AECOM

Shannon Technology and Energy Park Power Plant

Environmental Impact Assessment Report
Chapter 07A Marine Biodiversity

Shannon LNG Limited

April 2024

Delivering a better world

Prepared for:

Shannon LNG Limited

Prepared by:

AQUAFACT, a member of the APEM Group

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7A.1 Introduction

7A.1.1 Overview

AQUAFACT was commissioned to assess the potential impact of the proposed Shannon Technology and Energy Park (STEP) Power Plant development on the quality of the marine environment and on protected marine and estuarine species and habitats.

This chapter will describe the likely significant effects of the Proposed Development on marine ecology and biodiversity including flora, fauna and habitats.

It will provide a comprehensive assessment of the potential impact mechanisms associated with the Proposed Development.

The Site is located in the townlands of Kilcolgan Lower and Ralappane, between Tarbert and Ballylongford, Co. Kerry. The application Site boundary ('red line') encloses an area of approximately 41 hectares (ha) and is entirely owned by the Applicant.

Full details on the background, Site history and the Proposed Development is provided in **Chapter 02** (Description of the Proposed Development) and also the Planning Statement submitted with this planning application.

The impact mechanisms which will be reviewed include the release of pollutants during construction, the impact of underwater noise due to onshore blasting during construction, seabed habitat loss due to the installation of a trenched outfall pipe across the foreshore and the discharge to the Shannon Estuary of wastewater and processed effluent from the Proposed Development.

This assessment has been informed by targeted surveys of marine habitats and species and by reviewing outputs from a numerical pollutant dispersion model and noise model developed to support the previous planning application. The outputs from these models are still valid and can be used to assess the impact of the Proposed Development on water quality and underwater noise in the Shannon Estuary.

The chapter follows the protocols detailed in the Environmental Protection Agency's (EPA) Guidelines on the information to be contained in Environmental Impact Assessment Reports (EPA, 2022).

7A.1.2 Competent Experts

Dr Shane O'Boyle is the marine ecology lead for the Proposed Development and has responsibility for all associated ecological surveys and reporting. He is expert in ecological matters and the full spectrum of environmental assessment techniques, methodologies, and statutes. Professionally, he is a member and fellow of the Royal Society of Biology and the Royal Geographical Society and a chartered scientist (CSci).

Shane has 25 years of experience in the field of marine science and has published approximately 50 scientific papers and numerous reports specialising in understanding and monitoring the impact of different human activities on the ecological health of estuarine and coastal waters. Shane has been directly involved in the establishment of national ecological monitoring programmes and water quality standards in his time working in the Environmental Protection Agency, Ireland.

As Head of AQUAFACT Shane has been responsible for all aspects of management including the design, execution and reporting of numerous desk studies, surveys, assessments, and environmental outputs including NIS, AA screening and EIARs. Shane has been published in a number for peer-reviewed journals and his publications have been cited in over 1,000 documents.

Anthony Cawley holds an honours degree in Civil Engineering and a post graduate master's degree in Engineering Hydrology. He is a Chartered Civil Engineer with Specialist education and 30 years professional consulting experience in the water engineering field in a wide variety of activities relating to hydrology, hydrogeology and flooding, and hydrodynamic and hydraulic assessment of fluvial and tidal processes.

Anthony was expert witness on hydrology and flooding related issues at numerous Oral Hearings for major infrastructure projects (such as many of the Motorways, M6, M20 / M21 N23, Lansdowne Stadium redevelopment).

Anthony was a lecturer in hydrology and hydraulics at the Hydrology and Civil Engineering Department at NUI Galway and currently lectures in Hydrology at the University of Limerick (2011 to date). Mr Cawley has provided training courses in Hydrology to the Western and Northwestern Fisheries Board and to Engineers Ireland, and Irish Rail and NRA Design Offices.

Anthony is an expert hydraulic and coastal processes modeller and analyst with considerable experience in application of 1D, 2D and 3D models to rivers, estuaries and coastal waters. Anthony has estuarine and coastal modelling experience using Telemac Software system with recent projects that include the Shannon Estuary hydrodynamic model and tidal harmonic analysis of tide elevations and velocities for oil spill tracking, the sediment transport, wave climate and hydrodynamic assessment of the proposed New Port for Galway and the flood impact and scour assessment of Arklow Bridge and Kish Bank Wind Farm and numerous Sewage outfall and numerous aquaculture studies in Irish coastal waters

Dr Simon Berrow is a marine mammal biologist with over 30 years' experience. He is CEO of the Irish Whale and Dolphin Group and lecturer at the Galway-Mayo Institute of Technology. He started the Shannon Dolphin Project in the estuary in 1993, which has been ongoing each year for the last 28 years. The IWDG have extensive knowledge of the bottlenose dolphins in the estuary, having built the most comprehensive database and published widely.

For the current Proposed Development Simon prepared a series of survey reports on the use of the Site by bottlenose dolphins including fieldwork.

Darren Ireland holds a master's degree in ecology (fish and wildlife management) from Montana State University where he conducted research on Weddell seals in Antarctica. He is currently a Senior Wildlife Biologist and Vice President at LGL Ecological Research Associates, Inc. where he began working in 2005. While at LGL, Darren has worked primarily on projects related to anthropogenic sound impacts on marine mammals from a variety of activities including pile driving for wind farm and port development projects, deep penetration seismic surveys, high-resolution geophysical surveys, geotechnical investigations, exploration drilling programs, underwater explosions, and ice breaking.

Darren has authored or co-authored more than 45 environmental impact assessments and permit applications related to impacts of these activities on marine mammals, there habitat, and other marine life. Many of these projects also included developing and managing the implementation of multi-disciplinary monitoring plans to record and estimate potential impacts using methods such as vessel-based observers, manned and digital aerial surveys, unmanned aerial systems, static and towed passive acoustic recorders, and infrared camera systems.

Darren has also conducted baseline research on marine mammal distribution and abundance, conducted studies of novel research tools like unmanned aerial systems, infrared cameras, and satellite imagery, and performed evaluations of the potential impacts from new technologies and low-impact seismic sources. Through this work Mr. Ireland has gained a high level of expertise with the scientific and policy issues related to impacts of sound in the marine environment.

Per Trøjgård Andersen graduated from the Technical University in Denmark with a degree in acoustics in 1995. He has worked as consultant within noise, vibration, acoustics (including underwater noise) for more than 10 years in the company Odegaard & Danneskiold-Samsøe, and since 2005 at Lloyds Registers Engineering dynamics Team in Copenhagen, Denmark.

As part of the carve out of the Energy division from Lloyds Register, the Engineering Dynamics team became part of the Vysus Group in 2020, where he currently holds the position as Operations Manager for Engineering dynamics. Per's experience with underwater noise include consultancy on numerous projects with prediction and measurement of underwater noise from ships, wind turbines, oil & gas installations, as well as EU and privately funded research and development. He is the main author of the Lloyds Register underwater noise notation. He has further participated in ISO Technical Committee TC43 workgroup, developing the international standards for underwater noise measurements, including the ISO 17208 series.

7A.2 Summary of Proposed Development

The Proposed Development can be split into three phases: operation, construction, and decommissioning. Key activities proposed for the phases of the Proposed Development relevant to marine species and habitats of the Shannon Estuary are summarised in **Section 7A.2.1** through **Section 7A.2.3** below, while **Section 7A.2.4** outlines the potential impact mechanisms associated with the phases relevant to the marine biodiversity and ecology.

7A.2.1 Summary of Construction Phase Activities

This phase of the Proposed Development includes the construction of the Combined Cycle Gas Turbine (CCGT) gas-powered power plant capable of 600 MW of electricity generation, 120 MWh (1-hr) Battery Energy Storage System (BESS), Above Ground Installation (AGI), and associated plant, equipment and infrastructure.

Construction of the Proposed Development will require extensive pre-construction site preparation works including earth moving and rock breaking, installation of temporary surface water drainage and silt ponds, and temporary site access roads. Site preparation works may also require controlled rock blasting. Works at the Power Plant include the installation of gas turbine generators, heat recovery steam generator, a steam turbine generator, and an air-cooled condenser.

7A.2.2 Summary of Operation Phase Activities

Operational activities associated with the operational phase of the development include inspection and maintenance of the facilities at Power Plant buildings including carpark surface, access roadways etc. Other operation phase activities include the periodic maintenance of the pipeline infrastructure, and electrical substation and pump station. The equipment specifications of the Proposed Development are such that it will be required to operate under an IE Licence. The IE licence will be in place prior to commencement of operations and will be the result of an application process to the EPA, including an EIA process. Sampling and analysis of pollutants will be carried out where required including monitoring of exhaust emissions levels using Continuous Emission Monitoring Systems (CEMS) prior to discharge from the stacks, in accordance with the IE Licence.

7A.2.3 Summary of Decommissioning Phase Activities

The Proposed Development is expected to have a design life of 25 years, but this could be extended by maintenance, equipment replacement and upgrades or by the transition of the Site to use hydrogen capability (which would be subject to a future planning application).

The Proposed Development will be maintained in the long term by Shannon LNG Limited. It is expected that it would be a condition for the Proposed Development that a closure and residuals management plan, including a detailed decommissioning plan, be submitted to the EPA for their approval. Strict adherence to the proposed plan will ensure no significant impacts associated with decommissioning will occur.

7A.2.4 Potential Impact Mechanisms

Table 7A.1 lists the potential impact mechanisms associated with the phases of the Proposed Development relevant to receptors of the marine environment (see **Section 7A.4**). Brief descriptions of the impact mechanisms are presented in **Section 7A.5.1**, while assessment of impacts and effects of the impact mechanisms to the marine environment is presented in **Section 7A.5.3** through **Section 7A.5.6**.

Table 7A.1: Potential Impact Mechanisms

Potential Impact Mechanisms	Development Phase
1. Release of pollutants during construction	Construction Phase
2. Underwater noise	Construction Phase **and** Operational Phase
3. Seabed habitat loss	Construction Phase **and** Operational Phase
4. Wastewater discharge and Power Plant Process Heated Water Effluent	Operational Phase

7A.3 Methodology

7A.3.1 Overview

The assessment addresses the likely significant direct and indirect effects of the Proposed Development on marine ecology and biodiversity, including flora, fauna and habitats.

The assessment has been carried out in three stages:

- A desk study was undertaken to review published data describing ecological conditions within the greater area of the Proposed Development. Data bases included the National Parks and Wildlife Service (NPWS), the National Biodiversity Data Centre (NBDC), Inland Fisheries Ireland (IFI), Birdwatch Ireland (BWI) and the Irish Whale and Dolphin Group (IWDG).
- Site visits and field surveys by specialist ecologists to establish the existing ecological conditions at the location of the Proposed Development. The field surveys included intertidal and subtidal habitat surveys, walk over surveys, and land-based Vantage Point (VP) watches and static acoustic monitoring (SAM) to describe the use of the locality by marine mammals.
- Evaluation of the Proposed Development and determination of the scale and extent of likely direct and indirect significant effects on marine biodiversity (*i.e.* flora, fauna and habitats) and the provision of appropriate mitigation and monitoring.

The impact assessments and surveys undertaken for the marine ecology element of the EIAR was prepared by AQUAFACT ecologists. Other specialists and ecologists who contributed include:

- Anthony Cawley (Hydro Environmental).
- Dr Simon Berrow – IWDG.
- Darren Ireland – LGL.
- Dr Per Trøjgård Andersen.

7A.3.2 Legislation and Policy

The biodiversity assessment has been prepared with reference to the following legislation and guidance:

- Wildlife Act 1976, as amended.
- European Communities (EC) (Birds and Natural Habitats) Regulations 2011, as amended.
- Directive 2011/92/EU of the European Parliament and the Council on the assessment of the effects of certain public and private projects on the environment, as amended by Directive 2014/ 52/ EU (the 'EIA Directive').
- Council Directive 2009/ 147/ EEC, *i.e.* Birds Directive.
- Council Directive 92/ 43/ EEC (as amended), *i.e*. Habitats Directive.
- Heritage Council (2011). *Best Practice Guidance for Habitat Survey and Mapping*.
- Department of Arts, Heritage and the Gaeltacht – National Parks and Wildlife Service (DAHG NPWS) (2012) Marine Natura Impact Statements in Ireland Special Areas of Conservation, A Working Document.

