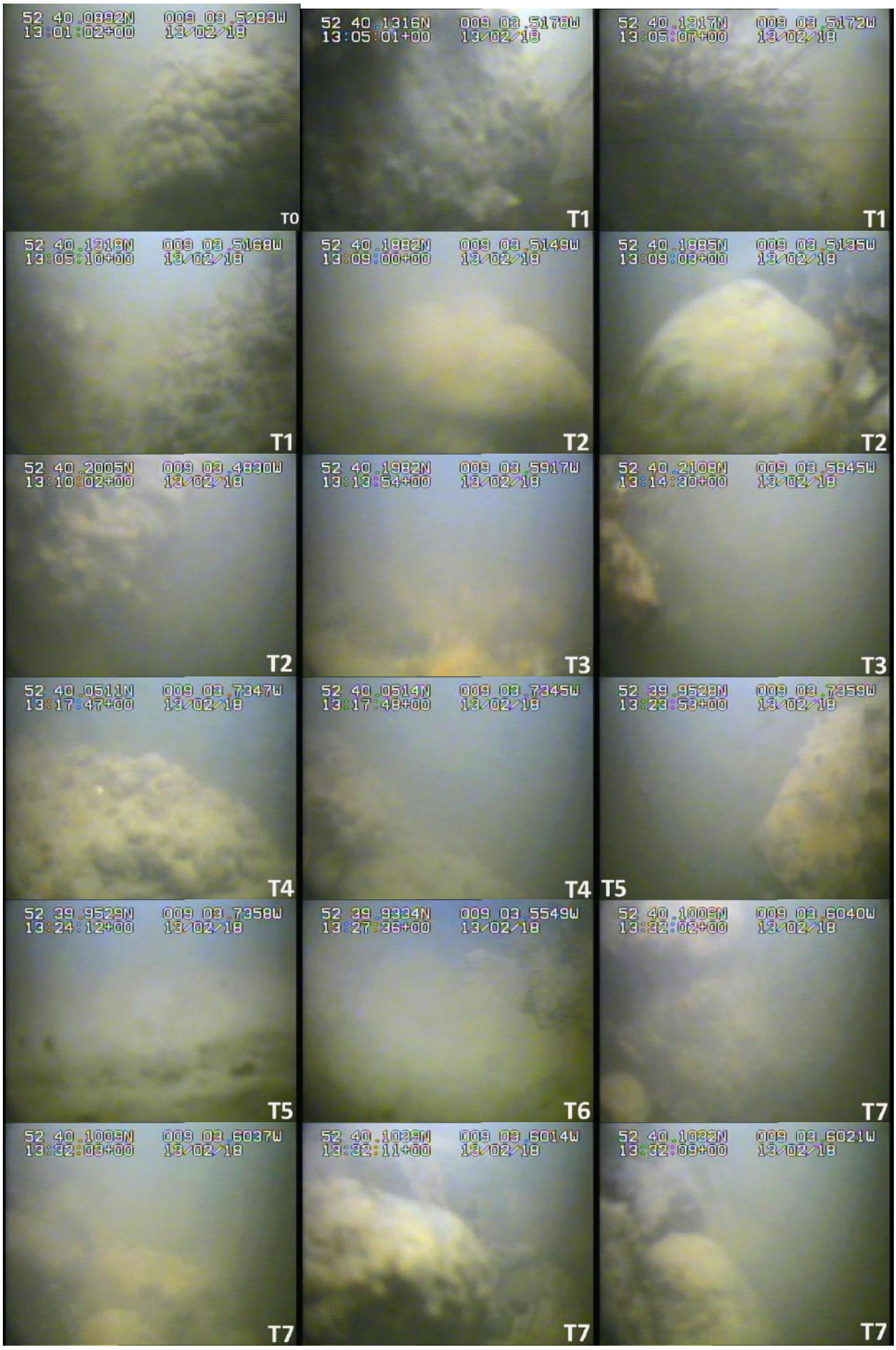


Figure 2: Representative images from rocky seabed within the proposed test site area.

2.2. Grab Survey

2.2.1. Fauna

The taxonomic identification of the benthic infauna across both grab stations sampled in the survey area on 13th February yielded a total count of 25 taxa ascribed to 7 phyla. Four of the 25 taxa could not be enumerated as they were colonial species (bryozoans and hydroids). The remaining 21 taxa consisted of 133 individuals. Of the 25 taxa recorded, 18 were identified to species level. The remaining 7 could not be identified to species level as they were either juveniles, partial/damaged or indeterminate. Appendix 2-2 shows the faunal abundances from the replicate samples.

Of the 25 taxa present, 1 was a cnidarian (hydroid), 1 was a nematode (roundworm), 14 were annelids (segmented worms), 2 were crustaceans (crabs, shrimps, prawns), 2 were molluscs (mussels, cockles, snails etc.), 3 were bryozoans (moss animals) and 1 was a tunicate (sea squirt).

Tables 4 and 5 shows the number of individual species and abundance from each station.

Station 1 was dominated by the tunicate *Dendrodoa grossularia* (19 individuals, 24.1% abundance), the oligochaete *Tubificoides amplivasatus* (9 individuals, 11.4% abundance) and the crustacean *Corophium volutator* (8 individuals, 10.1% abundance). Station 2 was dominated by the crustacean *Corophium volutator* (43 individuals, 79.6% abundance), the polychaete *Pygospio elegans* (3 individuals, 5.6% abundance) and the gastropod *Retusa obtusa* (2 individuals, 3.7% abundance).

Table 4: Faunal abundance returned from Station 1

Group	Species	No. Individuals	% Abundance
Tunicata	*Dendrodoa grossularia*	19	24.1
Oligochaeta	*Tubificoides amplivasatus*	9	11.4
Crustacean	*Corophium volutator*	8	10.1
Polychaeta	*Mediomastus fragilis*	6	7.6
	Cirratulidae (partial/damaged)	6	7.6
	Leitoscoloplos mammosus	4	5.1
	Pygospio elegans	4	5.1
Gastropoda	*Retusa obtusa*	4	5.1
Nematoda	Nematoda	3	3.8
Polychaeta	*Streblospio shrubsolii*	3	3.8
	Eunereis longissima	2	2.5
	Nephtys sp. (partial/damaged)	2	2.5
	Nephtys hombergii	2	2.5
Bivalvia	*Limecola balthica*	2	2.5
Polychaeta	Spionidae	1	1.3
	Ampharetidae (partial/damaged)	1	1.3

Group	Species	No. Individuals	% Abundance
	Eupolymnia sp. (partial/damaged)	1	1.3
Crustacean	*Balanus crenatus*	1	1.3
Bivalvia	*Barnea candida*	1	1.3
Hydroid	*Calycella syringa*	+	
Bryozoa	*Conopeum reticulum*	+	
	Electra monostachys	+	
	Escharella sp.	+	

Table 5: Faunal abundance returned from Station 2

Group	Species	No. Individuals	% Abundance
Crustacean	*Corophium volutator*	43	79.6
Polychaeta	*Pygospio elegans*	3	5.6
Gastropoda	*Retusa obtusa*	2	3.7
Polychaeta	*Nephtys* sp. (partial/damaged)	1	1.9
	Nephtys hombergii	1	1.9
	Dipolydora sp. (partial/damaged)	1	1.9
	Capitella sp. complex	1	1.9
	Mediomastus fragilis	1	1.9
	Ampharetidae (partial/damaged)	1	1.9
Bryozoa	*Conopeum reticulum*	+	
	Electra monostachys	+	

2.2.2. Sediment

Table 6 shows the sediment characteristics of the faunal stations sampled in the survey area. Gravel ranged from 3.6 to 14%, very coarse sand from 7.9 to 15%, coarse sand from 6.9 to 10%, medium sand from 4.7 to 7.7%, fine sand from 6.6 to 6.9%, very fine sand from 16.2 to 24.2% and silt clay from 29.5 to 46.1%. The sediment sampled was classified according to Folk (1954) as gravelly muddy sand at Station 1 and as slightly gravelly muddy sand at Station 2.

Table 6: Sediment grain size

Grain Size	Station 1	Station 2
Gravel (>2mm)	14	3.6
Very Coarse Sand (1-2mm)	15	7.9
Coarse Sand (0.5-1mm)	10.6	6.9
Medium Sand (0.25-0.5mm)	7.7	4.7
Fine Sand (125-250mm)	6.9	6.6
Very Fine Sand (62.5-125mm)	16.2	24.2
Silt-Clay (<63mm)	29.5	46.1
Folk (1954)	Gravelly muddy sand	Slightly gravelly muddy sand

Appendix 2-1

Sediment Grain Size Methodology

Granulometry

1. Approximately 25g of dried sediment is weighed out and placed in a labelled 1L glass beaker to which 100 ml of a 6 percent hydrogen peroxide solution was then added. This was allowed to stand overnight in a fume hood.
2. The beaker is placed on a hot plate and heated gently. Small quantities of hydrogen peroxide are added to the beaker until there is no further reaction. This peroxide treatment removes any organic material from the sediment which can interfere with grain size determination.
3. The beaker is then emptied of sediment and rinsed into a. 63µm sieve. This is then washed with distilled water to remove any residual hydrogen peroxide. The sample retained on the sieve is then carefully washed back into the glass beaker up to a volume of approximately 250ml of distilled water.
4. 10ml of sodium hexametaphosphate solution is added to the beaker and this solution is stirred for ten minutes and then allowed to stand overnight. This treatment helps to dissociate the clay particles from one another.
5. The beaker with the sediment and sodium hexametaphosphate solution is washed and rinsed into a 63µm sieve. The retained sampled is carefully washed from the sieve into a labelled aluminium tray and placed in an oven for drying at 100ºC for 24 hours.
6. When dry this sediment is sieved through a series of graduated sieves ranging from 4 mm down to 63µm for 10 minutes using an automated column shaker. The fraction of sediment retained in each of the different sized sieves is weighed and recorded.
7. The silt/clay fraction is determined by subtracting all weighed fractions from the initial starting weight of sediment as the less than 63µm fraction was lost during the various washing stages.

Appendix 2-2

Grab Survey Species Abundance

Station	AphiaID	1-A	1-B	1-C	2-A	2-B	2-C
CNIDARIA	1267						
HYDROZOA	1337						
LEPTOTHECATA	13552						
Campanulinidae	1607						
Calycella syringa	117402			+			
NEMATODA	799						
Nematoda	799	2		1			
ANNELIDA	882						
POLYCHAETA	883						
PHYLLODOCIDA	892						
Nereididae	22496						
Eunereis longissima	130375	2					
Nephtyidae	956						
Nephtys sp. (partial/damaged)	129370		1	1			1
Nephtys hombergii	130359		1	1			1
ORBINIIDA	884						
Orbiniidae	902						
Leitoscoloplos mammosus	130514		3	1			
SPIONIDA	889						
Spionidae	913						
Spionidae	913		1				
Dipolydora sp. (partial/damaged)	129611				1		
Pygospio elegans	131170	1	3		2	1	
Streblospio shrubsolii	131193		2	1			
COSSURIDA	888						
CAPITELLIDA	890						
Capitellidae	921						
Capitella sp. complex	129211					1	
Mediomastus fragilis	129892	5		1	1		
TEREBELLIDA	900						
Cirratulidae	919						
Cirratulidae (partial/damaged)	919	2	4				
Ampharetidae	981						
Ampharetidae (partial/damaged)	981			1	1		
Terebellidae	982						
Eupolymnia sp. (partial/damaged)	129693			1			
OLIGOCHAETA	2036						
HAPLOTAXIDA	2118						
Naidinae	176043						
Tubificidae	2040						
Tubificoides amplivasatus	137570		8	1			
CRUSTACEA	1066						
CIRRIPEDIA	1082						
SCALPELLIFORMES	534760						
SESSILIA	106033						
Balanidae	106057						
Balanus crenatus	106215			1			
MALACOSTRACA	1071						
AMPHIPODA	1135						
Corophiidae	101376						
Corophium volutator	102101	7	1		42	1	

Station	AphiaID	1-A	1-B	1-C	2-A	2-B	2-C
MOLLUSCA	51						
GASTROPODA	101						
CEPHALASPIDEA	154						
Retusidae	156						
Retusa obtusa	141134	1	3		2		
BIVALVIA	105						
CARDIIDA	869602						
Tellinidae	235						
Limecola balthica	880017	1	1				
MYIDA	245						
Pholadidae	252						
Barnea candida	140767	1					
BRYOZOA	146142						
GYMNOLAEMATA	1795						
CHEILOSTOMATIDA	110722						
Membraniporidae	110762						
Conopeum reticulum	111351		+	+		+	+
Electridae	110746						
Electra monostachys	111354		+				+
Escharellidae	152301						
Escharella sp.	110965		+				
CHORDATA	1821						
TUNICATA	146420						
ASCIDIACEA	1839						
STOLIDOBRANCHIA	103436						
Styelidae	103450						
Dendrodoa grossularia	103882		1	18			

Appendix 3

Bird Usage Survey (May 2017 to February 2018)

Bird counts from subsite OH533 from May to September 2017. I = Intertidal, SB = Subtidal, SP = Supratidal, T = Terrestrial. Species in red have the potential to occur within the subtidal zone (MKOS, 2017)

Species	Code	Feeding	Roosting	Subsite	Date
Black-headed Gull	BH	5	6	OH533I	18th May 2017
Black-tailed Godwit	BW	1		OH533I	18th May 2017
Common Tern	CN	2		OH533SB	18th May 2017
Cormorant	CA	1		OH533SB	18th May 2017
Cormorant	CA		1	OH533SP	18th May 2017
Curlew	CU	1	0	OH533T	18th May 2017
Great Black-backed Gull	GB		2	OH533SP	18th May 2017
Herring Gull	HG		1	OH533I	18th May 2017
Herring Gull	HG		1	OH533SP	18th May 2017
Mallard	MA		2	OH533I	18th May 2017
Oystercatcher	OC	5		OH533I	18th May 2017
Shelduck	SU	1	6	OH533I	18th May 2017
Shelduck	SU	4		OH533SB	18th May 2017
Shelduck	SU		6	OH533SP	18th May 2017
Black-headed Gull	BH	86		OH533I	22nd June 2017
Black-tailed Godwit	BW	3		OH533I	22nd June 2017
Cormorant	CA		4	OH533I	22nd June 2017
Curlew	CU	5		OH533I	22nd June 2017
Great Black-backed Gull	GB	1		OH533I	22nd June 2017
Grey Heron	H		1	OH533I	22nd June 2017
Herring Gull	HG	1		OH533I	22nd June 2017
Little Egret	ET	2		OH533I	22nd June 2017
Mallard	MA	2		OH533I	22nd June 2017
Oystercatcher	OC	1		OH533I	22nd June 2017
Shelduck	SU	2	8	OH533I	22nd June 2017
Black-headed Gull	BH	155		OH533I	29th August 2017
Black-headed Gull	BH	55		OH533SB	29th August 2017
Black-tailed Godwit	BW	161		OH533I	29th August 2017
Common Gull	CM	2		OH533SB	29th August 2017
Cormorant	CA		5	OH533I	29th August 2017
Cormorant	CA	1		OH533SB	29th August 2017
Curlew	CU	42		OH533I	29th August 2017
Curlew	CU	0	8	OH533T	29th August 2017
Great Black-backed Gull	GB		2	OH533I	29th August 2017
Greenshank	GK	2		OH533I	29th August 2017
Grey Heron	H	6		OH533I	29th August 2017
Grey Heron	H	0	2	OH533T	29th August 2017