- NPWS (National Parks & Wildlife Service) 2014. *Guidance to manage the risk to marine mammals from man-made sound sources in Irish waters. Department of Arts, Heritage and the Gaeltacht.*
- DEHLG (2009). *Appropriate Assessment of Plans and Projects in Ireland Guidance for Planning Authorities (Revised 2010).*
- EC (2018) Managing Natura 2000 sites. *The provisions of Article 6 of the Habitats Directive92/43/EEC Commission Notice (2018).*
- Office of the Planning Regulator (OPR) (2021). *Appropriate Assessment Screening for Development Management. Practice Note PN01. March 2021.*
- EC (2018). *Managing Natura 2000 sites. The provisions of Article 6 of the Habitats Directive 92/ 43/ EEC Commission Notice (2018).*
- EC (2001). *Managing Natura 2000 Sites: The provisions of Article 6 of the Habitats Directive 92/ 43/ EEC.*
- EC (2002). *Assessment of plans and projects significantly affecting Natura 2000 sites.*
- EU (2013). *Guidelines on Climate Change and Natura 2000: Dealing with the impact of climate change on the management of the Natura 2000 Network of areas of high biodiversity value.*
- CIEEM (2016). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal.*
- IFI (2016). *Guidelines on Protection of Fisheries during Construction Works in and adjacent to Waters. Inland Fisheries Ireland.*
- EPA (2022). *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.*
- EU (2017). *Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU).*

7A.3.3 Sources of Information

A review was carried out to collate the available information on the local ecological environment. The purpose of the review was to identify features of ecological value occurring within the Proposed Development and those occurring in proximity to it. The review also allowed the key ecological issues to be identified early in the assessment process and facilitates the planning of surveys.

- Specialist surveys and studies carried out between 2020 and 2024 as part of the EIA process to assess the potential impact of the Proposed Development on the ecology of the receiving marine environment included:
    - Surveys of intertidal and subtidal marine habitats.
    - Marine mammal monitoring, comprising a combination of land-based Vantage Point (VP) watches and static acoustic monitoring (SAM).
    - Hydrodynamic and dispersion modelling study to inform assessments of the environmental impact of:

        - Process water discharges.
        - Wastewater discharges.
    - Detailed modelling of noise emissions to inform assessment of the impact of noise:
        - Fish species.
        - Marine mammals.

Further details on the surveys undertaken between 2020 and 2024 are presented in **Section 7A.3.5**.

Other sources of information utilised for this report include the following:

- Conservation Status Assessment Reports, Backing Documents and Maps prepared to inform national reporting required under Article 17[1] of the Habitats Directive and Article 12[2] of the Bird Directive.
- Site Synopsis, Conservation Objective Reports and Natura 2000 Forms available from NPWS.
- Published and unpublished NPWS reports on protected habitats and species including Irish Wildlife Manual reports, Species Action Plans, and Conservation Management Plans.
- Existing relevant mapping and databases *e.g.* water body status, species and habitat distribution *etc.* (sourced from the Environmental Protection Agency, 2022, the National Biodiversity Data, 2021 and the NPWS, 2021).
- National Parks and Wildlife Service (NPWS).
- Environmental Protection Agency (EPA).
- National Biodiversity Data Centre (NBDC).
- Published academic papers and reports.
- *National Biodiversity Action Plan 2017-2021* (NPWS 2017) and 2023-2030 (NPWS, 2024).
- Kerry Co. Co. (2019) *Council Climate Change Adaptation Strategy 2019-2024.*
- Kerry Co. Co. (20220). *Biodiversity Action Plans 2022 – 2028*.
- Kerry Co. Co. (2022). *County Development Plan 2022 – 2028*.

7A.3.4 Limitations and Assumptions

Some general assumptions that have been made during preparation of this EIAR are set out below:

- In undertaking cumulative assessments, consented, but as yet un-built, developments have been assumed to have been built in accordance with and within the duration permitted by the associated grant of permission.
- Information provided by third parties, including publicly available information and databases, is correct at the time of publication.
- Local Authority and An Bord Pleanála public planning registers reviewed as part of the assessment process are up-to-date.

[1] Most recent Article 17 report is available at https://www.npws.ie/publications/article-17-reports/article-17-reports-2019
[2] Most recent Article 12 report is available at https://www.npws.ie/news/birds-directive-article-12-reporting

- Baseline conditions and assessments are accurate at the time of the surveys.

Some general limitations associated with the preparation of this chapter are set out below:

- The assessment of cumulative effects from built or consented developments is partially reliant on the availability of information provided by relevant third parties.

7A.3.5 Specialist Surveys and Studies

As outlined in **Section 7A.3.3** the assessment of potential impact to intertidal and subtidal benthic marine habitats, marine mammals and fish is supported by specialist studies and extensive marine survey work carried out over several years at the Site. The surveys which have been undertaken using standard methodologies are briefly described in **Section 7A.3.5.1** while **Section 7A.3.5.2** outlines the specialist studies undertaken to inform impact assessments.

7A.3.5.1 Surveys

Intertidal and Subtidal Marine Habitats

Intertidal surveys of the area have been undertaken since 2005 with the most recent survey having been undertaken in April 2024. In 2005/ 2006 and in 2012, AQUAFACT undertook intertidal transect surveys to the west and east of the Proposed Development north of Ballylongford Bay to Carrowdotia east of Ardmore Point. In 2020, three of the transects previously surveyed (T3, T7, T8) were revisited and resurveyed (see **Figure 7A.5**) and in April 2024 two of these transects, T3 and T7, in closest proximity to the planned outfall pipe were re-surveyed. In 2020 an additional transect (T1) was identified and surveyed.

In 2006 and 2007, a total of 31 subtidal sites were surveyed; of these sites, 10 sites were resurveyed in 2012 and 2020 (see **Figure 7A.8**). AQUAFACT survey reports are included in **Appendix A7A.1,** Volume 4. The intertidal and subtidal data collected are further augmented by data available on NPWS documents and data collated for the Lower River Shannon SAC. There are no limitations in relation to the suitability of the data to support the impact assessments presented within this chapter.

Lagoons

There is also a small undocumented lagoon located approximately 4.5 south-west of the Proposed Development. The Conservation Objectives report for the SAC (NPWS, 2013) indicates that the Site is designated for four lagoons. The lagoons are: Scattery Lagoon (5.9 km north-west of the Site), Clooconeen Pool (18.1 km west), Quayfield and Poulaweala Loughs (26.5 km east), Shannon Airport Lagoon (35.5 km north-east of the Site). To augment information included in the Conservation Objectives report, a specialist survey of the lagoon located at Knockfinglas Point was carried out in October 2007.

Marine Mammals

The assessment of potential impact to marine mammals is supported by extensive marine survey work undertaken between 2019 and 2023. For the Proposed Development, the Irish Whale and Dolphin Group (IWDG) were contracted to monitor the use of the marine area adjacent to the Site by bottlenose dolphins and any other marine mammals present. Monitoring, comprising a combination of land-based Vantage Point (VP) watches and static acoustic monitoring (SAM), was used to describe the use of the Site by bottlenose dolphins and any other marine mammals (seals) present, and their distribution and relative abundance at the Site.

Dedicated weekly VP watches were carried out over 12 months (April 2020 and April 2021) while CPOD passive acoustic devices were deployed at two sites for a period of 24 months between August 2019 and August 2021 to collect SAM data. Monitoring commenced again in May 2022 and is ongoing using CPODs and FPODs deployed in parallel. A report presenting the results of SAM data collected in 2022 and 2023 is provided in **Appendix A7A.7,** Volume 4.

These data augment marine mammal data collected in the Shannon Estuary over 20 years, which has spawned a wealth of scientific publications and datasets, including NPWS documents and data collated for the Lower River Shannon SAC, for which the bottlenose dolphins are a conservation feature. There are no limitations in relation to the suitability of the data to support assessment of the occurrence of marine mammals in the development area. IWDG monitoring reports are presented in **Appendix A7A.2** Volume 4.

Fish

Fish diversity in the Shannon Estuary was identified using a wide range of published reports, the most important of which are the stock surveys conducted by Inland Fisheries Ireland (IFI) in 2008, 2014 and 2017 in the Upper and Lower Shannon Estuary using a beach seine, fyke net, or beam trawl and reported in Kelly *et al.,* 2015 and Ryan *et al.*, 2018. There are no limitations in relation to assessment of fish diversity in the Shannon Estuary. The assessment also relied on document prepared by NPWS for the Lower River Shannon SAC. (NPWS, 2013).

7A.3.5.2 Specialist Studies

For the previous planning application (Ref: PA08.311233) Shannon LNG Limited commissioned Lloyd's Register (now Vysus Group) (VG) to carry out a modelling study on various sources of noise that would arise during the construction and operation phases. The two main sources of noise pollution considered included noise emanating from impact pile driving during jetty construction and noise pollution from vessels arriving and departing from the new jetty. The VG noise modelling report is presented in **Appendix A7A.3,** Volume 4.

In the absence of these main sources of noise pollution in the current application, LGL Ecological Research Associates Ltd, undertook an assessment to review the potential impact of the remaining sources of noise in the current development. The main source of noise will now be coming from onshore blasting during the construction phase of the Proposed Development. This review has taken the form of an addendum to the original LGL noise impact assessment report presented in **Appendix A7A.4**, Volume 4.

Similarly, AQUAFACT was commissioned by Shannon LNG in 2021 to carry out a dispersion modelling study to determine the fate of water discharges generated during the operation phases of the previous Proposed Development (Ref: PA08.311233). The outputs of the model were used to assess the likely impact of these discharges on the receiving environment of the Shannon Estuary. As the discharges of the current Proposed Development are the same as the previous planning application, the outputs of the model are still valid and can be used in this impact assessment. The AQUAFACT Hydrodynamic and Dispersion Modelling report is presented in **Appendix A7A.5**, Volume 4.

7A.3.6 Consultation

Consultations were carried out with statutory and non-statutory bodies. Those relevant to the current Chapter included consultation with the National Parks and Wildlife Service (NPWS), Inland Fisheries Ireland (IFI) National Monument Service and the Irish Whale and Dolphin Group (IWDG). Full details of consultation are included in **Chapter 01** (Introduction) **Section 1.6.**

7A.4 Baseline Environment

7A.4.1 Site Area Description

The Proposed Development will be located on the Shannon Estuary, 4.5 km from Tarbert and 3.5 km Ballylongford in Co. Kerry. The Site for the Proposed Development is 41 hectares. The Shannon Landbank on which the Site is located has a total area of 243 ha (603 acres).

The Site boundary is shown in **Figure 7A.1**. The Site consists primarily of agriculturally improved grassland, which runs along the southern shore of the Shannon estuary. The shoreline in the general area is relatively sheltered and composed of shingle or low earthen cliffs. The land within the Site is primarily used for grazing or hay/ silage. The type of grassland varies considerably with topography with some waterlogged sections. The lower section of a small watercourse forms the western boundary of the Proposed Development. To the west of the Site boundary, this stream forms a tidal creek and dense reed beds adjoin parts of its lower reaches near its discharge into the Shannon Estuary. Some drier land occurs close to the coast and there are larger, drier fields to the east of the site where the land is more intensively farmed.

The Site boundary is partly within and adjacent to the Lower River Shannon Special Area of Conservation (SAC) and the River Shannon and River Fergus Estuaries Special Protection Area (SPA) (see **Section 7A.4.2**). SACs and SPAs are designated respectively due to their significant ecological importance for habitats and species protected under Annex I and Annex II respectively of the Habitats Directive, and for the protection of populations and habitats of bird species protected under the EU Birds Directive (Council Directive 2009/147/EC).

Figure 7A.1: Site Boundary

7A.4.2 Designated Sites

Designated sites in Ireland include Special Area of Conservation (SAC) and Special Protection Area (SPA) sites designated respectively under the Habitats Directive and Birds Directive. SACs and SPAs are considered further in the following section.

In Ireland, areas considered important for the habitats present or which hold species of plants and animals whose habitat needs protection are designated as Natural Heritage Areas (NHAs). NHAs and proposed NHAs (pNHAs) are considered in **Chapter 07B** (Terrestrial Biodiversity).

7A.4.2.1 Overview

Sites of conservation importance hosting habitats and species needing to be either maintained at or, where appropriate, restored to favourable conservation status have been identified by each Member State. Sites, species, and habitats protected under Directive 92/43/EEC (Habitats Directive) and Directive 2009/147/EC (Birds Directive). These are referred to as Natura 2000 sites. Natura 2000 sites are referred to as European sites in the Planning and Development Act 2000 (as amended) and in other Irish legislation. These terms are synonymous. European sites in Ireland, which form part of the EU-wide Natura 2000 network of protected sites, comprise SAC sites designated due to their significant ecological importance for habitats and species protected under Annex I and Annex II respectively of the Habitats

Directive, and SPA sites designated for the protection of populations and habitats of bird species protected under the EU Birds Directive (Council Directive 2009/147/EC). A specific named habitat and/ or (non-bird) species for which a SAC or SPA is selected is called a 'Qualifying Interest' (QI) of the site, while a specific named bird species for which a SPA is selected is called a 'Special Conservation Interest' (SCI) of the site (OPR, 2021). QIs and SCIs can be collectively referred to as ‘conservation features’. European sites are formally designated under a statutory instrument.

Under Article 6(3) and 6(4) of the Habitats Directive, competent authorities are required to conduct a screening for Appropriate Assessment (AA) and, if necessary, an AA, on any plan or project for which it receives an application for consent, or which the authority itself wishes to undertake or adopt.

The Habitats Directive was originally transposed into Irish law by the *European Communities (Natural Habitats) Regulations, 1997* (S.I. No. 94 of 1997). The 1997 Regulations were subsequently revoked and replaced by the *European Communities (Birds and Natural Habitats) Regulations 2011*, as amended (herein referred to as the 2011 Birds and Natural Habitats Regulations).

Under Regulation 42 of the 2011 Birds and Natural Habitats Regulations, all competent authorities are required to conduct a *Stage 1 screening for Appropriate Assessment* (AA) and, if necessary, a *Stage 2 AA* on any plan or project on the foreshore for which it receives an application for consent, or which the authority itself wishes to undertake or adopt. This obligation derives from Article 6(3) and 6(4) of the Habitats Directive.

The AA provision of the Habitats Directive is also transposed in Ireland by the Planning and Development Act 2000 (as amended) in respect of land use plans and proposed developments requiring development consent.

For the Proposed Development a *Screening Statement for Appropriate Assessment (AA) and Natura Impact Statement (NIS)* has been prepared to provide information to enable the competent authority to carry out a *Stage 1: Screening for AA* and a *Stage 2: AA* of the Proposed Development as required under Article 6(3) obligations under the Habitats Directive. The *Screening Statement for Appropriate Assessment* is discussed in **Section 7A.4.2.2**.

7A.4.2.2 European Sites

The lower River Shannon SAC site and the River Shannon and River Fergus Estuaries SPA site extend along the northern / north-western boundary and also along part of the eastern boundary of the Proposed Development (**Figure 7A.2**). The proposed outfall will extend into the Lower River Shannon SAC and the River Shannon and River Fergus Estuaries SPA (see **Figure 7A.3** and **Figure 7A.4** respectively).

Short descriptions of the SACs and SPA are provided below, while detailed site descriptions are included in the Site synopsis reports presented in **Appendix A7A.6.**

Lower River Shannon SAC (Site code: 002165) (overlaps development area) – This very large site stretches along the Shannon valley from Killaloe in Co. Clare to Loop Head / Kerry Head, some 120 km. 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. The site is designated for a wide range of Annex I marine, coastal, freshwater aquatic and terrestrial habitats, while Annex II species for which the Site is designated include marine mammals, diadromous fish species and freshwater aquatic species.

River Shannon and River Fergus Estuaries SPA (Site code: 004077) (overlaps development area) – The estuaries of the River Shannon and River Fergus form the largest estuarine complex in Ireland. 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 has vast expanses of intertidal flats which contain a diverse macroinvertebrate community which provides a rich food resource for wintering birds. Salt marsh vegetation frequently fringes the mudflats and provides important high tide roost areas for the wintering birds. Elsewhere in the site the shoreline comprises stony or shingle beaches. The site is designated 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. The site is also designated for wetlands.

Potential impacts on designated European sites are addressed in the *Screening Statement for AA and NIS* which has been prepared to provide information to enable the competent authority to carry out a *Stage 1: Screening for AA* and a *Stage 2: AA* of the Proposed Development as required under Article 6(3) of the Habitats Directive. The *Screening Statement for AA and NIS* report concluded that the there are no likelihood of significant adverse effects on European sites.

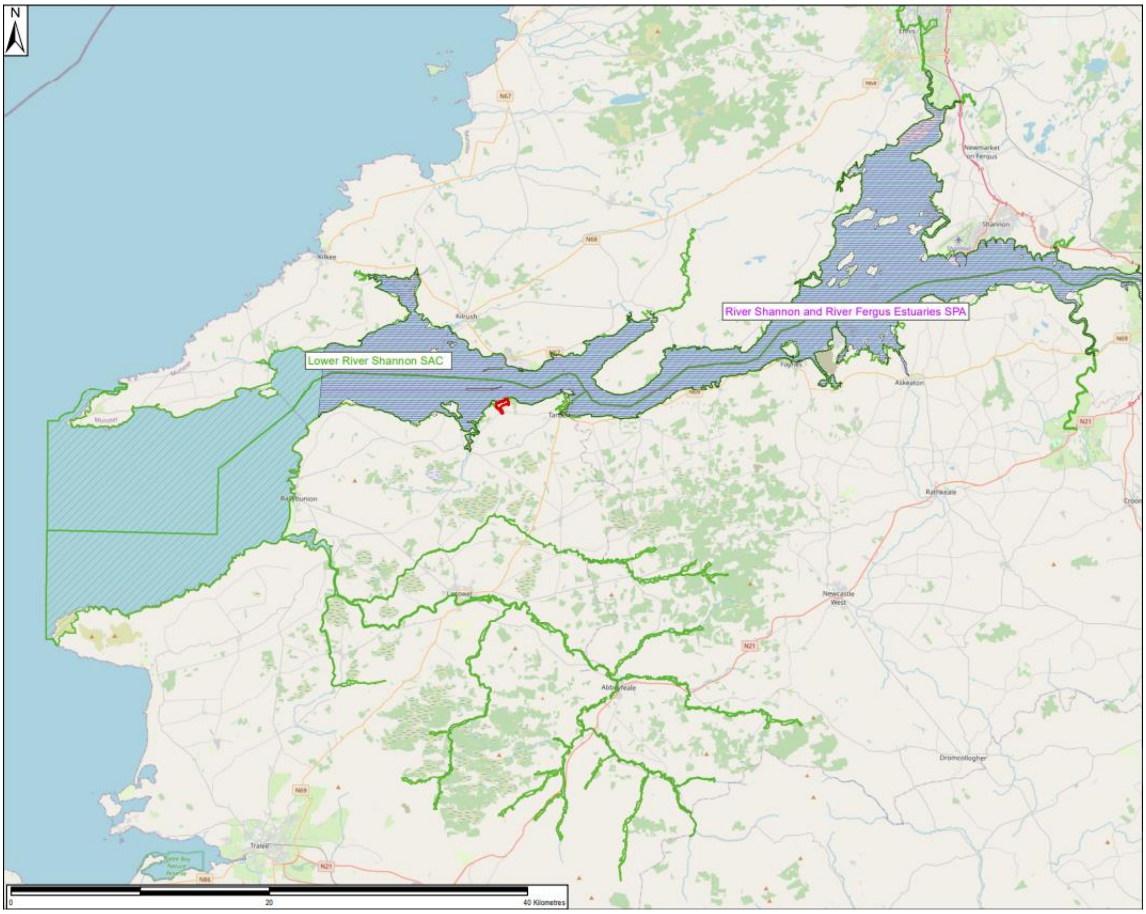

Figure 7A.2: Site Boundary Relative to the Lower River Shannon SAC and the River Shannon and River Fergus SPA

Figure 7A.3: Outfall Relative to the Lower River Shannon SAC

Figure 7A.4: Outfall Relative to the River Shannon and River Fergus SPA

7A.4.3 Habitats

7A.4.3.1 Marine/ Coastal Habitats

The Shannon and Fergus Estuaries form the largest estuarine complex in Ireland. They form a unit stretching from the upper tidal limits of the Shannon and Fergus Rivers to the mouth of the Shannon Estuary (considered to be a line across the narrow strait between Kilcredaun Point and Kilconly Point). Within this main unit there are several tributaries with their own 'sub-estuaries' *e.g.* the Deel River, Mulkear River, and Maigue River. To the west of Foynes, a number of small estuaries form indentations in the predominantly hard coastline, namely Poulnasherry Bay, Ballylongford Bay, Clonderalaw Bay and the Feale or Cashen River estuary. Both the Fergus and inner Shannon Estuaries feature vast expanses of intertidal mudflats, often fringed with saltmarsh vegetation (NPWS, 2013). 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.

In the transition zone between mudflats and saltmarsh, specialised colonisers of mud predominate. For example, swards of Common Cord-grass (*Spartina anglica*) frequently occur in the upper parts of the estuaries. Less common are swards of Glasswort (*Salicornia europaea* agg.). In the innermost parts of the estuaries, the tidal channels or creeks are fringed with species such as Common Reed (*Phragmites australis*) and club-rushes (*Scirpus maritimus*, *S. tabernaemontani* and *S. triquetrus*). In addition to the nationally rare Triangular Club-rush (*Scirpus triqueter*), two scarce species are found in some of these creeks (*e.g*. Ballinacurra Creek), Lesser Bulrush (*Typha angustifolia*) and Summer Snowflake (*Leucojum aestivum).*

The Site is an example of a large shallow inlet and bay. Littoral sediment communities in the mouth of the Shannon Estuary occur in areas that are exposed to wave action and also in areas extremely sheltered from wave action. Characteristically, exposed sediment communities are composed of coarse sand and have a sparse fauna. Species richness increases as conditions become more sheltered. All shores in the Site have a zone of sand hoppers (small crustaceans) at the top, and below this each of the shores has different characteristic species giving a range of different shore types (NPWS, 2013)

The intertidal reefs in the Shannon Estuary are exposed or moderately exposed to wave action and subject to moderate tidal streams (NPWS, 2013). 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 18 m. Below this depth, it becomes rare, and the community is characterised by coralline crusts and red foliose algae.

Other coastal habitats that occur within the site include stony beaches and bedrock shores (these support a typical zonation of seaweeds such as *Fucus spp., Ascophyllum nodosum* and kelps), shingle beaches (with species such as Sea Beet, Sea Mayweed – *Matricaria maritima*, Sea Campion and Curled Dock – *Rumex crispus*), sandbanks which are slightly covered by sea water at all times (*e.g.* in the area from Kerry Head to Beal Head) and sand dunes (a small area occurs at Beal Point, where Marram – *Ammophila arenaria* is the dominant species) (NPWS, 2013).

The Conservation Objectives report for the SAC (NPWS 2013) indicates that the Site is designated for four lagoons. The lagoons are: Scattery Lagoon (5.9 km north-west of the Site), Clooconeen Pool (18.1 km west), Quayfield and Poulaweala Loughs (26.5 km east), Shannon Airport Lagoon (35.5 km north-east of the Site). There is also a small undocumented lagoon located approximately 4.5 km south west of Proposed Development. Saltmarsh vegetation also occurs around a number of lagoons within the Site, two of which have been surveyed as part of a National Inventory of Lagoons. Cloonconeen Pool (4-5 ha) is a natural sedimentary lagoon impounded by a low cobble barrier. Seawater enters by percolation through the barrier and by overwash. This lagoon represents a type which may be unique to Ireland since the substrate is composed almost entirely of peat. The adjacent shore features one of the best examples of a drowned forest in Ireland. Aquatic vegetation in the lagoon includes typical species such as Beaked Tassle Weed (*Ruppia maritima*) and green algae (*Cladophora* sp.). The fauna is not diverse, but is typical of a high salinity lagoon and includes six lagoon specialists (*Hydrobia ventrosa*, *Cerastoderma glaucum*, *Lekanesphaera hookeri*, *Palaemonetes varians*, *Sigara stagnalis* and *Enochrus bicolor*). In contrast, Shannon Airport Lagoon (2 ha) is an artificial saline lake with an artificial barrier and sluiced outlet. However, it supports two Red Data Book species of stonewort (*Chara canescens* and *Chara cf. connivens*).

A brackish lagoon (CW1) occurs outside the development red line, to the south west of the Knockfinglas Point. A specialist survey of the lagoon was carried out in October 2007. A report on these surveys which was prepared concluded: 'Despite the recorded salinity (0.8 – 1.1 parts per thousand) and presence of one plant, the brackish water Tassle Weed *Ruppia maritima*, none of the faunal taxa can be regarded as indicator species of coastal lagoons. One species, *Sigara concinna* has been listed by some authors as a lagoonal specialist in Britain but is found at inland sites in Ireland. The lake may have been a brackish water coastal lagoon in the past and still has a barrier typical of lagoons but is at present dominated by characteristically freshwater insects and molluscs with only a few species, *e.g.* Three-spined Stickleback, *Sigara concinna*, *Haliplus rufficollis*) that can tolerate any measure of salinity. In particular, the presence of Common newts indicate that the lake has been dominated by fresh water for some time. This water body is a marginal example of a lagoon as salinity barely exceeds 1 psu. Plants frequently found in lagoons include *Ruppia maritima*, *Ranunculus baudotii* and *Potamogeton pectinatus* (although this species also occurs in freshwater and is not indicative of lagoons). No lagoonal specialist animals were noted. However the pond's morphology-isolated from the sea by a shingle barrier is a typical lagoonal feature. On balance the pond may be regarded as a lagoon based on plants and morphology but with no fauna of note. Its conservation interest lies in its transitional nature between fresh and brackish conditions.'