Herring Gull	HG		3	OH533I	29th August 2017
Herring Gull	HG	1		OH533SB	29th August 2017
Lapwing	L		11	OH533SP	29th August 2017
Little Egret	ET	18		OH533I	29th August 2017
Little Egret	ET	0	7	OH533T	29th August 2017
Mallard	MA	27		OH533I	29th August 2017
Mallard	MA	4		OH533SB	29th August 2017
Redshank	RK	51		OH533I	29th August 2017
Ringed Plover	RP	4		OH533I	29th August 2017
Wigeon	WN	10		OH533SB	29th August 2017
Black-headed Gull	BH	313		OH533I	4th September 2017
Black-tailed Godwit	BW	26		OH533I	4th September 2017
Cormorant	CA		1	OH533I	4th September 2017
Curlew	CU	44		OH533I	4th September 2017
Curlew	CU		21	OH533SP	4th September 2017
Dunlin	DN	12		OH533I	4th September 2017
Great Black-backed Gull	GB	2	2	OH533I	4th September 2017
Greenshank	GK	1		OH533I	4th September 2017
Grey Heron	H	4	1	OH533I	4th September 2017
Herring Gull	HG	7		OH533I	4th September 2017
Herring Gull	HG		1	OH533SB	4th September 2017
Lapwing	L	2		OH533I	4th September 2017
Little Egret	ET	13	6	OH533I	4th September 2017
Mallard	MA	4		OH533I	4th September 2017
Oystercatcher	OC	5		OH533I	4th September 2017
Redshank	RK	99		OH533I	4th September 2017
Shelduck	SU	6		OH533I	4th September 2017
Wigeon	WN	2		OH533I	4th September 2017
Black-headed Gull	BH	38		OH533I	19th October 2017
Black-tailed Godwit	BW	36		OH533I	19th October 2017
Black-tailed Godwit	BW		23	OH533T	19th October 2017
Curlew	CU	17		OH533I	19th October 2017
Golden Plover	GP	113		OH533I	19th October 2017
Great Black-backed Gull	GB	1		OH533I	19th October 2017
Great Black-backed Gull	GB	1		OH533SB	19th October 2017
Great Black-backed Gull	GB		1	OH533SP	19th October 2017
Grey Heron	H.	6		OH533I	19th October 2017
Grey Plover	GV	1		OH533I	19th October 2017
Little Egret	ET	7		OH533I	19th October 2017
Oystercatcher	OC	3		OH533I	19th October 2017
Oystercatcher	OC		1	OH533I	19th October 2017
Redshank	RK	110		OH533I	19th October 2017

Shelduck	SU	18		OH533I	19th October 2017
Snipe	SN		3	OH533T	19th October 2017
Spotted Redshank	DR	1		OH533I	19th October 2017
Teal	T.	10		OH533I	19th October 2017
Wigeon	WN		22	OH533I	19th October 2017
Black-headed Gull	BH	2		OH533I	27th November 2017
Black-tailed Godwit	BW	8		OH533I	27th November 2017
Black-tailed Godwit	BW		12	OH533I	27th November 2017
Black-tailed Godwit	BW		14	OH533T	27th November 2017
Curlew	CU	7		OH533I	27th November 2017
Curlew	CU		5	OH533SP	27th November 2017
Curlew	CU		73	OH533T	27th November 2017
Curlew	CU		27	OH533T	27th November 2017
Curlew Sandpiper	CV	1		OH533I	27th November 2017
Great Black-backed Gull	GB	4		OH533I	27th November 2017
Great Black-backed Gull	GB	1		OH533SB	27th November 2017
Great Black-backed Gull	GB		1	OH533SP	27th November 2017
Lapwing	L	4		OH533I	27th November 2017
Lapwing	L		45	OH533I	27th November 2017
Little Egret	ET		3	OH533I	27th November 2017
Mallard	MA	6		OH533I	27th November 2017
Mallard	MA	1		OH533SB	27th November 2017
Mallard	MA		5	OH533SP	27th November 2017
Oystercatcher	OC	4		OH533I	27th November 2017
Oystercatcher	OC		4	OH533I	27th November 2017
Oystercatcher	OC		2	OH533SP	27th November 2017
Redshank	RK	67		OH533I	27th November 2017
Shelduck	SU	10		OH533I	27th November 2017
Wigeon	WN	45		OH533SB	27th November 2017
Black-headed Gull	BH	21		OH533I	18th December 2017
Black-tailed Godwit	BW	4		OH533I	18th December 2017
Curlew	CU	22		OH533I	18th December 2017
Curlew	CU		6	OH533I	18th December 2017
Dunlin	DN	5		OH533I	18th December 2017
Golden Plover	GP	46		OH533I	18th December 2017
Golden Plover	GP		5	OH533I	18th December 2017
Great Crested Grebe	GG	6		OH533SB	18th December 2017
Greenshank	GK	4		OH533I	18th December 2017
Greenshank	GK		1	OH533I	18th December 2017
Grey Heron	H.	4		OH533I	18th December 2017
Herring Gull	HG		12	OH533I	18th December 2017
Lapwing	L.	358		OH533I	18th December 2017

Lapwing	L.		20	OH533I	18th December 2017
Little Egret	ET	1		OH533I	18th December 2017
Mallard	MA	3		OH533I	18th December 2017
Oystercatcher	OC	42		OH533I	18th December 2017
Redshank	RK	53		OH533I	18th December 2017
Snipe	SN		2	OH533T	18th December 2017
Teal	T.		73	OH533I	18th December 2017
Teal	T.	16		OH533SP	18th December 2017
Wigeon	WN	20		OH533I	18th December 2017
Wigeon	WN		75	OH533I	18th December 2017
Wigeon	WN	4		OH533SB	18th December 2017
Wigeon	WN		12	OH533T	18th December 2017
Cormorant	CA	2		OH533I	25th January 2018
Curlew	CU	4	2	OH533I	25th January 2018
Curlew	CU		6	OH533SP	25th January 2018
Curlew	CU		69	OH533T	25th January 2018
Dunlin	DN	38		OH533I	25th January 2018
Golden Plover	GP	155		OH533I	25th January 2018
Great Crested Grebe	GG	2		OH533I	25th January 2018
Greenshank	GK	1		OH533I	25th January 2018
Lapwing	L	110		OH533I	25th January 2018
Lapwing	L		218	OH533T	25th January 2018
Mallard	MA	4		OH533SB	25th January 2018
Redshank	RK	30	35	OH533I	25th January 2018
Shelduck	SU	4		OH533I	25th January 2018
Snipe	SN		3	OH533T	25th January 2018
Teal	T.	2		OH533I	25th January 2018
Teal	T.	2		OH533SB	25th January 2018
Wigeon	WN	71		OH533SB	25th January 2018
Black-headed Gull	BH	139	1	OH533I	1st February 2018
Black-tailed Godwit	BW	35		OH533I	1st February 2018
Curlew	CU	21		OH533I	1st February 2018
Dunlin	DN	1405		OH533I	1st February 2018
Golden Plover	GP		27	OH533I	1st February 2018
Greenshank	GK	4		OH533I	1st February 2018
Grey Heron	H	1		OH533I	1st February 2018
Grey Plover	GV	1		OH533I	1st February 2018
Herring Gull	HG	5		OH533I	1st February 2018
Lapwing	L	29	11	OH533I	1st February 2018
Little Egret	ET	3		OH533I	1st February 2018
Oystercatcher	OC	3		OH533I	1st February 2018
Redshank	RK	84		OH533I	1st February 2018

Shelduck	SU	24		OH533I	1st February 2018
Teal	T.	6		OH533I	1st February 2018
Wigeon	WN		4	OH533I	1st February 2018

Bird counts from subsite OH534 from May to September 2017. I = Intertidal, SB = Subtidal, SP = Supratidal, T = Terrestrial. Species in red have the potential to occur within the subtidal zone (MKOS, 2017)

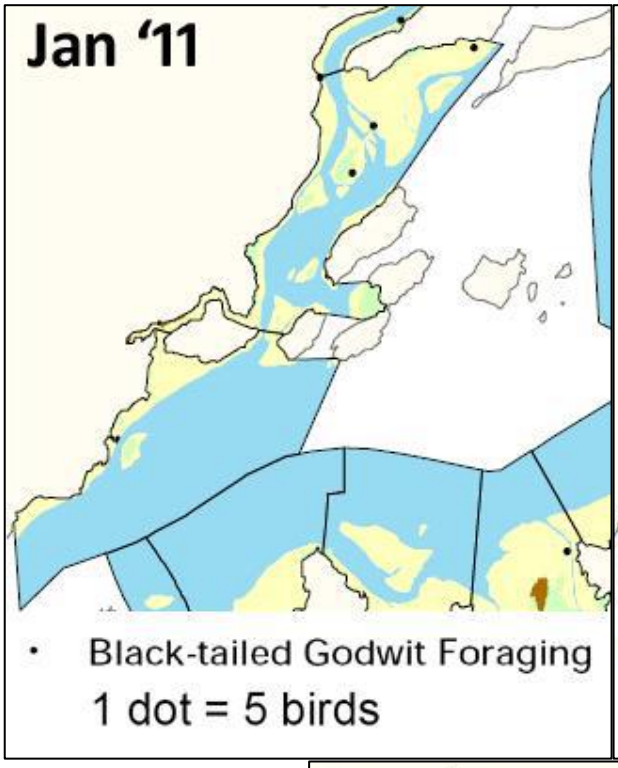
Species	Code	Feeding	Roosting	Subsite	Date
Black-headed Gull	BH	3		OH534I	19th May 2017
Black-headed Gull	BH		8	OH534SB	19th May 2017
Grey Heron	H	1		OH534SP	19th May 2017
Grey Heron	H	0	1	OH534T	19th May 2017
Herring Gull	HG	1	2	OH534I	19th May 2017
Mallard	MA	2	2	OH534I	19th May 2017
Mallard	MA	1		OH534SB	19th May 2017
Shelduck	SU	2		OH534I	19th May 2017
Black-headed Gull	BH	22		OH534I	23rd June 2017
Curlew	CU	12		OH534I	23rd June 2017
Grey Heron	H	2		OH534I	23rd June 2017
Little Egret	ET	1		OH534I	23rd June 2017
Mallard	MA	10		OH534I	23rd June 2017
Shelduck	SU	3		OH534I	23rd June 2017
Black-headed Gull	BH	2		OH534I	30th August 2017
Black-headed Gull	BH		47	OH534SP	30th August 2017
Cormorant	CA		1	OH534I	30th August 2017
Curlew	CU		65	OH534SP	30th August 2017
Great Crested Grebe	GG	5		OH534SB	30th August 2017
Greenshank	GK	7		OH534I	30th August 2017
Herring Gull	HG	1		OH534I	30th August 2017
Herring Gull	HG		15	OH534SP	30th August 2017
Little Egret	ET		4	OH534I	30th August 2017
Mallard	MA	8	6	OH534I	30th August 2017
Oystercatcher	OC		3	OH534I	30th August 2017
Redshank	RK	50		OH534I	30th August 2017
Black-headed Gull	BH	79		OH534I	5th September 2017
Black-tailed Godwit	BW	28		OH534I	5th September 2017
Cormorant	CA		1	OH534SP	5th September 2017
Curlew	CU	142		OH534I	5th September 2017
Grey Heron	H	2		OH534I	5th September 2017
Herring Gull	HG	1		OH534I	5th September 2017
Mallard	MA	32		OH534I	5th September 2017
Oystercatcher	OC	5		OH534I	5th September 2017
Redshank	RK	13		OH534I	5th September 2017
Black-headed Gull	BH	36		OH534I	18th October 2017
Black-tailed Godwit	BW	34		OH534I	18th October 2017

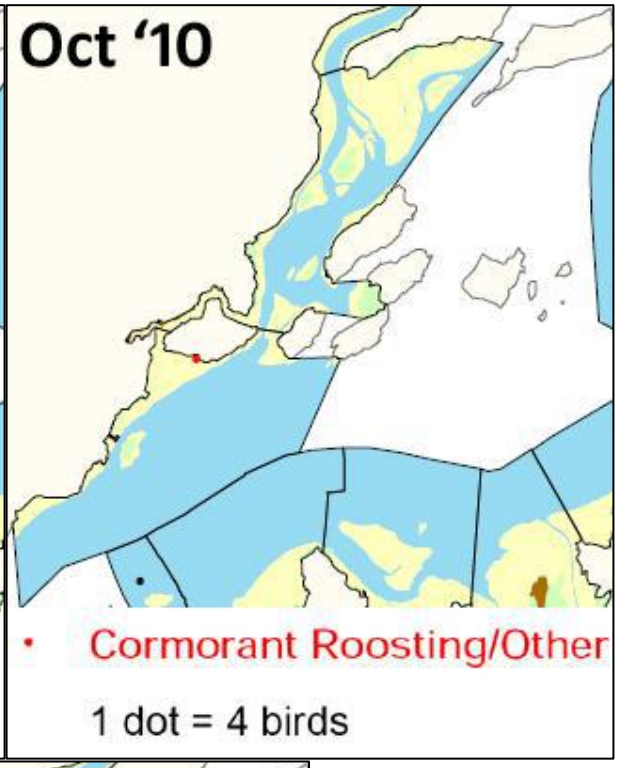
Species	Code	Feeding	Roosting	Subsite	Date
Curlew	CU	27		OH534I	18th October 2017
Greenshank	GK	2		OH534I	18th October 2017
Grey Heron	H.	1		OH534I	18th October 2017
Little Egret	ET	3		OH534I	18th October 2017
Mallard	MA	47		OH534I	18th October 2017
Moorhen	MH	1		OH534SB	18th October 2017
Mute Swan	MS		3	OH534SB	18th October 2017
Oystercatcher	OC	4		OH534I	18th October 2017
Redshank	RK	22		OH534I	18th October 2017
Teal	T.	10		OH534I	18th October 2017
Teal	T.		1	OH534SB	18th October 2017
Curlew	CU		2	OH534SP	19th October 2017
Black-headed Gull	BH	68		OH534I	27th November 2017
Curlew	CU	1		OH534SP	27th November 2017
Curlew	CU	21		OH534T	27th November 2017
Dunlin	DN	2		OH534I	27th November 2017
Great Crested Grebe	GG	4		OH534I	27th November 2017
Greenshank	GK	1		OH534SP	27th November 2017
Little Grebe	LG		1	OH534T	27th November 2017
Mallard	MA	1		OH534SP	27th November 2017
Moorhen	MH		3	OH534T	27th November 2017
Mute Swan	MS		1	OH534T	27th November 2017
Redshank	RK	7		OH534I	27th November 2017
Redshank	RK	5		OH534SP	27th November 2017
Teal	T.		17	OH534T	27th November 2017
Wigeon	WN	4		OH534SP	27th November 2017
Wigeon	WN		5	OH534T	27th November 2017
Black-headed Gull	BH	41		OH534I	18th December 2017
Curlew	CU	36		OH534I	19th December 2017
Dunlin	DN	42		OH534I	19th December 2017
Great Crested Grebe	GG	5		OH534I	19th December 2017
Greenshank	GK	4		OH534I	19th December 2017
Grey Plover	GV	14		OH534I	19th December 2017
Little Egret	ET	2		OH534I	19th December 2017
Little Grebe	LG	2		OH534T	19th December 2017
Moorhen	MH	4		OH534T	19th December 2017
Mute Swan	MS	2		OH534T	19th December 2017
Oystercatcher	OC	2		OH534I	19th December 2017
Redshank	RK	6		OH534I	19th December 2017
Teal	T.	26		OH534I	19th December 2017
Wigeon	WN	15		OH534I	19th December 2017