7A.4.3.2 Intertidal and Subtidal Survey

Shannon LNG Limited commissioned AQUAFACT to undertake a series of intertidal and subtidal surveys in the vicinity of the Proposed Development in 2020 and 2024. The details of the surveys undertaken in 2020 and 2024 are provided in **Appendix A7A.1** and **Appendix A7A.8**. In April 2020, four intertidal transects (T1, T3, T7, T8) were surveyed and in March 2024 two transects (T3 and T7) closest in proximity to the proposed outfall pipe were surveyed. Transects T3, T7 and T8 were previously surveyed in 2012 while T1, T3, T7 and T8 were surveyed in 2006/2007. The locations of the transects are shown **Figure 7A.5**. For the subtidal survey a total of 10 stations were sampled in April 2020. All stations sampled can be seen in **Figure 7A.6** and their locations were selected in order to be representative of the previous survey sites. Station coordinates are presented in **Table 7A.2Error! Reference source not found.**. The intertidal habitats encountered are typical of cobbly rocky shores in Ireland being dominated by *Pelvetia canaliculata*, Fucus sp. and *Ascophyllum nodosum*. No rare, protected or unusual species were observed, and no changes were observed compared to previous surveys undertaken.

The subtidal fauna was dominated by species typical of fine sandy habitats *e.g.* the polychaetes *Nephtys cirrosa*, *Paradoneis lyra*, *Travisia forbesii*, *Pholoe inornata* and *Scoloplos armiger*, the bivalve *Nucula* spp. and the amphipods *Metaphoxus simplex* and *Harpinia antennaria*. In areas with boulders or cobbles there were abundant populations of the tunicate *Dendrodoa grossularia*. No rare, protected or unusual species were observed. One-way ANOVA shows a significant difference between the Shannon-Weiner Diversity and the Effective Number of Species between the 2020 and 2012 results. Whether this is a seasonal variation due to the difference in time of surveys (October in 2012 and April in 2020) is unknown. Despite the significant decreases in these indices from 2012 to 2020, the dominant taxa present are similar in both surveys and indicate similar community types between surveys. All species observed are typical of this area of the Lower River Shannon Estuary SAC. AMBI analysis indicated that all sites were either undisturbed or slightly disturbed due to the high proportion of sensitive species at each station. Slight variations in the substrate type were observed between this survey and the previous one. Given the strong current speeds and mobile sediments in the area, this is not unusual.

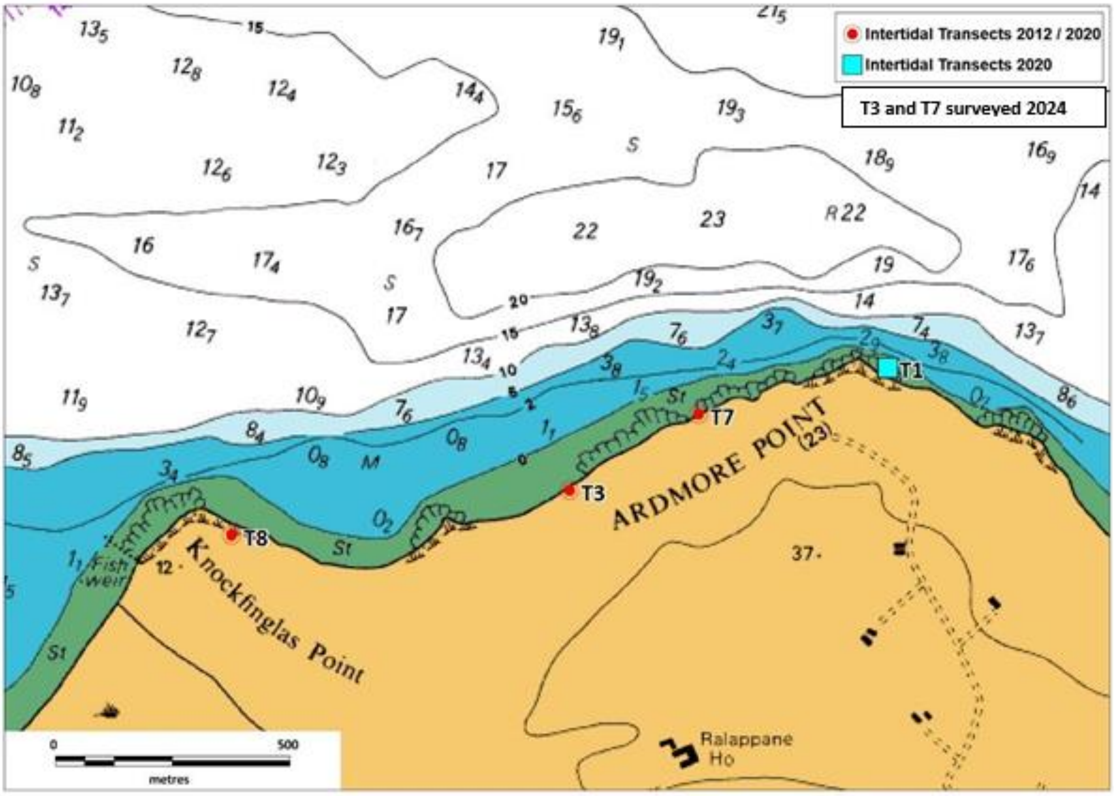

Figure 7A.5: Location of the Intertidal Transects Surveyed

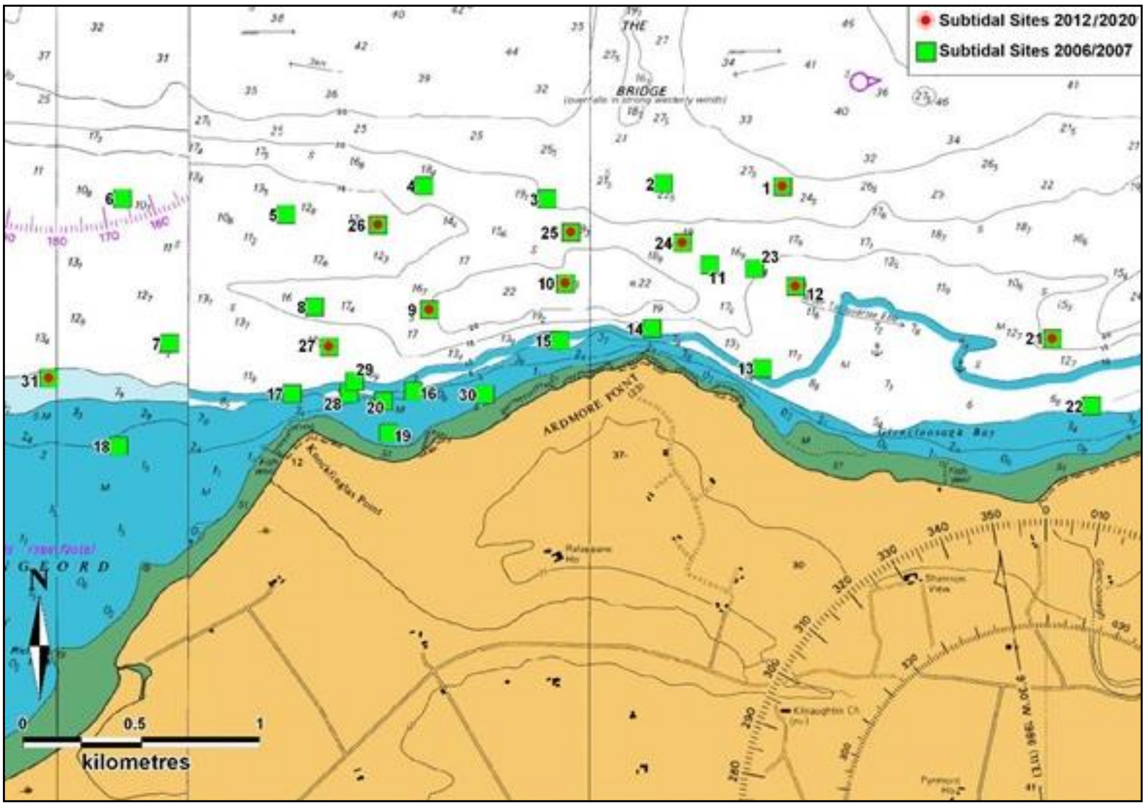

Figure 7A.6: Location of all 10 Stations Sampled in April 2020 and October 2012, and the 31 Stations Sampled in 2006/ 2007

Table 7A.2: Coordinates

Station	Longitude	Latitude	Longitude	Easting	Northing
S1	-9.42206	52.59132	-9.42206	103676.3	149798.2
S9	-9.44401	52.58662	-9.44401	102178.6	149304.8
S10	-9.43554	52.58762	-9.43554	102754.8	149404.6
S12	-9.42125	52.58752	-9.42125	103722.9	149374.3
S21	-9.40523	52.58555	-9.40523	104804.4	149134.3
S24	-9.42828	52.58917	-9.42828	103250.1	149567.5
S25	-9.43522	52.58955	-9.43522	102781.1	149619.4
S26	-9.44723	52.58982	-9.44723	101967.3	149665.4
S27	-9.45025	52.5852	-9.45025	101752.5	149155.8
S31	-9.4677	52.58398	-9.4677	100567.1	149044.3

7A.4.4 Marine Mammals

Bottlenose Dolphin (*Tursiops truncatus*)

The Lower River Shannon SAC is one of five sites designated for bottlenose dolphins in Irish waters. Studies on the resident bottlenose dolphin population in Shannon Estuary have been occurring since 1993 by the Irish Whale and Dolphin Group (IWDG) and by the National Parks and Wildlife Service (NPWS) of Ireland as part of the EU's obligation to ensure conservation of this species (Blázquez *et al.,* 2020).

Data collected over 20 years by the Irish Whale and Dolphin Group show that the Shannon Estuary dolphin population is genetically and demographically isolated from other coastal dolphins (Mirimin *et al.,* 2011; O'Brien *et al.,* 2016; Rogan *et al.,* 2018). Mark-recapture photo-identification studies indicate that bottlenose dolphins in the Shannon Estuary exhibit long-term site fidelity and seasonal residency (*e.g.*, Ingram 2000; Ingram and Rogan 2002; Ingram and Rogan 2003; Englund *et al.,* 2007, 2008; Berrow 2009; Rogan *et al.,* 2018). The most recent photo-identification study occurred during June–October 2018, resulting in a mark-recapture abundance estimate of 139 individuals (CV=0.11, 95% CI=121–160) (Rogan *et al.,* 2018). Baker *et al.,* (2018a) provided an estimate of 145 individuals for 2015, based on direct counts. The median group size based on boat surveys throughout the estuary is 6 (*e.g.*, Englund *et al.,* 2007, 2008; Rogan *et al.,* 2018), and the average group size has been reported as 9.71 (Barker and Berrow, 2016). The mean group size (±SD) at the proposed LNG Site at Ardmore Point was estimated at 6.2 ± 3.1 dolphins, based on watches from shore (Berrow *et al.,* 2020).

Although the dolphins inhabit the Shannon Estuary year-round, the greatest number appear to occur there between June and August (Garagouni *et al.,* 2019), with decreasing numbers during the winter (Ingram 2000; Englund *et al.,* 2007; Rogan *et al.,* 2018). The lower numbers during winter may be due to animals dispersing over a wider region in pursuit of prey affected by the seasonal changes (Garagouni *et al.,* 2019); however, data on the distribution of the population during winter is generally lacking. However, dolphin sightings were made off Ardmore Point each month during monitoring from October 2020 to March 2021 (Berrow, 2020 a,b,c, 2021 a,b,c). One photo-identification study found that at least

62% of individuals from the Shannon bottlenose dolphin population also use waters outside of the Shannon Estuary during the summer (May–August), including Brandon Bay and Tralee Bay located adjacent to estuary (Levesque *et al.,* 2016).