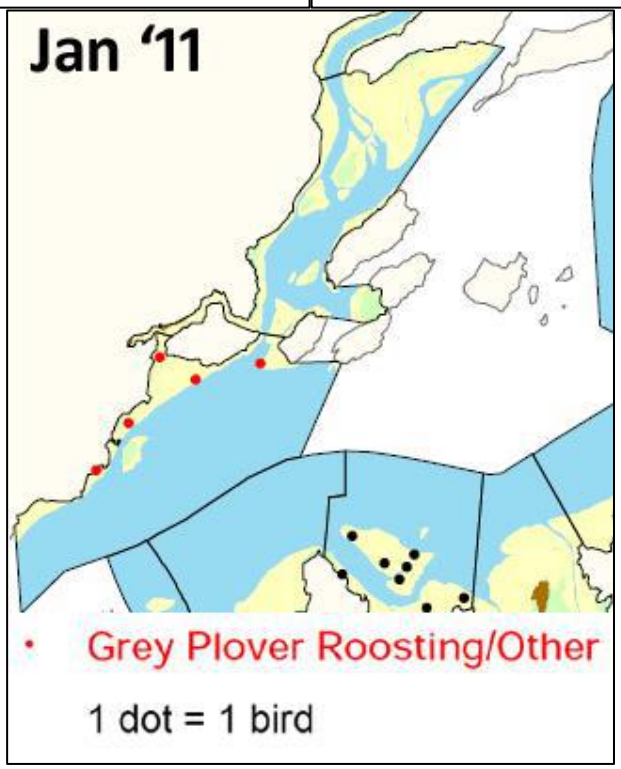
Species	Code	Feeding	Roosting	Subsite	Date
Wigeon	WN	2		OH534T	19th December 2017
Black-headed Gull	BH		2	OH534I	26th January 2018
Common Sandpiper	CS	1		OH534I	26th January 2018
Cormorant	CA	1		OH534SB	26th January 2018
Curlew	CU		19	OH534I	26th January 2018
Great Crested Grebe	GG	9		OH534SB	26th January 2018
Lapwing	L		28	OH534I	26th January 2018
Mallard	MA		9	OH534I	26th January 2018
Mallard	MA	3		OH534SB	26th January 2018
Mallard	MA		2	OH534T	26th January 2018
Moorhen	MH	1		OH534T	26th January 2018
Mute Swan	MS		3	OH534T	26th January 2018
Oystercatcher	OC		1	OH534I	26th January 2018
Redshank	RK	10	2	OH534I	26th January 2018
Shelduck	SU	2		OH534I	26th January 2018
Teal	T.		23	OH534I	26th January 2018
Teal	T.		3	OH534T	26th January 2018
Wigeon	WN	4		OH534I	26th January 2018
Wigeon	WN		2	OH534T	26th January 2018
Black-headed Gull	BH	38		OH534I	2nd February 2018
Cormorant	CA		1	OH534I	2nd February 2018
Curlew	CU	41		OH534I	2nd February 2018
Great Crested Grebe	GG	6		OH534SB	2nd February 2018
Lapwing	L	40		OH534I	2nd February 2018
Light-bellied Brent Goose	PB	1		OH534I	2nd February 2018
Little Egret	ET	3		OH534I	2nd February 2018
Mallard	MA	2	1	OH534I	2nd February 2018
Mute Swan	MS	3		OH534T	2nd February 2018
Redshank	RK	13		OH534I	2nd February 2018
Shelduck	SU	15		OH534I	2nd February 2018
Teal	T.	4		OH534I	2nd February 2018
Wigeon	WN		2	OH534SB	2nd February 2018

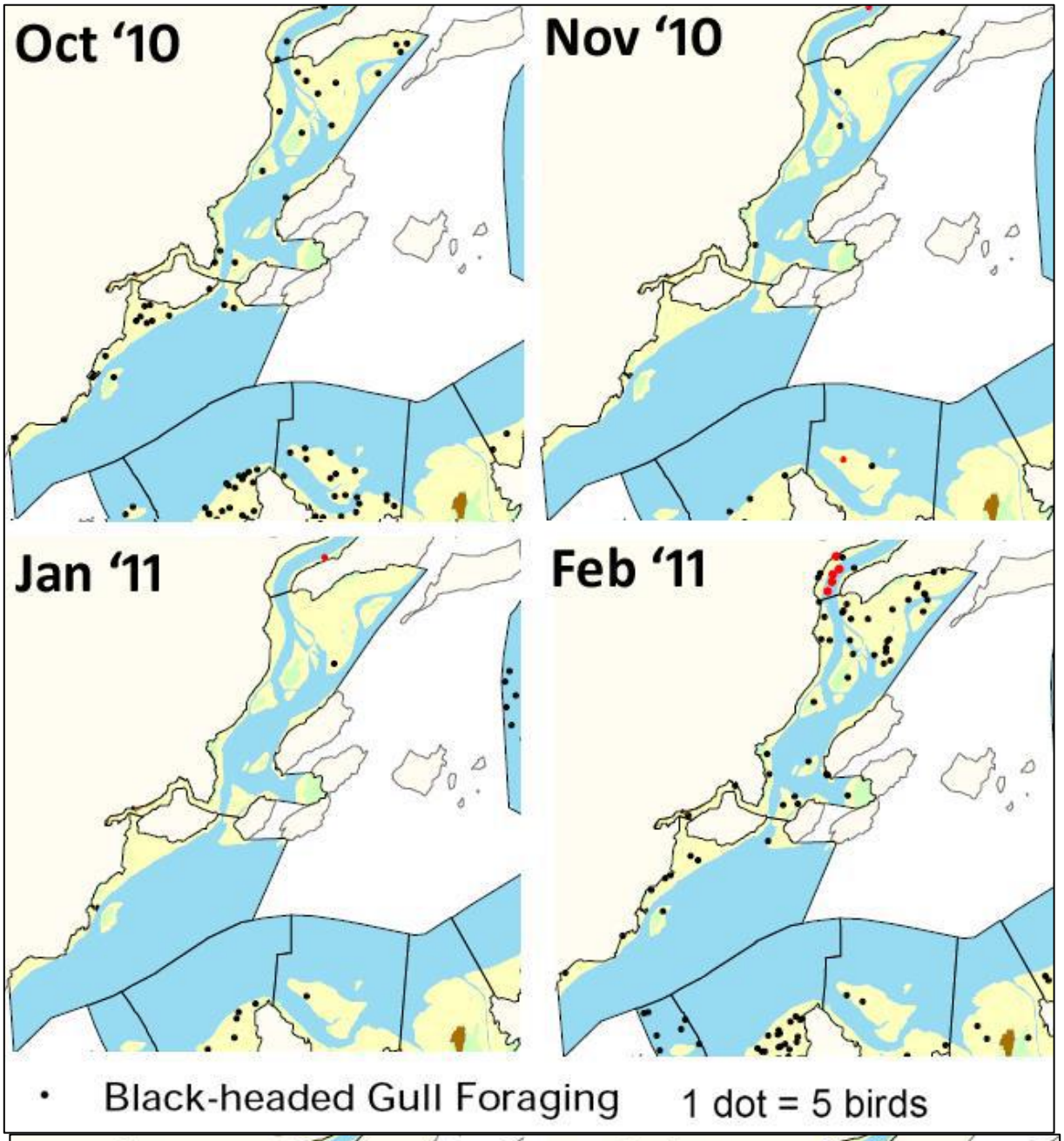
Appendix 4

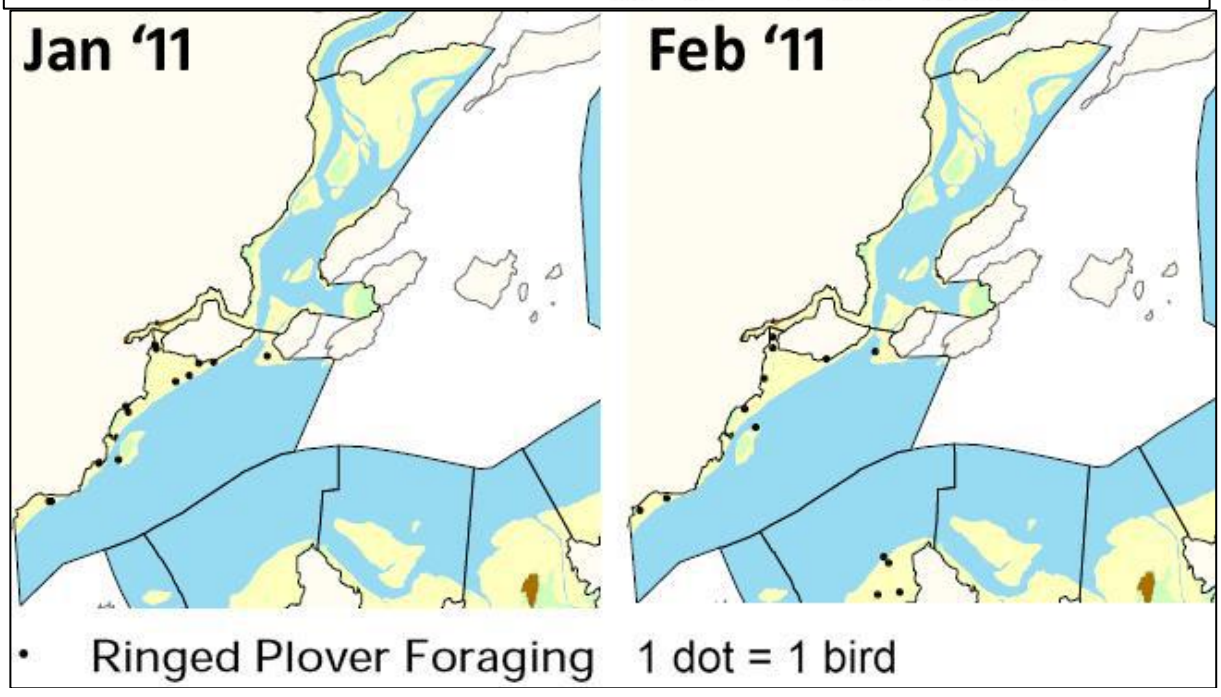
NPWS Winter Waterbird Survey October 2010 – February 2011 – Dot Density Maps (OH533 and OH534)

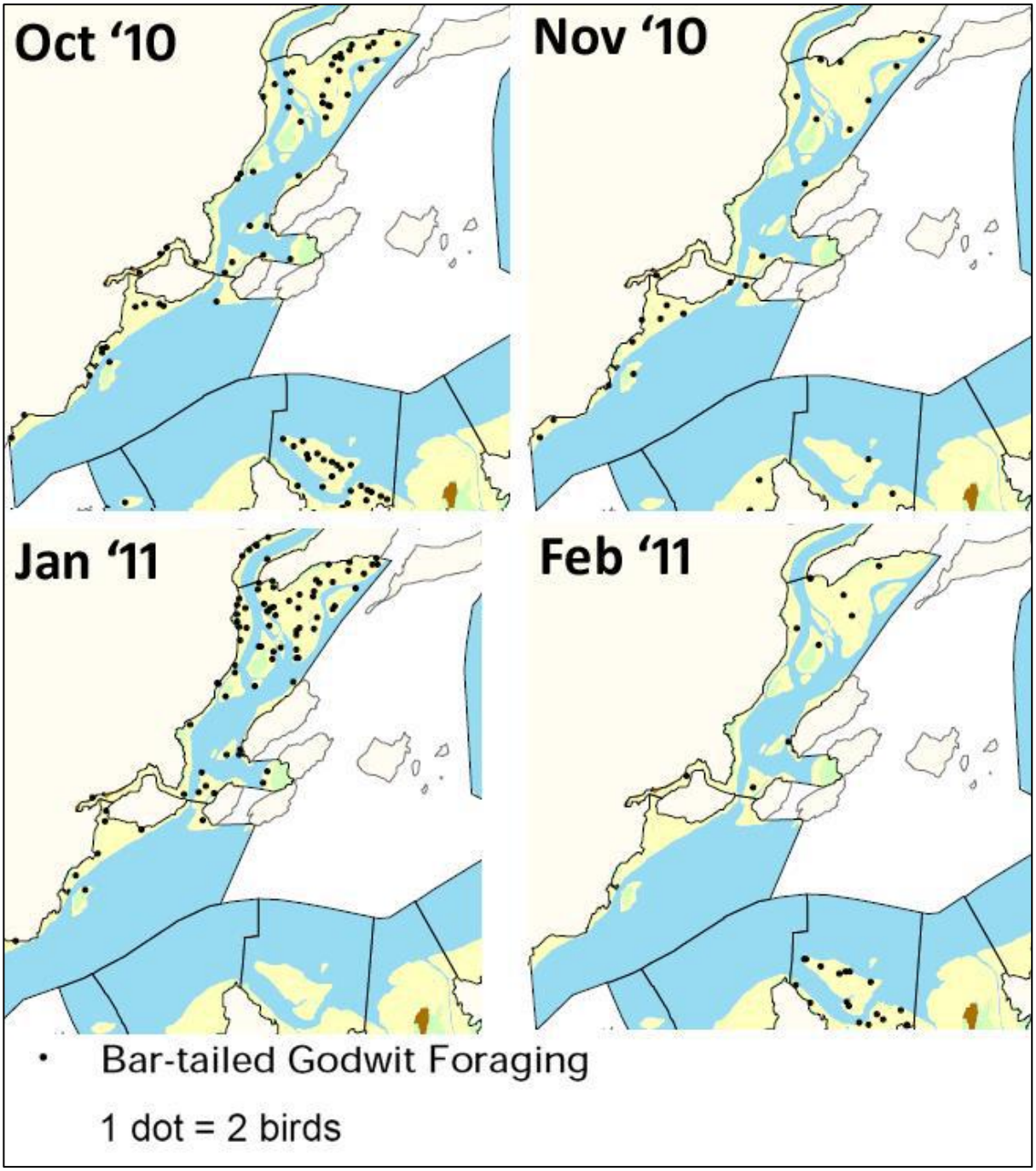

Jan '11
Black-tailed Godwit Foraging
1 dot = 5 birds

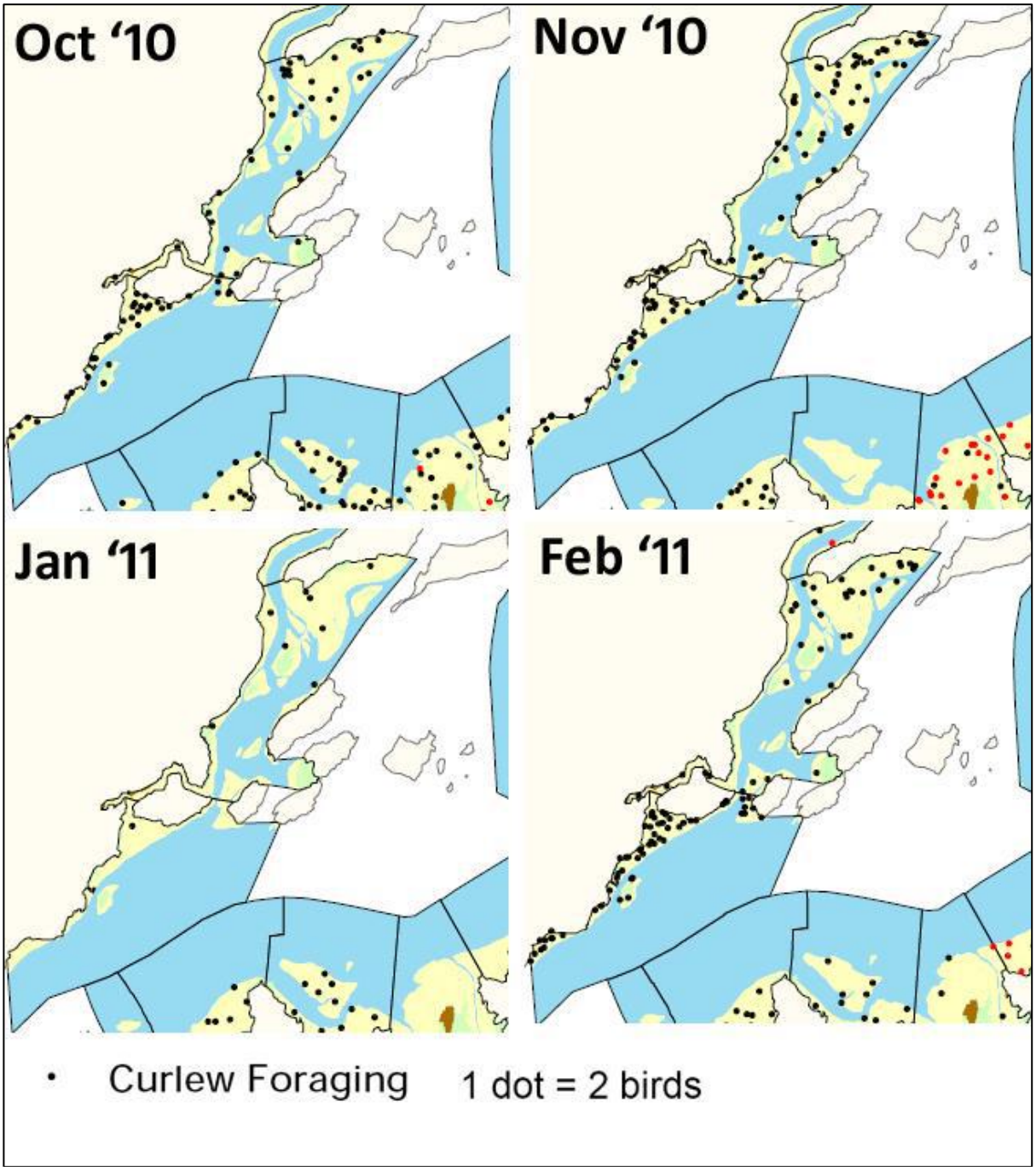

Oct '10
Cormorant Roosting/Other
1 dot = 4 birds

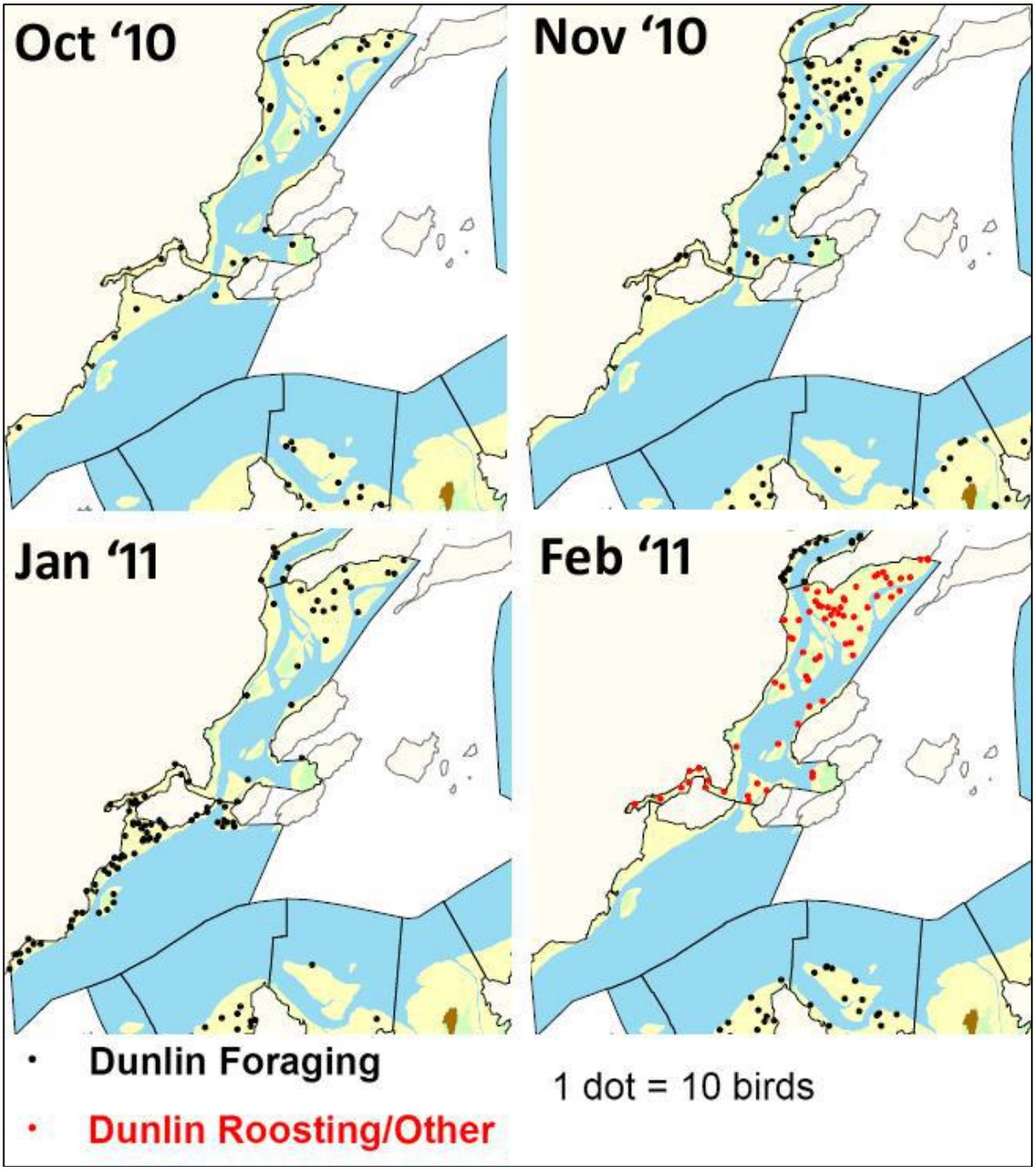

Jan '11
Grey Plover Roosting/Other
1 dot = 1 bird

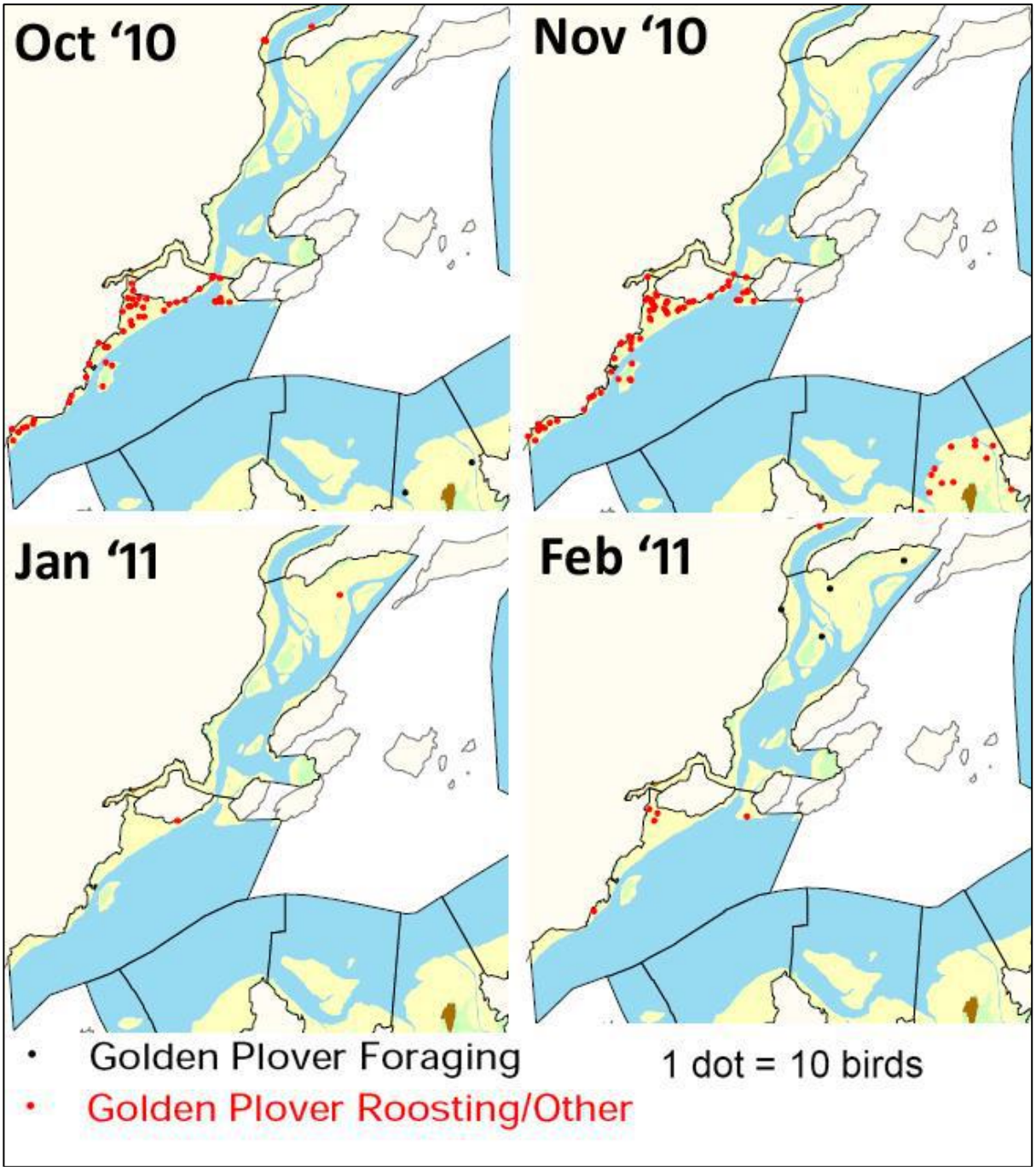

Oct '10
Nov '10
Jan '11
Feb '11
• Black-headed Gull Foraging 1 dot = 5 birds

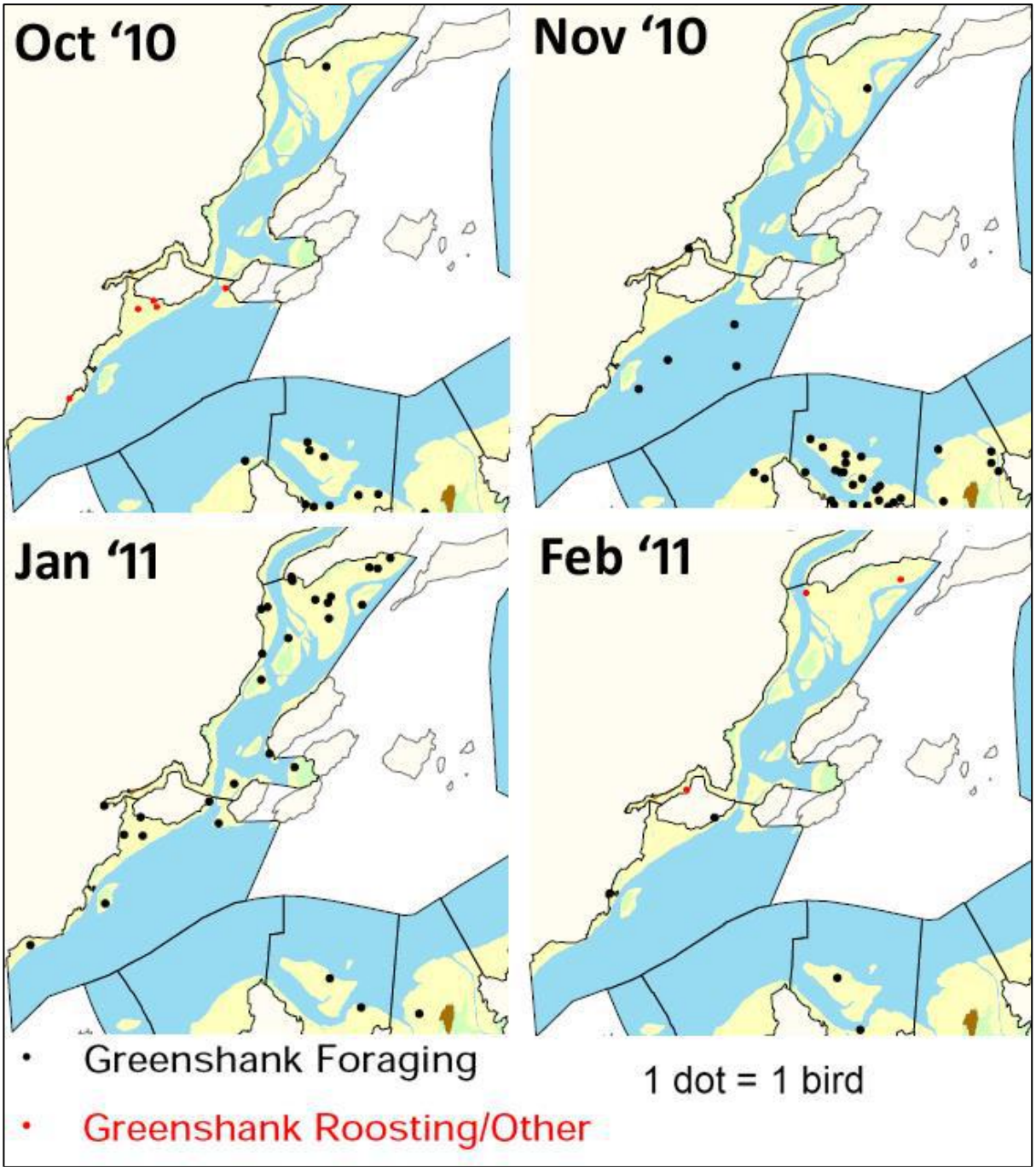

Jan '11
Feb '11
• Ringed Plover Foraging 1 dot = 1 bird

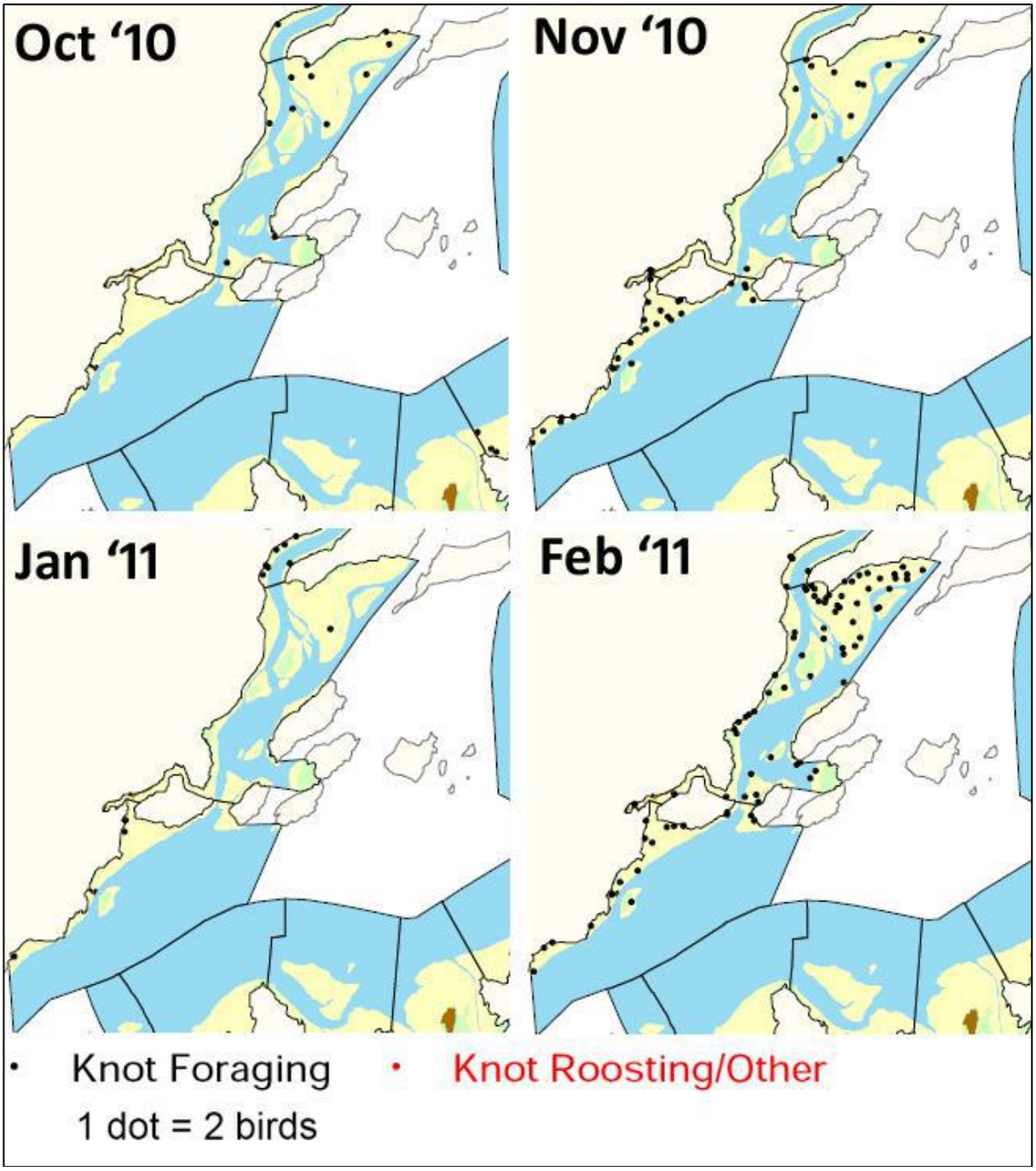

Oct '10