Bottlenose dolphins in the Shannon Estuary prefer areas with the greatest slope and depth (Ingram and Rogan 2002). Two critical habitat areas occur within Shannon Estuary that at least part of the population migrates between throughout the year; the larger of the two areas is located near the mouth of the estuary closest to Kilcredaun, and the smaller is located off Moneypoint, close to the Proposed Development (see **Figure 7A.9**; NPWS 2012, Ingram and Rogan, 2002; Rogan *et al.,* 2018). In general, a smaller proportion of the population is found in the eastern part of the estuary compared to the western part (Baker *et al.,* 2018b). The distribution of sightings in 2018 showed that dolphin presence throughout the estuary was similar to past studies but noted greater activity within the inner estuary where it constricts near Tarbert/ Killimer and farther upriver (see **Figure 7A.8** and **Figure 7A.10**) (Ingram and Rogan, 2002; Rogan *et al.,* 2018). Baker *et al.,* (2018b) found that only 25% of the population regularly uses the inner estuary; those dolphins were also seen in the outer estuary. Within the critical habitat areas, the dolphins appear to most commonly be found near northern-facing slopes (Garagouni *et al.,* 2019). Dolphin distribution in the estuary is also correlated with tide level, with higher presence in bottleneck areas during ebb and slack low tides (Garagouni *et al.,* 2019).

The area around the Proposed Development has not been identified as a hot spot for bottlenose dolphin occurrence based on commercial dolphin-watching activities (see Berrow *et al.,* 2020 (see **Appendix A7A.2**, Volume 4). However, sightings have been made in the area during several vessel-based surveys (*e.g.*, Ingram and Rogan, 2003; Englund *et al.,* 2007, 2008; Berrow *et al.,* 2012). Visual observations from shore at Ardmore Point show that the Site is regularly used by the dolphins, which pass by the area but rarely stop and socialize or forage there; it is more likely used as a transition corridor to move between the outer and inner estuary (Berrow *et al.,* 2020). During 23 days of observations from April through September 2020, 21 sightings of dolphins were made on 13 separate watch days. Most sightings were made off Moneypoint, near the ferry, near Scattery Island, and mid-channel; six sightings were made within 500 m of Ardmore Point, and a total of 22 individual dolphins were identified. During 23 observation days from October 2020 to March 2021, 20 dolphin sightings were made on 15 different watch days (Berrow, 2020 a,b,c, 2021 a,b,c). Thus, the encounter rates of bottlenose dolphin groups were similar during spring / summer and fall/ winter, at 0.2 groups / hour of observation.

Shannon LNG Limited also commissioned the IWDG to undertake Passive Acoustic Monitoring (PAM) at two sites off Ardmore Point from August 2019 through August 2021; dolphin clicks were detected on 62 and 69% of monitoring days at each of the two sites (Berrow et al., 2021). The C-POD located closest to the LNG site (LNG1) had a mean detection positive minutes (DPM) per day of 3.9, whereas LNG2 had a DPM of 3.7; DPM was lower at LNG1 during the winter than during other seasons. The low DPM per day at these two sites supports evidence from visual monitoring that the area around Ardmore Point is primarily a transit corridor (Berrow *et al.,* 2021).

Ongoing SAM monitoring with CPOD / FPOD combinations off Ardmore Point has continued since May 2022 and is on-going (**Table 7A.3**). Dolphins were recorded on average 49% of days across the two sites.

Table 7A.3: CPOD Monitoring Results at two Locations off Ardmore Point in 2022 and 2023

Location	No. of Days	Year	Dolphin	%Days Detected	Mean DPM/Month
LNG 2	229	2022	826	50	3.6
LNG 3	229	2022	724	48	3.1
LNG 2	353	2023	1,013	48	2.9
LNG 3	251	2023	535	51	2.1

The Shannon Estuary also acts as a calving area for the species, with neonates most frequently observed from July to September (Ingram, 2000; Baker *et al.,* 2018a). An average of seven calves are born each year, with weaning taking place at a mean age of 2.9 years (Baker *et al.,* 2018a). During watches from Ardmore Point, 10 calves were recorded, including four that were born in 2018 and 2019 (Berrow *et al.,* 2020).

Figure 7A.7: Bottlenose Dolphin Critical Areas, Representing Habitat Used Preferentially by the Species (adapted from NPWS 2012, Ingram and Rogan 2002; Rogan *et al*. 2018)

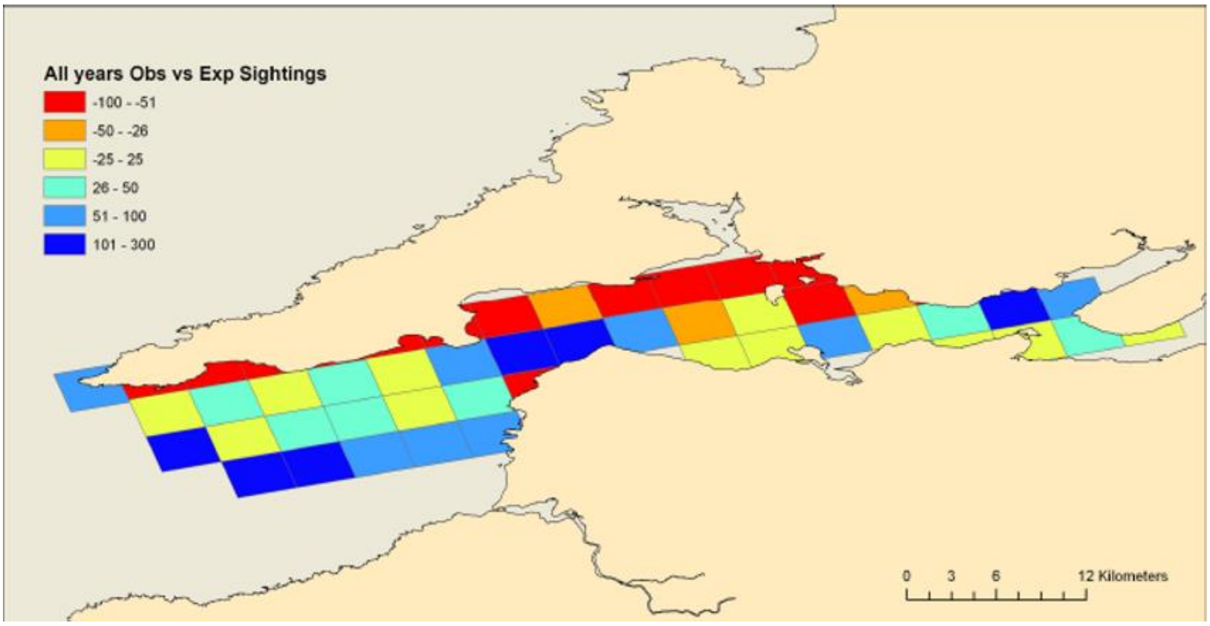

Figure 7A.8: Scoring Assessment for Habitat Suitability for Bottlenose Dolphins in the Shannon Estuary (adapted from Berrow *et al*., 2012)

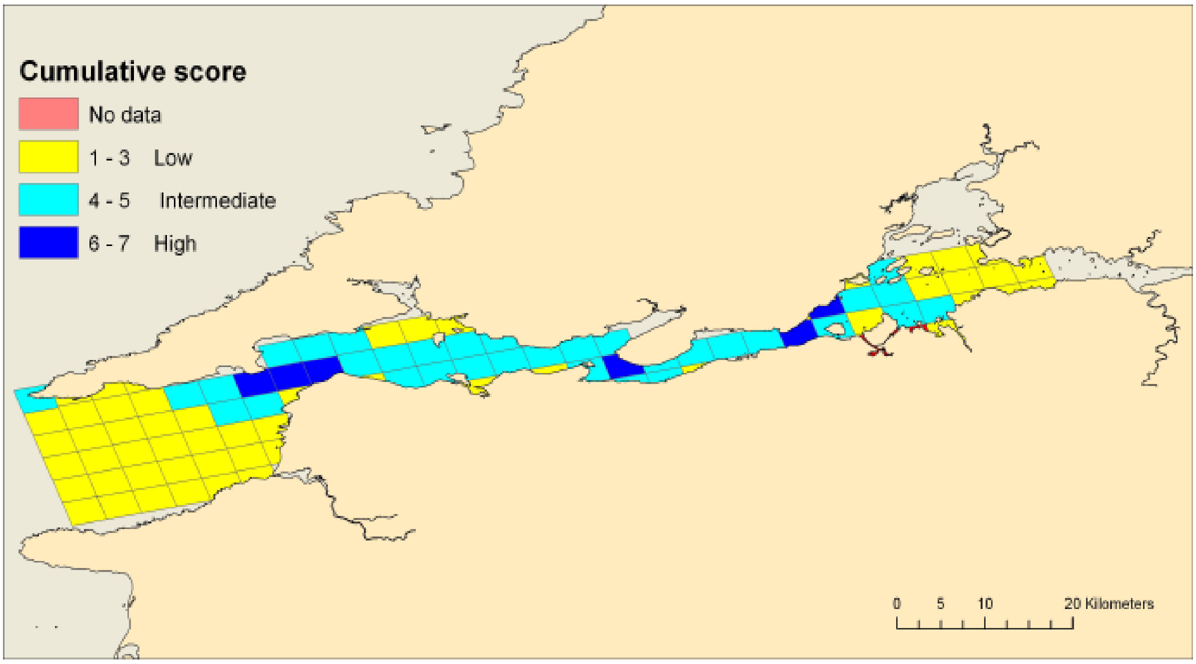

Figure 7A.9: Scoring assessment for Habitat Suitability for Bottlenose Dolphins in the Shannon Estuary (adapted from Berrow *et al.,* 2012)

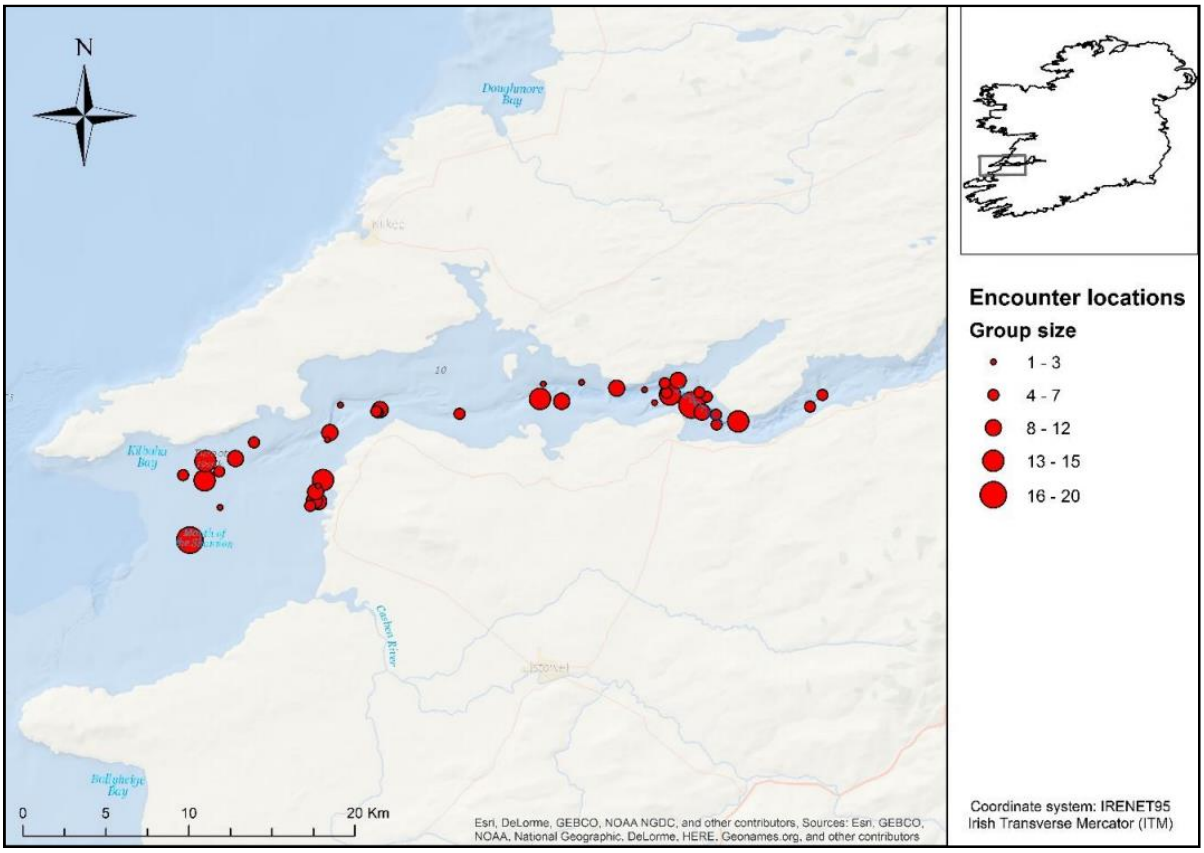

Figure 7A.10: Locations of Bottlenose Dolphin Schools Encountered during Surveys of the Lower Shannon Estuary, 2018. Estimated Group Sizes are Denoted by Symbol Diameters (adapted from Rogan *et al*., 2018)

Harbour Porpoise (*Phocoena phocoena*)

The Harbour Porpoise (*Phocoena phocoena*) (Linnaeus, 1758) is the most widespread and abundant cetacean species present in Irish waters (Berrow, 2001). Harbour Porpoise have been recorded all along the Irish coast but are most abundant off the south west and south east coasts (Wall *et al.* 2013). Harbour porpoise are listed on Annex II of the EU Habitats Directive and thus Special Areas of Conservation are required in order to protect a representative range of the habitats for this species in the member state. The sites are designated as Special Areas of Conservation (SACs) and must be surveyed regularly to ensure favourable conservation status of the qualifying interest is achieved.