Nov '10
Jan '11
Feb '11
• Bar-tailed Godwit Foraging
1 dot = 2 birds

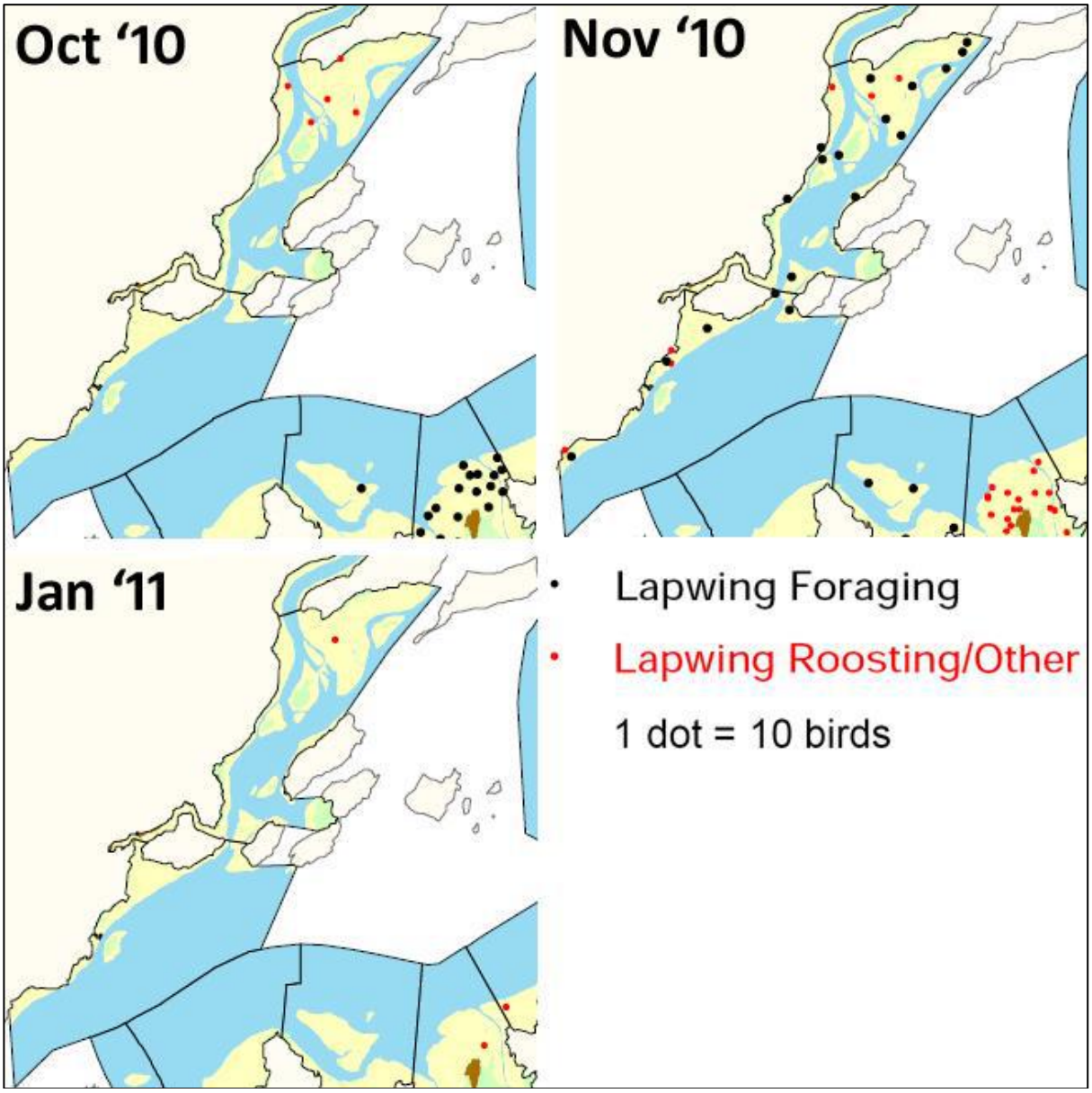

Oct '10
Nov '10
Jan '11
Feb '11
• Curlew Foraging 1 dot = 2 birds

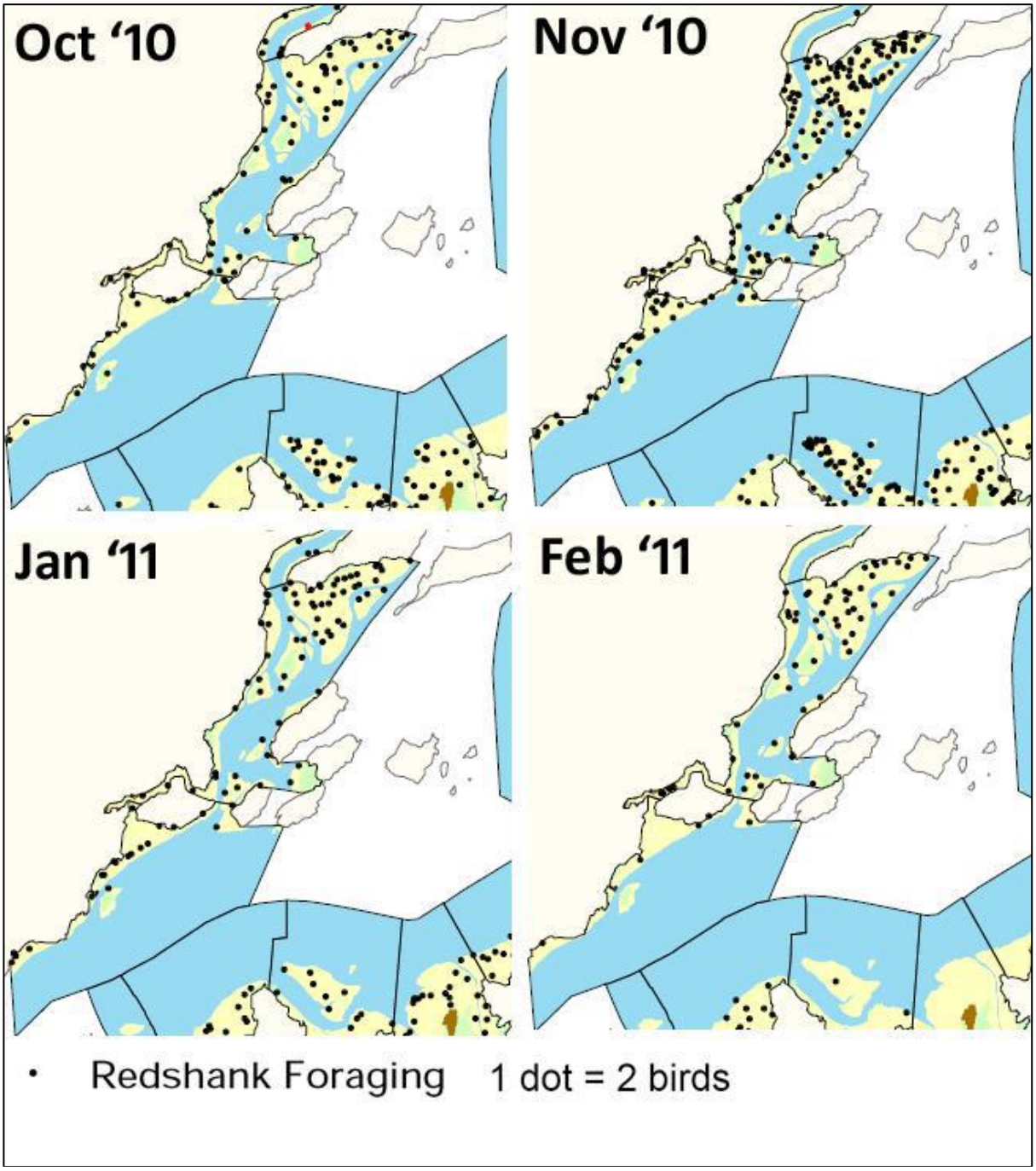

Oct '10
Nov '10
Jan '11
Feb '11
Dunlin Foraging
Dunlin Roosting/Other
1 dot = 10 birds


Oct '10
Nov '10
Jan '11
Feb '11
• Golden Plover Foraging
• Golden Plover Roosting/Other
1 dot = 10 birds

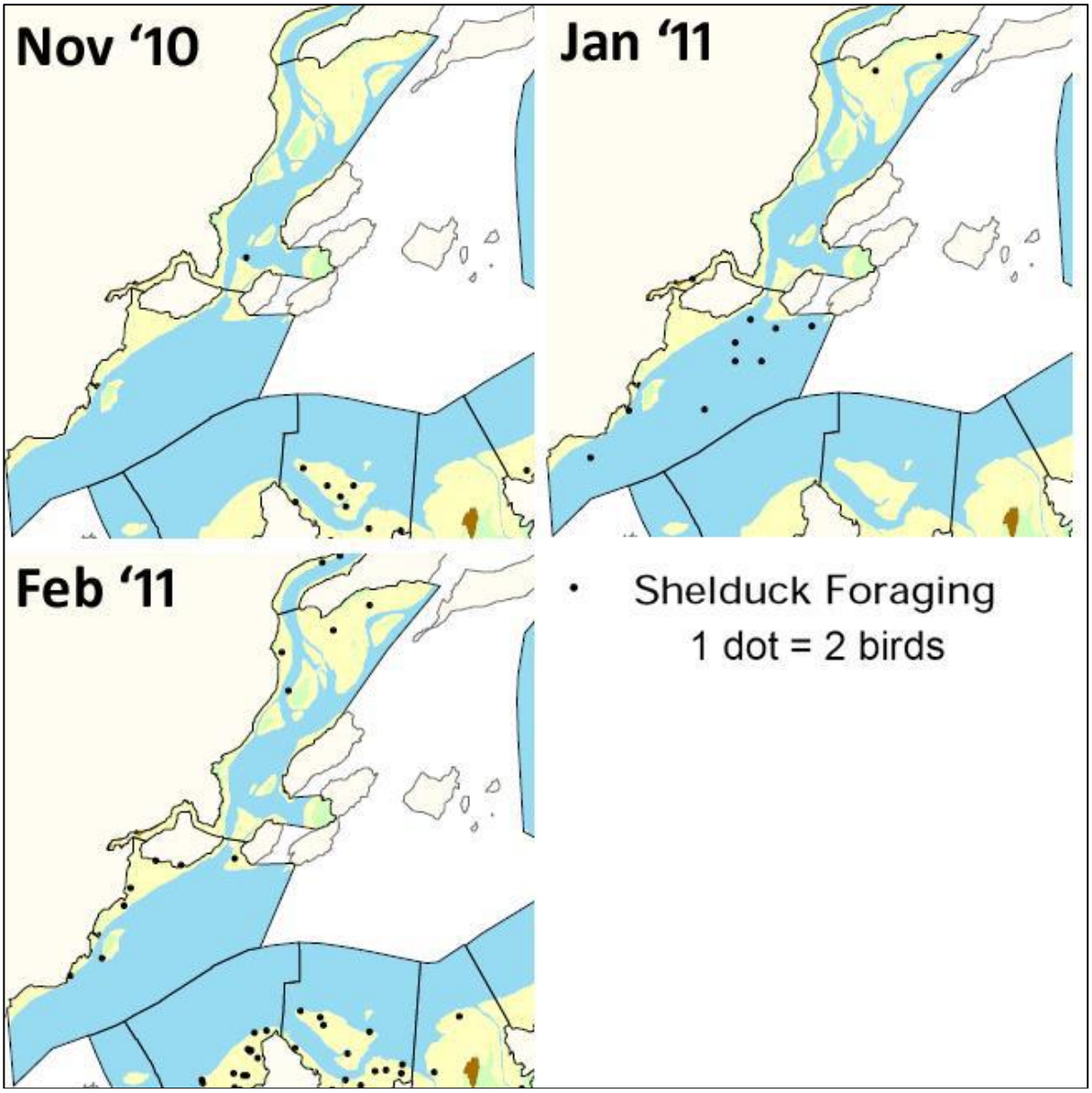

Oct '10
Nov '10
Jan '11
Feb '11
Greenshank Foraging
Greenshank Roosting/Other
1 dot = 1 bird

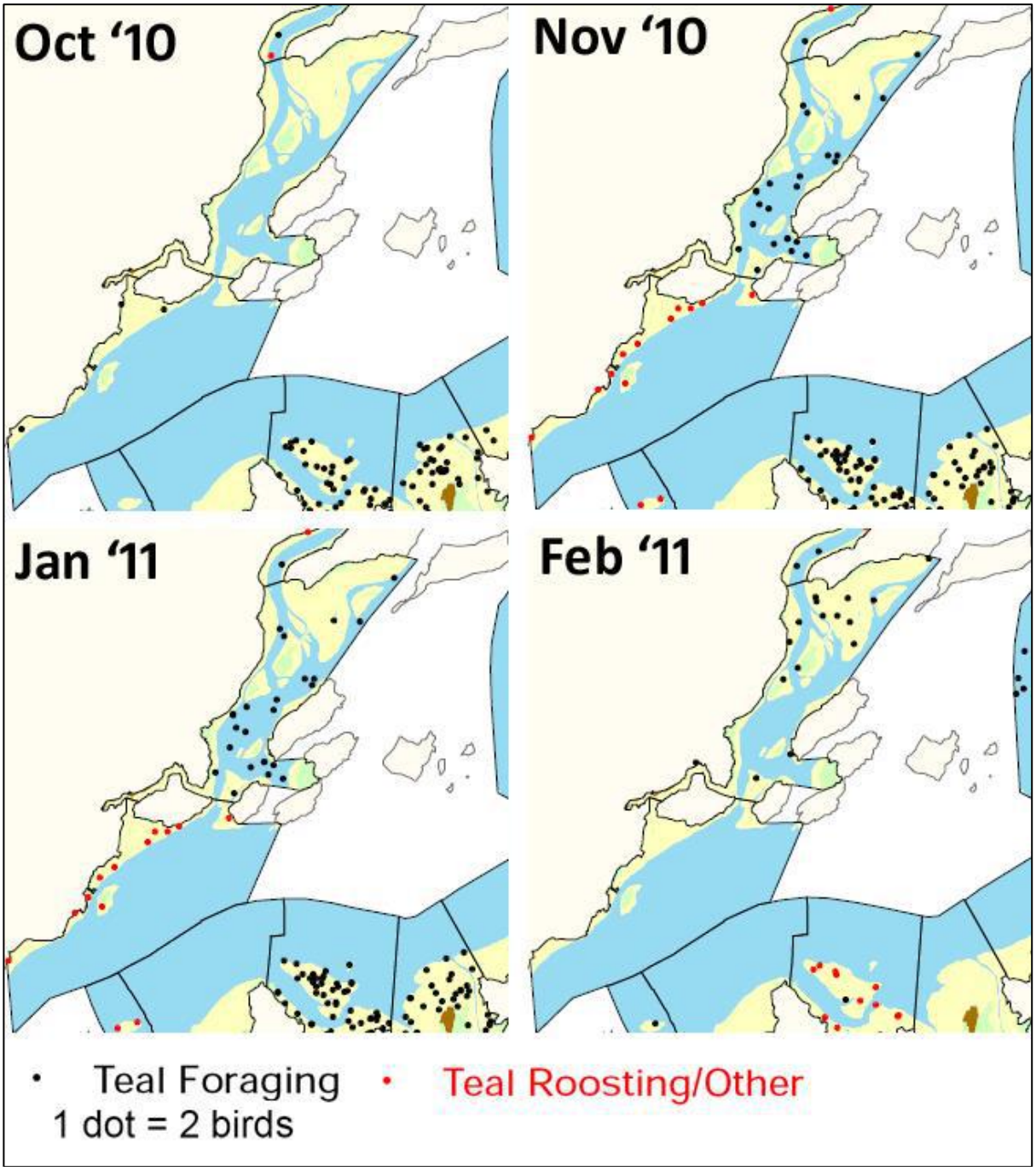

Oct '10
Nov '10
Jan '11
Feb '11
• Knot Foraging
• Knot Roosting/Other
1 dot = 2 birds

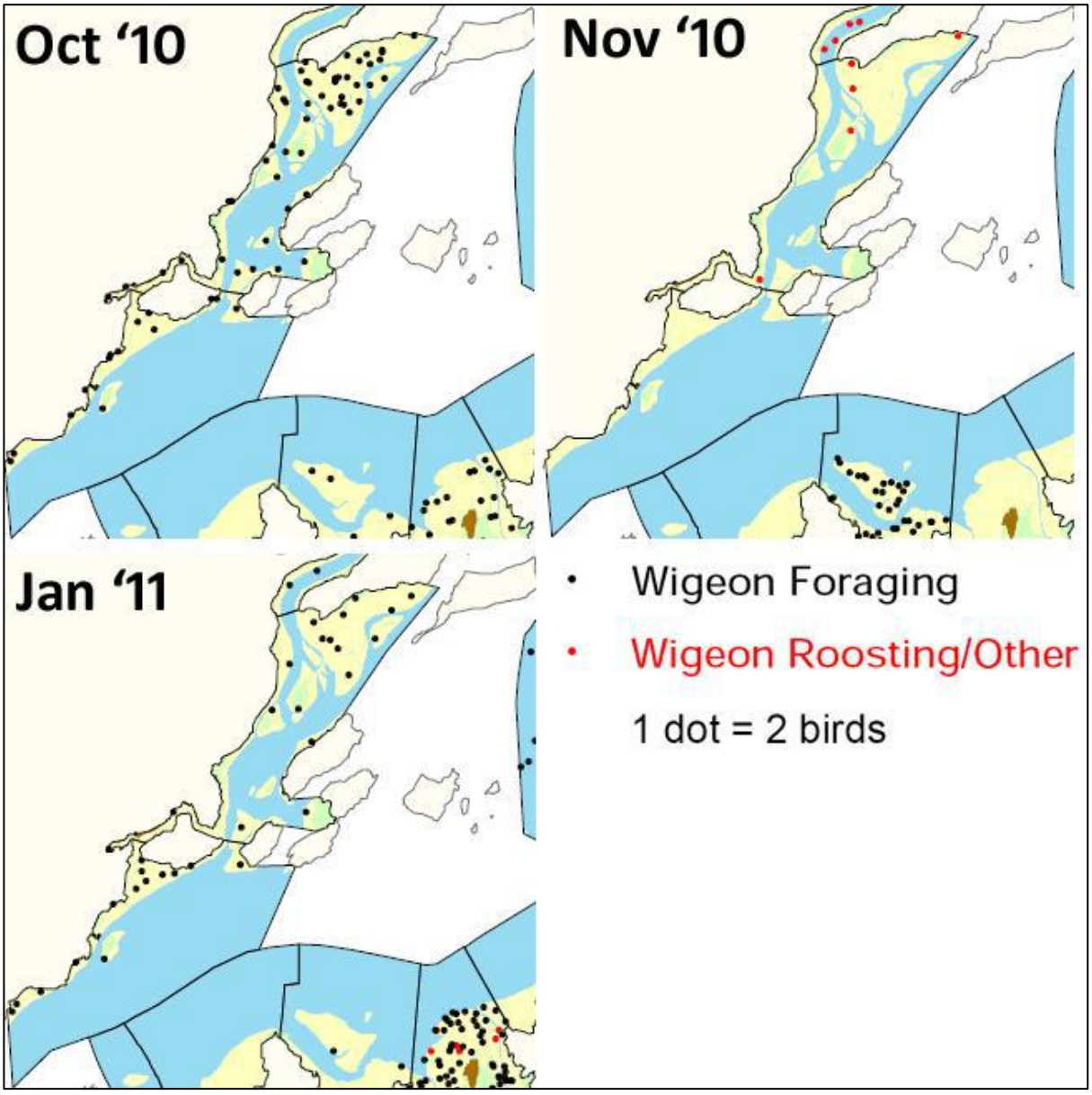

Oct '10
Nov '10
Jan '11
Lapwing Foraging
Lapwing Roosting/Other
1 dot = 10 birds



- Redshank Foraging 1 dot = 2 birds


Nov '10
Jan '11
Feb '11
Shelduck Foraging
1 dot = 2 birds


Oct '10
Nov '10
Jan '11
Feb '11
Teal Foraging
Teal Roosting/Other
1 dot = 2 birds


Oct '10
Nov '10
Jan '11
Wigeon Foraging
Wigeon Roosting/Other
1 dot = 2 birds

Appendix 5

Installation & Operation

Risk Assessment & Contingency Planning

March 2018

DPR60 – Preliminary Marine Installation Manual

H2020 60kW Test Project

Submitted to:

Vincent McCormack – Design Pro

Submitted by:

Dare Technology

CONTENTS

Note - *This report is a deliverable under proposal PR-TMOS-001 which has been awarded to Daretech by DesignPro Ltd. The purpose of the study is to develop a preliminary marine operations plan in order to support the Foreshore application to Clare County Council. All engineering and calculations notes are therefore preliminary, and not for construction at this point.*

1. OVERVIEW

PROJECT OVERVIEW

This European Union H2020 funded project has been awarded to DesignPro to design, build, test and validate the 60kW version of the GKinetic Tidal Turbine. The project has a 25-month duration and has begun in XXXX.

A key deliverable is to obtain a site to test the latest 60kW generation of the technology in 2018. The device will be designed and manufactured at the DesignPro facility in Rathkeale Limerick. Following completion of manufacture, the device will be delivered to Foynes, where it will be mobilised into the water. It will be installed at the test site in the Shannon Estuary between Canon Island, and Inistubbrid Island in a water depth of approximately 20m. The device is expected to be tested for a period of at least 9 months where it may be temporarily relocated to shore multiple times for either weather or maintenance reasons.

The purpose of this document is to outline the key operational steps to install the DPR60 device at the test site within 2018.

TECHNOLOGY

The GKinetic tidal turbine is a floating device, that uses 2 x vertical axis rotors to capture kinetic energy from tidal currents or river flows.

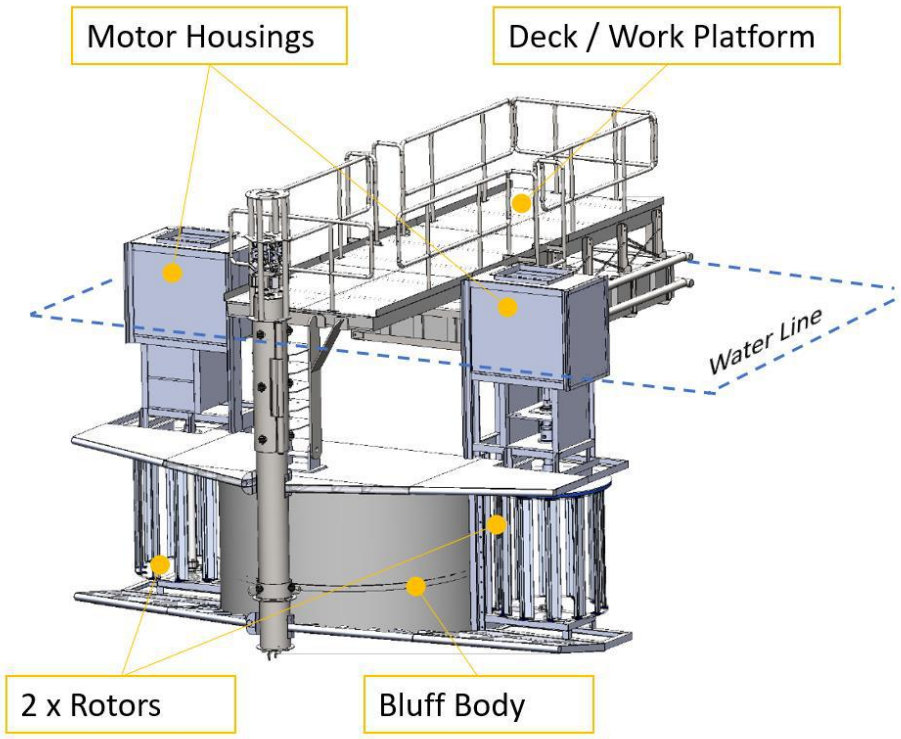


Figure 1 - DPR60 Tidal Turbine in Operating Configuration

The device is moored at the surface to the moving current with the rotor and bluff body section facing into the current. The bluff body diverts flow into the rotors and thereby increases the inflow current speed to the rotors. The blades, which are self-aligning to the flow, rotate a central drive shaft which are connected to the AC generators contained within the housings. The electricity produced within the generators is conditioned using the onboard switch gear, and transferred to shore via a subsea cable, (not shown). The key characteristics of the Design 60kW, (DPR60), machine is:

Characteristics	Value
Device Dimensions	11m x 9.5m x 6m (l x w x h)
Installed Draught	4m
Dry Weight	20T
Power Capacity	60kW

Table 1 - DPR60 Key Characteristics

STUDY INPUTS

The following has been used as inputs to the preliminary study and calculations.

Criteria	Value Used
Design Current Speed	2.6m/s
Tidal Range	6m
Water Depth	20m
Wave Climate	Sheltered
Co-Efficient of Drag	0.7
Seabed Composition	Unknown
Submerged Service Area (Towing)	17 m^2
Submerged Service Area (Operation)	33.25 m^2
DPR60 Weight	20T
Design Life	5 years
Environmental Loads	See appendix A

Table 2 - Study Inputs and References

2. SITE OVERVIEW

Figure 2 - Overview of Mobilisation, Deployment & Standby Area

MOBILISATION PORT - FOYNES

Due to the proximity, and good road access from the manufacturing site at Rathkeale, the device will be lifted into the water in Foynes port. A site within the port that has sufficient set down areas will be identified and the unit will be offloaded from the delivery truck in the 'towed configuration'

A crane of sufficient lift capacity will be selected, and the device will be lifted directly into the water. It is likely a small vessel will be required to access the device to release the rigging. Final preparations will then be made before the machine is deemed ready for the installation phase. A detailed mobilisation plan will be developed in due course.

DEPLOYMENT SITE

Figure 3 - Deployment Site

The test site sits between Canon Island, and Inishtubbrid Island on the Clare side of the Shannon Estuary in Ireland. The following area has been selected for the device installation:

Latitude	52°40'4.97"N
Longitude	9° 3'36.21"W
Installation Target Area	75m radius about nominal

Table 3 - Installation Co-ordinates

The device will be held in place using a mooring system which extends up to 250m from the device. Following installation, the device will operate within an 10m radius from nominal range depending on changing tidal range and flow direction. This will leave sufficient room for passing of other marine users at all times.

3. MARINE EQUIPMENT

INSTALLATION VESSEL

There are several suitable vessels in the area capable of undertaking the installation work, however due to the requirement for a stern winch, and a mooring system it is recommended to utilise the Shannon 1 Multicat which is the 1908 series from Damen. This is a versatile workboat with suitable engine power to undertake the tow from Foynes to the site, and complete the installation works.

Figure 4 - Shannon 1 MultiCat [1908 Series]

Dimension	Value
Length Overall (m)	19.7
Beam (m)	8.1
Bollard Pull (T)	12.3
Max Speed (Knts)	9.2
Power (BPW)	714
Ancillary Equipment	Loader Crane 5.4 ton @ 8.44 m Winch System – 20 ton @ 16m/min

Table 4 - Shannon 1 Key Characteristics

Based on the available information for the Shannon 1 vessel, we can determine the limitations of the installation window. By derating the maximum Bollard Pull linearly over the speed range, and furthermore reducing the max engine power to 80%, it can be shown the max current for maintaining control of the vessel in the flowing current while under tow is approx. 4.2knots. This becomes the T0 time for the installation as shown in high level timing chart in later sections.