Although harbour porpoise occurs regularly along the coast of Ireland (O'Brien, 2016), they are rarely seen in the Shannon Estuary (O'Callaghan *et al*., 2021). Sightings have occurred in the inner estuary (Berrow, 2020a, Berrow *et al.,* 2020; O'Callaghan *et al*,. 2021). One sighting was made on 22 October 2020 of a single harbour porpoise that was foraging for ~1 hr near Moneypoint (Berrow, 2020a; O'Callaghan *et al*., 2021). Another sighting of an adult and juvenile was made near Scattery Island in 2018 (O'Callaghan *et al.,* 2021). One sighting of two porpoise was made in the outer estuary during July 2005 (O'Callaghan *et al.,* 2021). In addition, six strandings have been reported in the Shannon Estuary (O'Callaghan *et al*., 2021). Possible porpoise clicks have also been detected during monitoring in summer/ fall 2018 at two sites off Ardmore Point (Berrow *et al.,* 2020) and off Moneypoint (O'Brien *et al.,* 2013). However, O'Callaghan *et al*., (2021) note that these high-frequency clicks could have been generated by dolphins.

Grey seal (*Halichoerus grypus*)

The grey seal (*Halichoerus grypus*) is the larger of two species of true seal (Phocidae) that commonly breed around the coast of Ireland and that travel, find food and engage in other ecological functions in its inshore and offshore waters. Grey seals in Ireland are generally considered part of a larger interacting population or metapopulation that also inhabits adjacent jurisdictions (*i.e.,* the UK and France at least). They occur widely in estuarine, coastal and offshore marine areas while individual seals may also occasionally travel upstream within river systems to a distance several kilometres from the coast (Ó Cadhla *et al*., 2013).

Grey seals are common in the Shannon Estuary. The National Biodiversity Data Centre (NBDC) database contains 231 records of the species in the Shannon Estuary, 46 of which are within close proximity to the proposed project. Rogan *et al*. (2018) reported four sightings of grey seals in Shannon Estuary during dolphin surveys in the summer/ fall of 2018, including two pups hauled out on a beach. During shore-based observations from Ardmore Point from April to August 2020, individual grey seals were seen on six occasions, five of which occurred within 500 m of the Site (Berrow *et al*., 2020). Sightings of individual grey seals were also made during monitoring in October 2020, January 2021, February 2021 (Berrow, 2020a, 2021a,b). Cronin *et al.,* (2011) also reported movement of grey seals from the outer coast into the estuary and Cadhla and Strong (2007) documented a breeding site in the outer estuary. Duck and Morris (2013) reported two sightings in the Inner Shannon Estuary during summer surveys in 2003, but no sightings during surveys in 2012.

Harbour seal (*Phoca vitulina vitulina*)

The harbour seal *Phoca vitulina vitulina* is one of two seal species native to Irish waters. Like their larger grey seal (*Halichoerus grypus*) relatives, harbour seals have established themselves at terrestrial colonies (or haul-outs) along all coastlines of Ireland, which they leave when foraging or moving between areas, for example, and to which they return to rest ashore, rear young, engage in social activity, etc. (Cronin *et al.,* 2004). These seals come to shore during June to give birth and mate again around this time but usually in the water. Pups are capable of swimming within a few hours of being born but stay with their mother until weaned. Common Seals also come to shore to moult (shed their fur) during July and August often forming large groups on sheltered shores that have ready access to the sea. During this period when the majority of seals are ashore is when counts of animals are undertaken to estimate population size (Cronin *et al*., 2004).

Sightings reported through the NBDC identify three records of sightings of harbour seal in the inner Shannon Estuary, in the Fergus Estuary. The NBDC also identifies seven sightings of harbour seal close to the vicinity of the project, three at Kilrush, three at Scattery Island, and one at Tarbert.

Cronin *et al*., (2010) reported a gap in harbour seal distribution in the Shannon Estuary. Sightings reported through the NBDC include three records for the Fergus Estuary, and seven records near the proposed project location — three at Kilrush, three at Scattery Island, and one at Tarbert. Duck and Morris (2013) reported one harbour seal sighting in the Inner Shannon Estuary during surveys in 2012, and eight sightings during surveys in 2003; no sightings were made in the Outer Shannon Estuary during either survey.

Other Species of Marine Mammal

The NBDC online database records sightings and strandings of marine mammal species around the Irish coast. A total of 4 other whale and dolphin species have been recorded in the Shannon Estuary see **Table 7A.4**.

Table 7A.4: Marine Mammals Recorded in the Shannon Estuary (source NBDC)

Odontocetes (Toothed Whales and Dolphins)
Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)
Common Dolphin (*Delphinus delphis*)
Long-finned Pilot Whale (*Globicephala melas*)
Striped Dolphin (*Stenella coeruleoalba*)

Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)

This dolphin often occurs in groups from tens to hundreds, and can occur in groups of up to 1,000, most often offshore. Their distribution in northwest Europe is predominantly clustered in an area from west of Ireland, to the north and north-west of Britain. Smaller numbers occur around the west of Ireland. It is possible that they follow mackerel as they spawn off the south-west of Ireland's coast in February / March. The only record of an Atlantic White-sided dolphin in the Shannon Estuary was a stranded animal observed in 2005.

Common dolphin (*Delphinus delphis*)

Common dolphin is the most widespread and abundant dolphin species in Ireland, occurring throughout all Irish waters to varying densities with the bulk of the records from offshore waters on the Irish Shelf off the south and southwest coasts (Wall *et al*., 2013). Recorded all year round, the highest densities were recorded off the south and south-west coasts in the summer and autumn. Extremely large pods (100 – 1000s) can occur in the southern approaches of the Irish Sea in spring and summer. There are three records of Common Dolphin strandings from 2005-2015.

Long-finned Pilot Whale (*Globicephala melas*)

The long-finned pilot whale is one of the largest dolphins, with lengths averaging 6.7m for males and 5.7 m for females, they have a square bulbous head with a lightly protruding beak. The body is dark grey to black with a grey-white anchor shaped patch on the chin. The species is typically found in water depth of 200 – 3,000 m beyond the Irish shelf edge where bottom relief is greatest but can also swim into coastal bays and fjords. They are often seen with other cetaceans, notably bottlenose dolphins. Most often, pilot whales occur in large pods (approximately 20 individuals), and large numbers of up to 1,000 have been observed off the British Isles during April, coinciding with the start of peak conception. There have been 4 events involving long-finned pilot whales in the Shannon Estuary according to the NBDC. These events occurred at Ballybunnion, Kerry; Carrigaholt, Clare; Beal Strand, Kerry and Poulnasherry, Clare.

Striped Dolphin (*Stenella coeruleoalba*)

These dolphins are sleek in appearance, with a body coloration consisting of dark grey cape extending from the beak to the dorsal fin, lighter grey flanks, leading to a pink-white underside. Sightings of striped dolphin in Ireland are very rare. By-catch data indicate their presence in the deep waters to the southwest of the Irish Shelf. This data is insufficient to infer seasonal or temporal trends. The NBDC database includes a number of 4 recorded strandings of the species in the Shannon Estuary, 1 at Carrigaholt, Clare, in 1993 and 3 at Ballybunnion between 2007 and 2012.

7A.4.5 Fish

A number of Ireland's native diadromous species pass through the Lower Shannon Estuary on their way to or from freshwater spawning grounds or reside there for feeding as they mature. These include four species of nature conservation interest in the area, namely twaite shad (*Allosa fallax fallax*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*), and Atlantic salmon (*Salmo salar*). These are all listed on Annex II of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (EU Habitats Directive). The Habitats Directive ensures the conservation of a wide range of rare, threatened, or endemic species in Europe. Annex II species are classified as such when core areas of their habitat are designated as sites of community importance (SCIs), which must be managed corresponding to the species' ecological requirements. Additionally, the twaite shad and the sea lamprey are listed under Annex V, which mandates that EU Member States are required to manage exploitation of the species so that conservation status remains favourable (EU Commission 2021).

Fish stock surveys were conducted by Inland Fisheries Ireland in September to November 2008 and in October 2014 in the Upper and Lower Shannon Estuary using a beach seine, fyke net, or beam trawl (Kelly *et al*. 2015). Within the Upper Shannon Estuary, 15 and 22 species of fish were recorded during 2008 and 2014, respectively, and flounder, sprat and sandy goby were the most abundant species during the 2014 survey. Within the Lower Shannon Estuary, 31 fish species were recorded in a 2008 survey and 29 were recorded in 2014. Out of these species, sprat was the most abundant, followed by sand goby, thick-lipped mullet, and sand smelt (Kelly *et al*., 2015). European eels were caught in the Upper Shannon Estuary in 2008 and 2014, and the Lower Shannon Estuary in 2014 only (Kelly *et al.,* 2015).

Twaite Shad (*Alosa alosa fallax*)

Twaite shad is an anadromous fish and member of the herring (Clupeidae) family that is distributed across the north-eastern Atlantic, with Iceland as the northernmost extent of its range, Morocco as the southernmost and the Baltic Sea as the easternmost (Aprahamian *et al*., 2003). They are listed as *least concern* globally on the IUCN Red List (IUCN 2021) but as *vulnerable* in the Ireland Red List (King *et al*., 2011), a version of the IUCN Red List (using the same population status evaluations) in which regional species population statuses in Ireland are assessed, established by the National Parks and Wildlife Service. Adult twaite shad generally migrate from the marine environment into freshwater environments to spawn from February in the south of its range to May and June in the north (Davies *et al.,* 2020). The river migration period can last for three months, and seaward migration occurs for surviving adults after spawning and for young-of-the-year in the summer and fall (Maitland and Hatton-Ellis, 2003; Davies *et al*., 2020).

Four rivers in Ireland have been shown to support spawning grounds and spawning populations of twaite shad including the Munster Blackwater and the three rivers within the Barrow-Nore-Suir river system

(King and Roche, 2008; Davies *et al*., 2020; Gallagher *et al*,. 2020), entries to which are located on the southwestern coast of Ireland.

Sea Lamprey (*Petromyzon marinus*) and River Lamprey (*Lampetra fluviatilis*)

Sea lamprey and river lamprey are anadromous species found in the Northern Hemisphere. The sea lamprey is listed as near threatened in the Ireland Red List (King *et al*., 2011), but as least concern globally on the IUCN Red List (IUCN, 2021), and the river lamprey is listed as least concern on both Red Lists. Their populations are declining in Ireland and Europe due to overharvesting, habitat destruction, and the loss of spawning and nursery grounds from the construction of anthropogenic barriers blocking upstream access (Igoe *et al*., 2004; Bracken *et al*., 2018). For example, Silva *et al*. (2019) found that sea lampreys in the River Ulla experience a mean delay of 6.3 days per river obstacle during upstream migration. Lampreys typically spend their first years (two to eight for sea lampreys, three to five for river lampreys) in freshwater before migrating out to sea following a period of metamorphosis (Igoe *et al*. 2004). During this period of metamorphosis, lampreys will spend up to ten months without feeding and will begin early feeding in estuarine or coastal waters (Silva *et al.* 2012). Sea and river lampreys return to freshwater as adults and will spawn in areas with fast-flowing water and gravel bottoms where they can create shallow depressions or nests. All lampreys are semelparous and will die after a single spawning event (Bracken *et al*., 2018).

Sea lampreys are found in all suitable rivers in Ireland and have been particularly noted in the River Shannon, River Suir, River Nore, River Moy, and the River Corrib (Igoe *et al.*, 2004). On the Mulkear River, a main tributary of the River Shannon, adult sea lamprey have been found spawning over nests until mid-May, and most adults leave by early August (Igoe *et al.,* 2004). A study by Bracken *et al.* (2018) used environmental DNA (eDNA) to identify critical habitat for sea lamprey in Ireland. The eDNA sampling technique allows for the detection of low-density species and enables more effective and accurate deployment of resources and time allocation when collecting biological samples. Over a three-year period (2015-2017), they surveyed two different catchments in Ireland that included the Munster Blackwater and the Mulkear, the latter of which forms part of the Lower River Shannon SAC. Sea lamprey spawning aggregations and habitat use within both catchment areas were confirmed following eDNA collection and eDNA concentrations were higher within the Mulkear catchment (Bracken *et al.,* 2018). River lampreys are less apparent than sea lampreys due to smaller body size, and documentation of distribution information in Ireland is less thorough, although its riverine range seems to largely overlap with that of the sea lamprey (Igoe *et al.*, 2004). Key populations of river lamprey have been documented in the Mulkear River, and large numbers have been recorded in the Lower River Shannon and its tributaries. Additionally, they inhabit rivers including the Slaney, Barrow, Nore, Munster Blackwater, Laune and Boney (Igoe *et al*., 2004), and lamprey larvae have been found in the Mulkear and Munster Blackwater rivers

European Eel (*Anguilla anguilla*)

The common or European eel, *Anguilla anguilla* (Linnaeus, 1758), occur throughout Ireland. The European eel is not listed as part of the EU Habitats Directive; however, it is considered critically endangered on the IUCN Red List (IUCN, 2021) and the Ireland Red List (King *et al.,* 2011) and is listed as a CITES Appendix II species, meaning the species is not currently threatened with extinction but trade is controlled to prevent this from occurring (CITES, 2021). Recruitment of juveniles into Irish catchments has declined dramatically.

European eels are a catadromous species that undergo five principal stages throughout their life history including the *leptocephalus*, glass eel, elver, yellow eel, and silver eel (adult) stages. Adult eels spawn in the Sargasso Sea, and larvae and *leptocephali* drift on the Gulf Stream until they are transported across the Atlantic Ocean (Arai *et al.*, 2006). *Leptocephali* metamorphose into glass eels and then elvers, with both stages typically arriving on the Irish coast during December and increasing in numbers during spring (Moriarty, 1999). At this point they typically migrate upstream, approximately six to eight months after hatching, with elvers using freshwater habitats to grow into yellow eels and mature as silver eels. However, not all eels undergo full upstream migration and are instead estuary-dependent, relying entirely on the estuarine environment for food resources, shelter, and nursing grounds. The estuarine environments in Ireland, however, are limited by high altitude land patterns; therefore, most eels are constrained during their growth period to either freshwater or marine environments (Arai *et al*., 2006). Mature adults will then migrate downstream to the sea in autumn with possible continuation through late spring.

The River Shannon is Ireland's largest river system, and it has a network of lakes which are important habitats for the European eel. Within the river system, otolith analysis has determined that male silver eels are 11 years old on average, and females are 15 years old (McCarthy *et al*., 2008). Stocking programs of juvenile eel have been in place to address adverse effects of the Shannon hydropower structures on eel recruitment and were most successful during the 1970s and 1980s; however there are still steady declines in both yellow and silver eel populations in the Shannon system (McCarthy *et al.,* 2008). The fishery for European eel in the River Shannon is long established, with detailed records dating from 1960 onwards (McCarthy *et al.,* 1999).

Atlantic Salmon (*Salmo salar*)

Atlantic salmon is an anadromous species that is found in Europe and North America. Adult salmon migrate from the sea into rivers to spawn, usually in the same river that they spent time as a juvenile (CEFAS, 2021). Salmon require clean, well oxygenated rivers with gravel beds for the female to bury her eggs in redds. Spawning in Europe typically takes place from November to December. Juveniles hatch as alevins, emerge from the redds as fry and grow into parr. After approximately four years, parr become smolt through a process called smoltification and migrate to sea where they can mature (CEFAS, 2021). Atlantic Salmon are listed as vulnerable in Europe under the IUCN Red list (IUCN, 2021) and in Ireland under the Ireland Red List (King *et al*., 2011). Atkinson *et al.* (2020) studied the effects of river obstacles to anadromous species including Atlantic salmon and concluded that the removal of river obstacles such as bridges, culverts, would improve connectivity between river catchments and habitats.

Atlantic salmon has been observed spawning in the Lower Shannon Estuary and its tributaries. Catch and release studies of Atlantic salmon have estimated that the annual rod catch between 2009-2013 in the Mulkear, a large tributary of the Shannon catchment, was 970 salmon, while the Feale had an annual catch average of 1,350 (Gargan *et al*., 2015). Salmon monitoring programs conducted in the Shannon River Basin district since 2007 have concluded that three rivers (the Feale, Kilmastula, and Old Shannon) meet the conservation threshold of 17 salmon fry/ 5 min during electrofishing surveys showing healthy juvenile salmon abundance (Gargan *et al*., 2020).

Hearing

All fish have hearing and skin-based mechanosensory systems, such as the inner ear and the lateral line, that provide information about their surroundings (Popper *et al*., 2019a; Putland *et al*., 2019). While all fish are likely sensitive to particle motion, not all fish (*e.g.*, cartilaginous fish, such as sharks and jawless fish) are sensitive to the sound pressure component. Potential effects of exposure to anthropogenic sound on fish can be behavioural, physiological, or pathological.

Several authors have reviewed the hearing ability of fish (*e.g.* Popper and Fay, 1993, 2011; Popper *et al*., 2014, 2019a; Putland *et al*., 2019). At least two major pathways for sound transmittance between sound source and the inner ear have been identified for fish. The most primitive pathway involves direct transmission to the inner ear's otolith, a calcium carbonate mass enveloped by sensory hairs. The inertial difference between the dense otolith and the less-dense inner ear causes the otolith to stimulate the surrounding sensory hair cells. This motion differential is interpreted by the central nervous system as sound. The second transmission pathway between externally received sounds and the inner ear of fish is via the swim bladder, a gas-filled structure that is much less dense than the rest of the fish's body. The swim bladder, being more compressible and expandable than either water or fish tissue, will differentially contract and expand relative to the rest of the fish in a sound field. The pulsating swim bladder transmits this mechanical disturbance directly to the inner ear.

Some fish have been described as being hearing 'generalists' or 'specialists' where generalists conventionally detect sound to no more than 1-1.5 kHz and only detect the particle motion component of the sound field. Whereas specialists detect sounds above 1.5 kHz and detect both particle motion and pressure. However, Popper and Fay (2011) have suggested that the terms be dropped due to vagueness in the literature, and that the most common mode of hearing in fishes involves sensitivity to acoustic particle motion via direct inertial stimulation of the otolith organs. Additionally, they found that any possible sensitivities to pressure were the result of the presence of a swim bladder in the fish and that hearing sensitivity may be enhanced if the fish has a specific connection between the inner ear and the swim bladder (Popper and Fay, 2011).

Popper and Fay (2011) have also noted that there is a range of hearing abilities across fish species that is like a continuum, presumably based on the relative contributions of pressure to the overall hearing abilities of a species. One end of this continuum is represented by fish that only detect particle displacement because they lack pressure-sensitive gas-filled body parts (*e.g.* swim bladder). These species include elasmobranchs (*e.g.* sharks) and jawless fish and some teleosts including flatfish. Fish at this end of the continuum are typically capable of detecting sound frequencies <1.5 kHz *(e.g.*, Casper *et al*., 2003; Casper and Mann, 2006; 2007; 2009). The other end of the fish hearing continuum is represented by fishes with highly specialized otophysical connections between pressure receptive organs, such as the swim bladder and the inner ear. These fishes include some squirrelfish, mormyrids, herrings and otophysan fishes (freshwater fishes with Weberian apparatus, an articulated series of small bones that extend from the swim bladder to the inner ear). Rather than being limited to 1.5 kHz or less in hearing, these fishes can typically hear up to several kHz. One group of fish in the anadromous herring sub-family Alosinae (shads and menhaden) can detect sounds to well over 180 kHz (Mann *et al*., 1997, 1998, 2001). This is one of the widest hearing ranges of any vertebrate that has been studied to date. While the specific reason for this very high frequency hearing is not totally clear, there is strong evidence that this capability evolved for the detection of the ultrasonic sounds produced by echolocating dolphins to enable the fish to detect, and avoid, predation (Mann *et al*., 1997; Plachta and Popper, 2003). All other fishes have hearing capabilities that fall somewhere between these two extremes of the continuum. Some have unconnected swim bladders located relatively far from the inner ear (*e.g*. salmonids, tuna) while others have unconnected swim bladders located relatively close to the inner ear (*e.g*. Atlantic cod, *Gadus morhua*).

Trout *(Salmo trutta)*

Trout share many of the biological features of its close relative, the salmon, but forms two basic types, the migratory sea trout and the non-migratory brown trout, *Salmo trutta* (Linnaeus, 1758). Trout spawn in winter from October to January. The eggs are shed in redds cut by the female in the river gravel, usually in upstream reaches, although many spawn in the gravel below weirs.

The Rivers Shannon, Fergus and Ballycorick are important habitats for trout (Michael Fitzsimons, Shannon Regional Fisheries Board, pers. comm.)

Smelt *(Osmerus eperlanus)*

The smelt, *Osmerus eperlanus* (Linnaeus, 1758), is considered an indigenous species in Ireland despite being recorded from only six locations. It is primarily a marine pelagic fish which congregates in river mouths before moving upstream to spawn in February to April (Whitehead *et al.*, 1984). The adults spawn in rivers and estuaries before returning to the sea. Juvenile fish remain in the estuary for the rest of the summer.

Smelt are one of the rarest fish in Ireland and are listed as vulnerable in the Irish Red Data Book. Smelt have been recorded from the River Shannon (Kennedy, 1948) and river Fergus where breeding populations have been confirmed (Quigley & Flannery, 1996). Their main breeding grounds are in the Shannon, upstream of Limerick to the Ardnacrusha Power Station Tailrace canal (M. Fitzsimmons, pers. comm.).

Resident fish species

The lower Shannon estuary, the River Fergus and Ballycorick Creek are typical estuarine environments and support diverse communities of small fish species, juvenile flatfish, gobies and sticklebacks. They are rich feeding grounds for adults and juvenile fish of many species including bass (*Dicentrarchus labrax*) plaice (*Pleuronectes platessa*) and flounder (*Platichthys flesus*).

In addition to diadromous species, the Shannon Estuary hosts a number of resident species, comprising rich species diversity. A survey was carried out by Inland Fisheries Ireland in 2014 and looked at the composition of fish species in the Lower Shannon estuary. A total of 29 fish species were recorded in the Lower Shannon Estuary in October 2014. Sprat was the most abundant fish species, followed by sand goby, thick-lipped mullet and sand smelt. Flounder was well distributed throughout this water body.

A number of species were newly recorded in 2014, including bib, coalfish/ saithe, grey gurnard, mackerel and sand sole. A number of species were previously caught in 2008 but not captured in the 2014 survey, including black goby, cod, European sea bass and European eel. This was the only water body surveyed during 2014 in which thornback ray was recorded.

Other species which account for a large proportion of the biomass in the Shannon Estuary include flounder (*Platichthys flesus*) and common goby (*Pomatoschistus microps*). The Shannon estuary provides rich feeding grounds for many other species such as sand smelt (*Atherina presbyter*), dab (*Limanda limanda*), three-spined stickleback (*Gasterosteus aculeatus*) and cod (*Gadus morhua*).

7A.5 Assessment of Impact and Effect

7A.5.1 Likely Significant Effects

Annex III of the amended Directive 2014/ 52/ EU requires that the EIAR should assess:

- The magnitude and spatial extent of the impact (for example geographical area and size of the population likely to be affected).
- The nature of the impact.
- The transboundary nature of the impact.
- The intensity and complexity of the impact.
- The probability of the impact.
- The expected onset, duration, frequency and reversibility of the impact.
- The cumulation of the impact with the impacts of other existing and/ or approved projects.
- The possibility of effectively reducing the impact.

The potential impact mechanisms of the construction and operational phases of the Proposed Development on marine ecology are presented in **Table 7A.5.** Impact mechanism is associated with the construction phase, impact mechanism 2 and 3 are common to both the construction and operation phase, while impact mechanism 4 is associated with the operation phase. **Table 7A.5** also indicates where in this chapter impacts are assessed (**Section 7A.5.3** through **Section** Error! Reference source not found.).