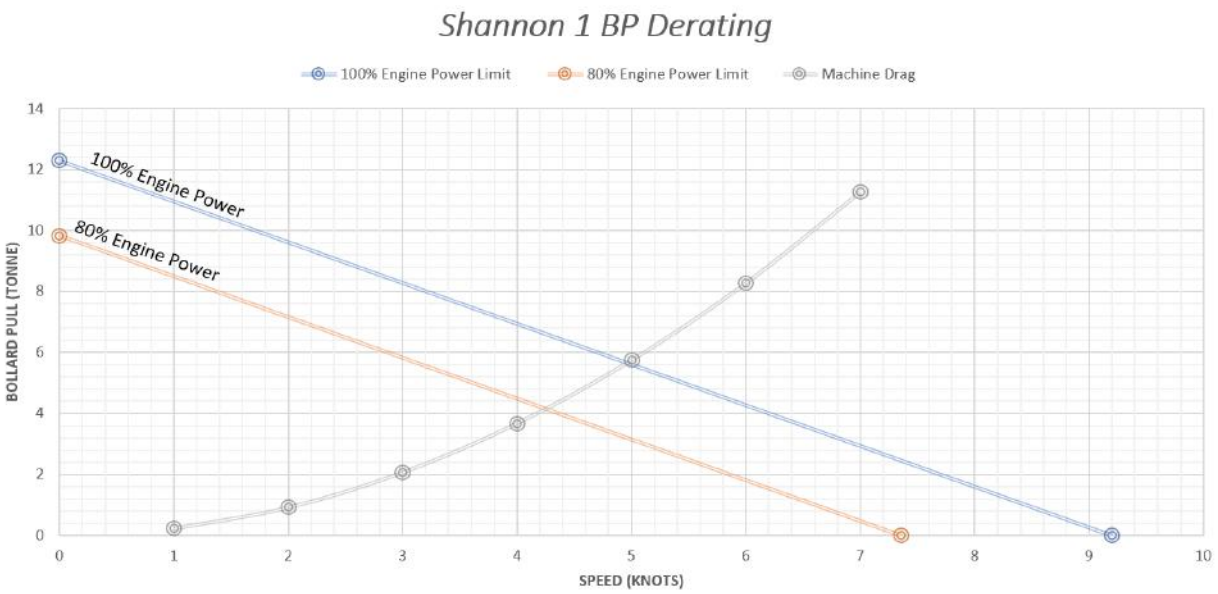


Figure 5 - Shannon 1 Capacity

OTHER SUITABLE / AVAILABLE VESSELS

Vessel	Details	Mooring Install	Device Install	Support
Shannon 1	• See above	✔	✔	
Ard Ri	• Workboat with forward ramp. • 15 x 4m LOA with 11 x 4.5m deck • 8 Knots top speed • Loader Crane 3.4T @ 1.5m, 0.75T @ 9m • P2 Certificate	✔	✔	✔
Capa Lass	• 12 x 3.6m LOA • 1.5m draught			✔
Cava Lass	• 3T Bollard Pull • P5 Licence			✔

Table 5 – Available Marine Assets

4. SITE PREPARATION

MOORING INSTALLATION

Following the preliminary analysis, it is deemed a 2-point mooring system is the most suited to the application. The lines comprising of heavy duty marine grade chain, and rope will extend approx. 280m to the northeast of the device location, and approximately 275m to the southeast.

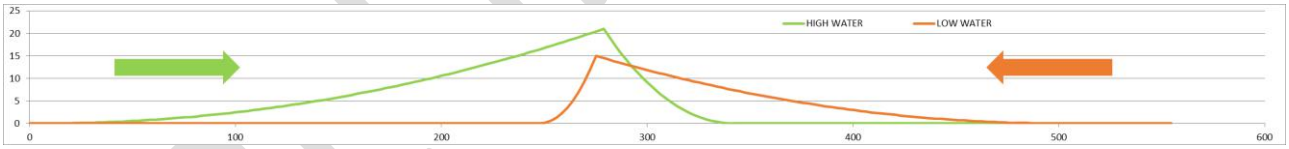


Figure 6 - Mooring Cross Section

At the end of the lines an anchor which has the holding capacity of >180kN will be installed. The details of this anchor will be determined following further site investigation. See Appendix B for mooring system calculations.

The mooring system will be installed in a separate marine operation in advance of the device installation. The abandoned pennant will be left on the seabed with a pick-up line buoyed to the surface ready for recovery on the day of the device installation. The pick-up line will be clearly marked with a large Norwegian buoy to ensure visible to passing marine traffic.

A detailed method statement for installation of fixed moorings will follow more detailed planning stage.

NAVIGATIONAL AIDS

The DPR 60 will contain navigational aids for both the installation, and operational phase of the project to provide hazard identification, channel and waypoint marking to other seafarers.

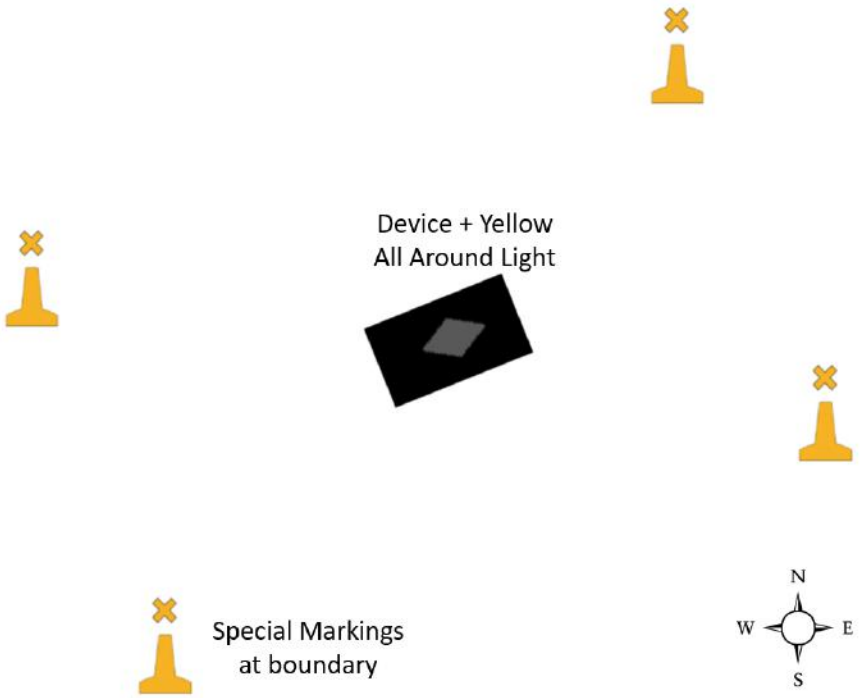


Figure 7 - Navigational Markings for Operation

It is recommended the device is fitted with a masthead containing a white or yellow light and sidelights over the forward centreline. and has a recharging system for the battery. Navigational Aids should be installed to the satisfaction of Shanon Foynes Port Harbour Master.

Situation	Markings
Under Tow	Port / Starboard Lights
Moored	White or Yellow Light on mast
Area Boundary	Special Markings around perimeter

Table 6 - Navigational Aids

The navigational aids will be ready to be operational immediately following the installation of the device at the test site.

5. DEVICE INSTALLATION

ENVIRONMENTAL LIMITS

Marine operations for device installation shall be restricted with the following environmental limits at all times. The final call of what constitutes acceptable will be made by the vessel master on the day of installation, however must not exceed limits set out below.

	Limit
Wind Speed	20 knots (max)
Wave Height	1.0m significant wave.
Peak Current (Day of installation)	4.2 knots[1]
Tidal Condition (For installation)	Neap Ebb Tide

Table 7 - Environmental Limits for Installation

HIGH LEVEL TIMING

The following section gives an hour by hour overview of the installation sequence, from operations in Foynes port, to the completion of the device installation at the test site.

Time	Event
T0 – 24hrs	• Mobilisation complete, Device sign off for installation
T0 – 9 hrs	• Departure from Foynes. • Transit to standby area due NE of installation target.
T0-6 Hrs	• All vessels on station. • Final preparations. • Prepare for temporary mooring hook up.
T0-3 Hrs	• Forward vessel prepares mooring hook up • Support vessel tends hook up lines • Standby for T0

[1] ***Note – this is specific to installation vessel – see Figure 6 Shannon 1 Capacity***

T0	• Load up on moorings and walk back to target position. • Handover messenger line from support vessel. • Messenger line connected. • Hoist in on slack rope
T0 + 30mins	• Recover pennant from seabed. • Pennant locked into position on DPR60 • Slip towing bridle
T0 + 40mins	• DPR60 now moored. • Installation vessel recovery of temporary moorings. • Tidal operations complete.

Table 8 - High Level Step by Step for Installation

Activities which are tidal dependent have been plotted on a sample tidal curve of current speed v time to show the period of the tidal cycle it is intended they occur at. This graph can be updated with detailed current speed, and time during the detailed planning stage.

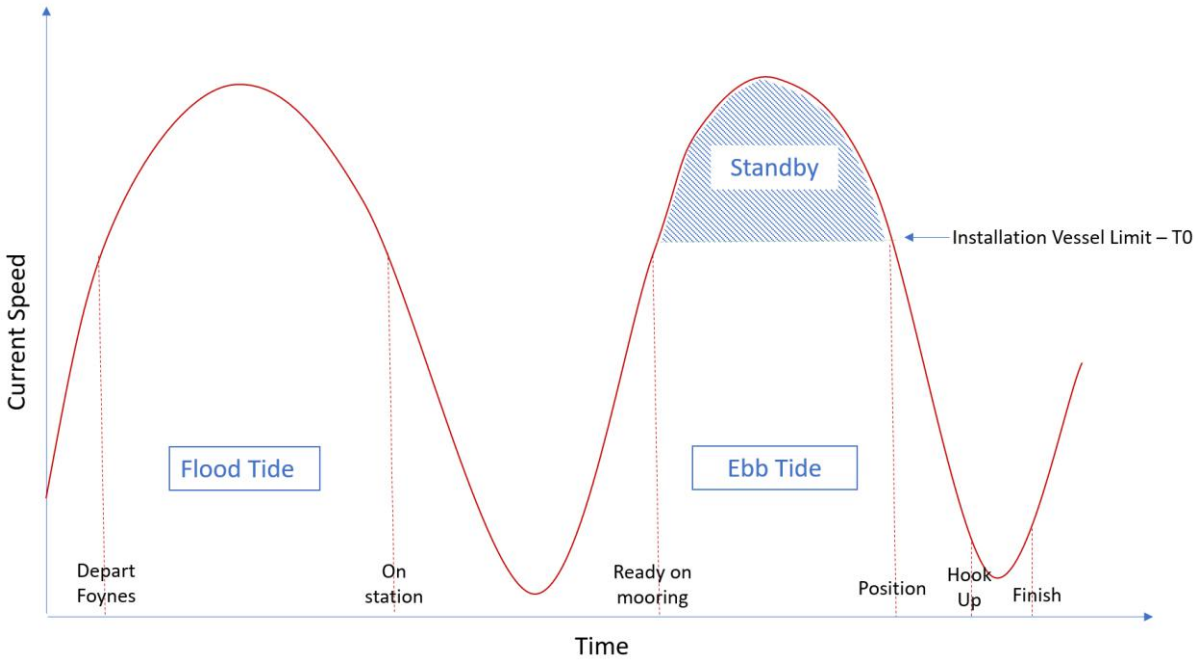


Figure 8 - Sample Operational Timings [Refer to device installation – overview section below]

The device will be towed from Foynes port and will be connected to the forward vessel via a short towing bridle. The length of the tow is to be confirmed but may require the installation of a towing diamond as a marker to other users.

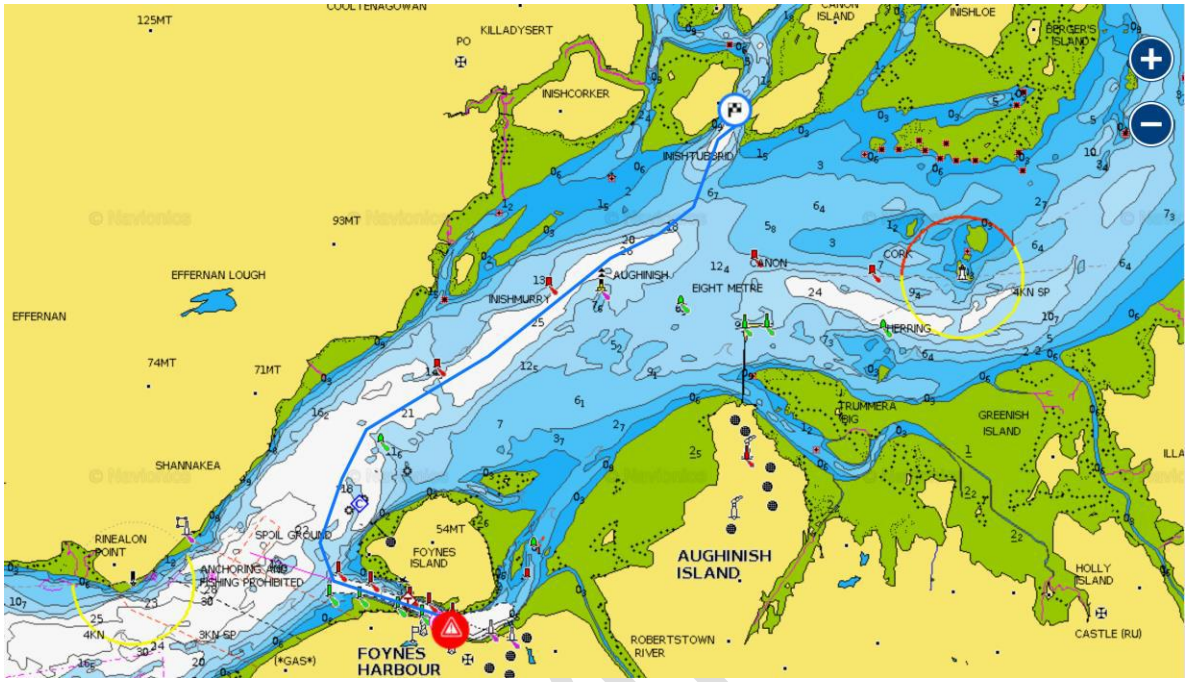


Figure 9 - Indicative Tow Route - [Not for Navigation]

Furthermore, a notice to mariners will be issued to cover the entire installation operation. While under tow the vessels will have the following draughts.

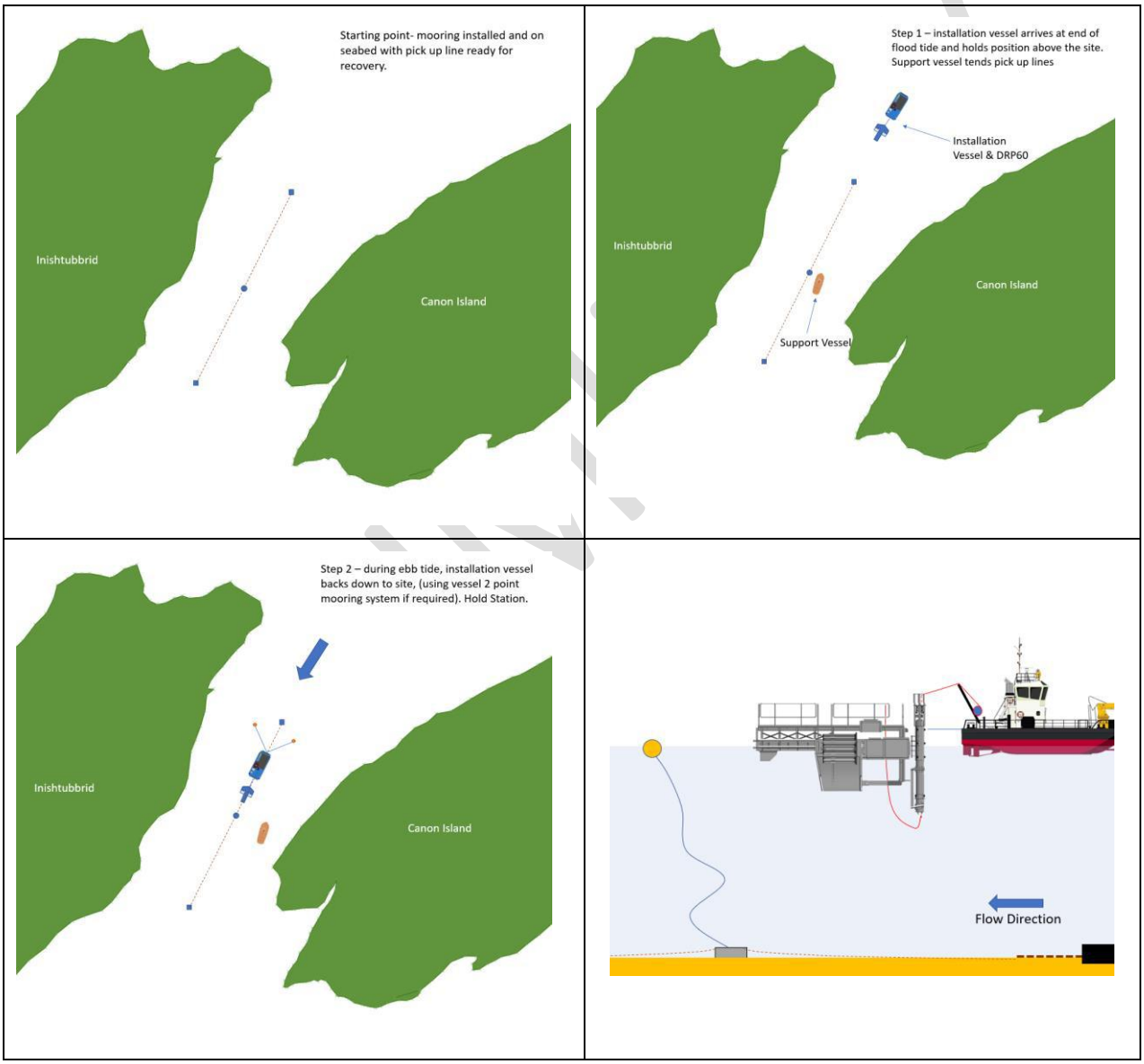
Vessel	Draught
DPR60	3m
Forward Tug	4m Maximum [Final TBC]

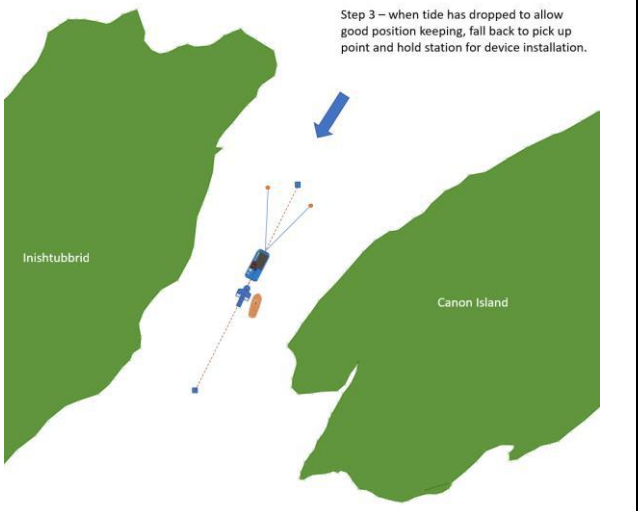
Table 9 - Vessel Draughts under Tow

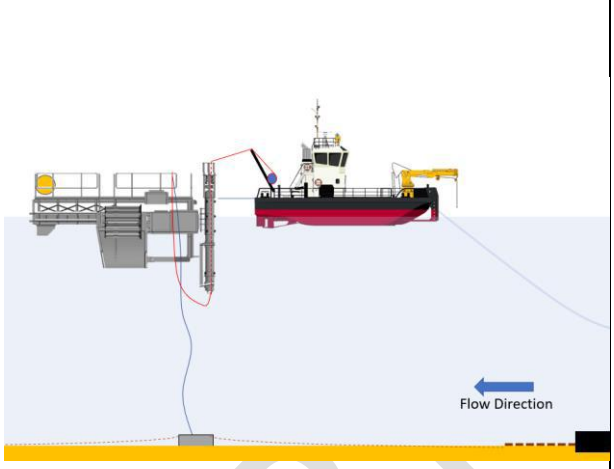
An indicative tow route is given above, the distance to be covered from Foynes to the installation site is just over 5nm and is expected to take approx. 2.5hrs. The towage company will be responsible for producing the passage plan in accordance with IMO Resolution A.893 (21) Guidelines For Voyage Planning. The convoy will leave Foynes approx. 3 hours in advance of high water, and travel to the installation site on the flood tide. It will then standby north of the installation tide and conduct final preparations until the tidal installation window opens. The tow will commence once a valid towing certificate has been issued from the Warranty Surveyor.

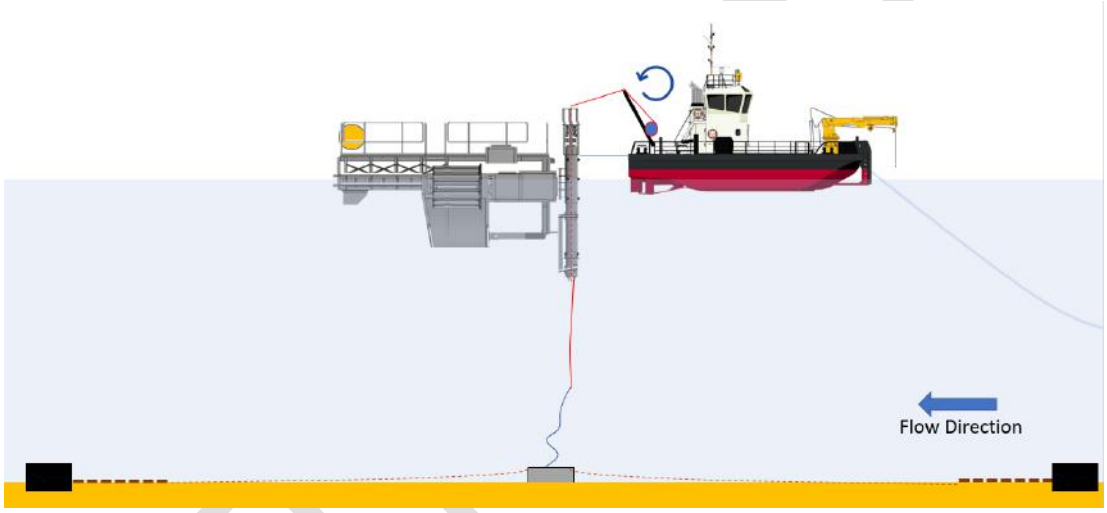
DEVICE INSTALLATION – OVERVIEW

The following gives a high level pictorial overview of the planned operation **which will be undertaken on a single tidal cycle.** At an early point in the project, a detailed marine method statement must be developed, with input from the vessel and device owners, and any other stakeholders through means of a Hazard Identification & Risk Assessment workshop. The outcome of this workshop will be incorporated into the detailed installation procedure.

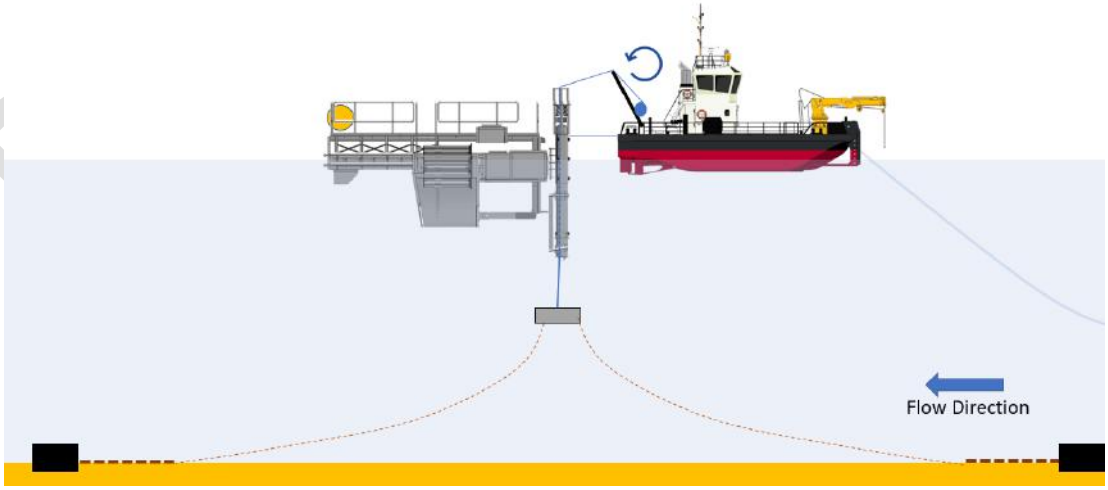




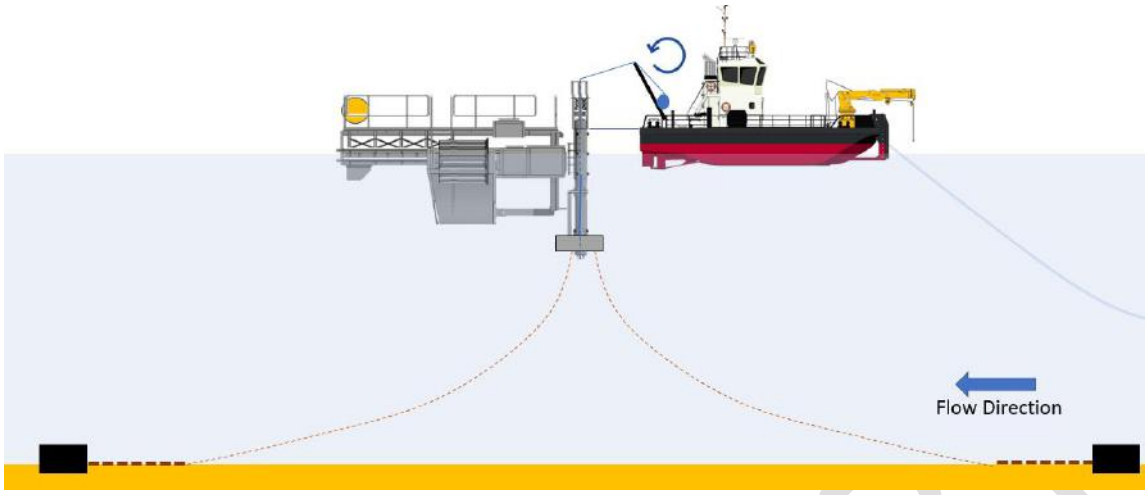




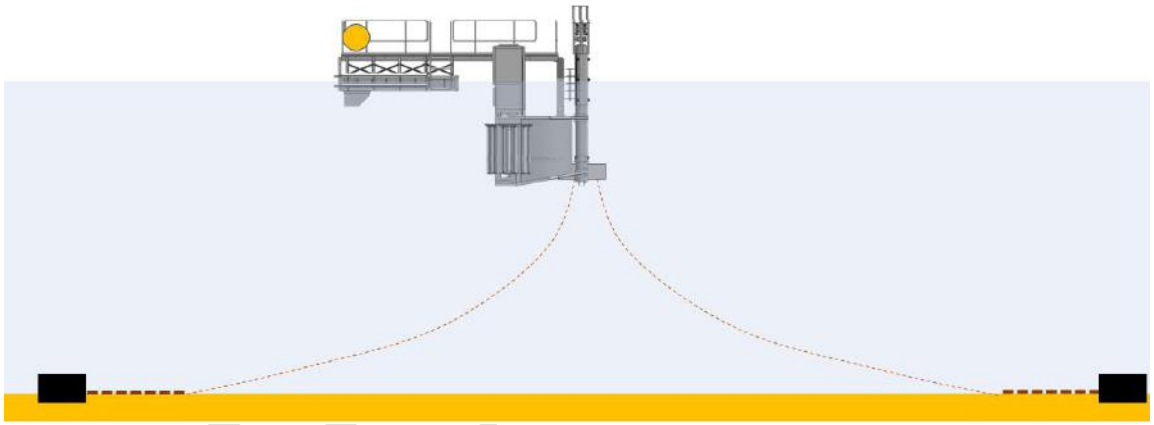
Installation vessel pulls up mooring system on winch, (expected lift force 7T).



As mooring system is lifted device and installation vessel now become anchored. Any position keeping no longer required.



Mooring system to be 'pinned' in place, and lines to installation vessel inch will slack and can be disconnected. ***Note*** – 'Pinning' method to be determined with input from device design team.



Installation vessel can now completely detach and leave the site. DesignPro team can begin the commissioning at any stage from the moored device.

Figure 10 - Installation Overview [Not to Scale]

6. POST INSTALLATION

CHANNEL RESTRICTIONS

Upon installation an 'As Built' drawing of the final position will be submitted to the harbour master, and Clare County Council, confirming the device is installed in accordance with the permit and licence application.

Due to the reversing currents and change in water surface elevation of the device it's important to note the device will move within a radius of 10m about its installed position. This will leave a suitable channel for other marine users to pass at all times. The extents of this boundary will be marked with 'Special Marking' surface buoys in order to identify and ensure awareness of any associated hazards.

7. PRELIMINARY RISK ASSESSMENT

Ref.	Phase	Hazard	Initial Risk			Control	Final Risk		
			L (1-4)	S (1-4)	R		L (1-4)	S (1-4)	R
1.	Installation Phase	Marine Collision - vessels	3	4	12	• Notice to mariners issued by harbour master • Inter vessel communication systems in place and checked. • Clear briefing and understanding by all vessel masters and crew. • Navigational markings in place and operating. • Emergency bridle on device.	1	4	4
2.		Loss of installation position keeping	4	3	12	• Installation vessel capable of holding station on own power. • Use of vessel mooring system for fine control over positioning. • Support vessel in standby • Careful selection of tidal and weather windows.	2	3	6
3.		Marine incident	3	4	12	• Stability checks for vessel and device to be undertaken. • Hazard Identification & Risk Assessment undertaken with all involved. • Detailed planning undertaken of all operational task and risks.	1	4	4
4.		Abort of operation for operational issue	3	3	9	• Stage gates of operation, and time to reverse process at any point.	3	1	3
5.	Operation Phase	Marine Collision – vessels with device	2	4	8	• 50m Exclusion zone around device marked with 'special markings' • Notice to mariners issued and As Built submitted to Clare Co.CO & SFPC.	1	4	4
6.		Mooring Failure	2	3	6	• Detailed design of anchor within load capacity. • Use of certified materials.	1	2	2
7.		Extreme weather	4	3	12	• Device can be removed within one tidal cycle. • Relocation to more sheltered area north of test site.	4	1	4