Table 7A.5: Potential Impact Mechanisms

Potential Impact Mechanisms	Development Phase	Description	Assessed in
1. Release of pollutants during construction	Construction Phase	As with any construction project there is a risk that activities proposed for the construction of the Power Plant and the installation of the gas pipeline may result in the accidental release of chemical pollutants or other waste material pollution to nearby habitats, watercourses and water bodies. Potential chemical pollutants associated with construction plant equipment include fuels, oils, greases, hydraulic fluids (hydrocarbons). There is also risk of the accidental release of construction materials including concrete. Runoff from construction excavated material may result in the release of sediment, potentially impacting habitat and water quality. Given the nature and scale of the proposed works, there is potential that conservation features located adjacent to the works and immediately downstream and upstream of the works may be affected.	**Section 7A.5.3**
2. Underwater noise	Construction Phase **and** Operation Phase	There is potential that controlled rock blasting on land will generate underwater noise disturbance.	**Section 7A.5.4**
3. Seabed habitat loss	Construction Phase **and** Operation Phase	During the construction phase a trenched water outfall will be constructed across the shoreline into the Shannon estuary, which will result in the direct loss of habitats and associated fauna.	**Section 7A.5.5**

Potential Impact Mechanisms	Development Phase	Description	Assessed in
4. Discharge of Wastewater and Power Plant Process Heated Water Effluent	Operation Phase	Potential environmental impact associated with the treatment and disposal of secondary treated wastewater from onsite hygiene facilities. Heated water will be discharged to the estuary via the storm water outfall point, potentially affecting local water conditions in the vicinity of the proposed discharge points. Given local water currents, the plume of discharge waters may extend over a large area.	**Section7A.5.6**

7A.5.2 Impact Assessment

7A.5.2.1 Potential Impacts

When describing changes/ activities and impacts on ecosystem structure and function, important elements to consider include positive/ negative, extent, magnitude, duration, frequency and timing, and reversibility.

Section 3.7 of '*Guidelines on the Information to be Contained in Environmental Impact Assessment Reports'*, (EPA, 2022) provides standard definitions which have been used to classify the effects in respect of ecology. This classification scheme is outlined below in **Table 7A.6**.

Table 7A.6: EPA Impact Classification

Impact Characteristic	Term	Description
Quality	Positive	A change which improves the quality of the environment.
	Neutral	No effects or effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error.
	Negative	A change which reduces the quality of the environment.
Significance	Imperceptible	An effect capable of measurement but without significant consequences.
	Not Significant	An effect which causes noticeable changes in the character of the environment but without significant consequences
	Slight	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.
	Moderate	An effect that alters the character of the environment in a manner consistent with existing and emerging trends.
	Significant	An effect, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
	Very Significant	An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment.
	Profound	An effect which obliterates sensitive characteristics.
Duration and Frequency	Momentary Effects	Effects lasting from seconds to minutes.
	Brief Effects	Effects lasting less than a day.
	Temporary Effects	Effects lasting less than a year.
	Short-term	Effects lasting one to seven years.

Impact Characteristic	Term	Description
	Medium-term	Effects lasting seven to fifteen years.
	Long-term	Effects lasting fifteen to sixty years.
	Permanent	Effects lasting over sixty years.
	Reversible Effects	Effects that can be undone.
	Frequency	Describe how often the effect will occur. (once, rarely, occasionally, frequently, constantly – or hourly, daily, weekly, monthly, annually)
	Irreversible	When the character, distinctiveness, diversity, or reproductive capacity of an environment is permanently lost.
	Residual	Degree of environmental change that will occur after the proposed mitigation measures have taken effect.
	Synergistic	Where the resultant effect is of greater significance than the sum of its constituents.
	'Worst Case'	The effects arising from a development in the case where mitigation measures substantially fail.

7A.5.2.2 Determining Impact Significance

According to the EPA (2022), significance of effects is usually understood to mean the importance of the outcome of the effects and is determined by a combination of objective (scientific) and subjective (social) concerns.

The EPA further notes that:

> '*While guidelines and standards help ensure consistency, the professional judgement of competent experts plays a role in the determination of significance. These experts may place different emphases on the factors involved. As this can lead to differences of opinion, the EIAR sets out the basis of these judgements so that the varying degrees of significance attributed to different factors can be understood*'.

With this in mind, the geographic frame of reference applied to determining impact significance by the NRA (2009) in Ireland and CIEEM (2019) in Ireland and the UK, has been adopted in this report in tandem with the EPA's qualitative significance criteria**. Table 7A.7** compares the qualitative versus geographic approaches to determining the significance of effects.

Table 7A.7: Equating the Definitions of Significance of Effects Using a Geographic vs. Qualitative Scale of Reference

Geographic Scale of Significance (NRA, 2009; CIEEM, 2019)	Qualitative Scale of Significance of Effects (EPA, 2022)
Negligible or Local Importance (Lower Value). No significant effects predicted to significant ecological features.	**Imperceptible**. An effect capable of measurement but without significant consequences. **Not significant**. An effect which causes noticeable changes in the character of the environment but without significant consequences.

Geographic Scale of Significance (NRA, 2009; CIEEM, 2019)	Qualitative Scale of Significance of Effects (EPA, 2022)
Local Importance (Higher Value), County, National, Regional, or International.	**Slight/ Moderate/ Significant/ Very Significant/ Profound** *i.e.* effects can be slight, moderate, significant, very significant, or profound at Local scale, subject to the proportion of the local population/ habitat area affected.

The geographic frame of reference can be a good fit to assessments of biodiversity impacts because it allows clear judgements to be made about the scale of significance, with reference to published estimates for the population size of a given species at county, national and/ or international scales or areas of habitats at such scales.

The proportion of a known feature impacted at county scale (*i.e.* 1% of the known or estimated population in a given county) is measurably different from that impacted at national scale (*i.e.* 1% of the known or estimated national population).

A non-geographic qualitative approach can be a poor fit to assessments of biodiversity since the definitions provided for the different qualitative terms do not relate to measurable units of space such as a county or national boundary. For instance, a significant effect is defined by the EPA as '*an effect which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment without affecting its sensitivities*', whilst a very significant effect is that which '*by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment'*.

7A.5.2.3 Summary Valuation of Significant Marine Ecology Features

As per the impact assessment methodology outlined in above, significant ecological features are considered to be those valued at Local Importance (Higher Value) or higher as per NRA (2009) and CIEEM (2019) definitions. **Table 7A.8** summarises all significant ecological features identified within the zone of influence (ZoI) of potentially significant impacts.

Table 7A.8: Summary Valuation of Significant Marine Ecological Features and Identification of Features

Feature		Highest Value within Zone of Influence	At risk of significant impact	Scoped into marine ecology assessment
Designated sites	Lower River Shannon SAC	International	Yes	Yes
	River Shannon and River Fergus Estuaries SPA	International	Yes	Yes
Habitats	Mudflats and sandflats not covered by seawater at low tide [1140]	International importance	Yes	Yes
	Large shallow inlets and bays [1160]	International importance	Yes	Yes
	Estuaries [1130]	International importance	Yes	Yes
	Reefs [1170]	International importance	Yes	Yes

Feature		Highest Value within Zone of Influence	At risk of significant impact	Scoped into marine ecology assessment
	Sandbanks which are slightly covered by sea water all the time [1110]	International importance	Yes	Yes
	Coastal lagoons [1150]	International importance	Yes	Yes
	Salicornia and other annuals colonising mud and sand [1310]	International importance	Yes	Yes
	Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]	International importance	Yes	Yes
	Mediterranean salt meadows (*Juncetalia maritimi*) [1410]	International importance	Yes	Yes
Marine Mammals	*Tursiops truncatus* (Common Bottlenose Dolphin) [1349]	International importance	Yes	Yes
	Phocoena phocoena (Harbour Porpoise) [1351]	International importance	Yes	Yes
	Halichoerus grypus (Grey Seal) [1364]	International importance	Yes	Yes
	Phoca vitulina (Harbour Seal) [1365]	International importance	Yes	Yes
Fish species	*Salmo salar* (Atlantic Salmon) [1103]	International importance	Yes	Yes
	Lampetra fluviatilis (River Lamprey) [1099]	International importance	Yes	Yes
	Petromyzon marinus (Sea Lamprey) [1095]	International importance	Yes	Yes
	Alosa alosa fallax (Twaite Shad) [1103]	International importance	Yes	Yes
	Osmerus eperlanus (Smelt)	International importance	Yes	Yes
	Anguilla anguilla (European Eel)	International importance	Yes	Yes

7A.5.3 Impact Mechanism 1. Release of Pollutants During Construction

7A.5.3.1 Relevant Receptors

- Habitats.
- Marine Mammals.
- Fish.

7A.5.3.2 Assessment

Impact mechanism 1 is associated with the construction phase.

Potential effects associated with construction activity include the accidental release of sediment and chemical pollutants to the Shannon Estuary immediately adjacent to, and upstream and downstream, of the Proposed Development.

Sediment

The Shannon Estuary is naturally turbid with background level suspended solids ranging from 1 mg/l up to 86 mg/l (McMahon and Quirke, 1992). Excessive suspended sediments can cause stress and affecting the gills of fish, resulting in injury or mortality and the loss of suitable fish spawning habitat and declines in egg and early life stage success rates. Increased turbidity can reduce feeding rates and affect prey abundance and predation efficacy in visual feeders such as salmon. Resident fish species in the Shannon Estuary including Lamprey, Salmon, Seatrout have evolved over geological time to migrate through estuaries on their way to spawning grounds and as many estuaries are naturally high in turbidity, these species evolved mechanisms to deal with high suspended sediment loads.

Bottlenose dolphin use echolocation as their principal means of navigation, communication, foraging and predator avoidance. In murky waters, the use of echolocation means that objects are often ‘heard’ before they are seen (Ansmann, 2005). As dolphin are accustomed to the naturally turbid nature of the Shannon Estuary impacts due to short-lived changes in turbidity are unlikely to impact the species.

Should sediments be released to the Shannon Estuary, the effect of increased turbidity, if realised, will be short lived with the local currents in the immediate area resulting in sediment being rapidly removed from the system and significant sediment deposition in the area will not occur. In the event of significant release of sediment from the construction works, local currents are such that any localised deposition of sediment will be short lived with sediments rapidly dispersed seaward.

In addition, any effects are not likely to be significant for local habitats and fauna, as the area is naturally turbid (see above) and hydrodynamically active and experiences a high degree of natural suspended solids. Consequently, there is no risk of significant effects to benthic habitats.

Through the implementation of construction best practice and mitigation and monitoring measures, the risk of activities during the construction resulting in the uncontrolled release of sediment material to the nearby river and habitat types is extremely unlikely to occur. Mitigation and monitoring measures and the general construction practices to be implemented are outlined in **Section 7A.6** and the Construction Environmental Management Plan (CEMP) provided in **Appendix A2.3**, Volume 4.

Chemical Pollutants

Accidental release of hydrocarbons from plant machinery and fuel stocks, and organic polymers or heavy metals associated with cementing/ concreting materials used for construction activities. These materials are toxic to organisms in sufficient quantities and will potentially contaminate the seabed sediments adjacent to the project, inhibiting recolonisation of the area.

Chemical contamination of the river and river sediments could also occur from accidental spillages, such as oil and other chemicals through poor operational management, the non-removal of spillages, poor storage, handling and transfer of oil and chemicals. Hydrocarbon spills from poorly secured or non-bunded fuel storage areas, leaks from vehicles or plant or spills during re-fuelling can all give rise to the escape of hydrocarbons from construction sites.

Wash off from poorly cured cement can also be highly alkaline and potentially dangerous to fish. Spills of hydrocarbons and chemicals can give rise to tainting of fish or, if large enough, fish kills and invertebrate kills. Accidental release of chemicals and pollutants must be controlled to ensure risk of impacts are minimised.

If suitable precautions are taken and best practice for the storage, handling and disposal of such material are followed, impacts should be minimal.

Mitigation measures specifically designed to avoid the introduction of runoff and contaminants to the Shannon Estuary are detailed in **Section 7A.7.1** and the CEMP provided in **Appendix A2.3**, Volume 4.

Accidental spillages will be contained and cleaned up immediately. Remediation measures will be carried out in the unlikely event of pollution of the marine environment.

7A.5.3.3 Conclusion

Likely impacts during the construction phase in the absence of mitigation are assessed as **Negative**, **Significant** and **Short-Term**.

Mitigation measures to prevent release of sediments, chemical and pollutants during construction are detailed in **Section 7A.7.1**.

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7A.5.4 Impact Mechanism 2. Underwater Noise

7A.5.4.1 Relevant Receptors

- Marine Mammals.
- Fish.

7A.5.4.2 Assessment

Impact mechanism 2 is associated with the construction and operational phases.

Activities associated with the construction and operation of the Power Plant have the potential to impact marine mammals and fish by introducing sound into the marine environment.

The two largest sources of noise associated with the previous proposal were the in-water impact piling for the jetty construction and the movement and arrival of vessels at the LNG Terminal during operations. Both of these activities have now been removed with the main source of noise coming from onshore construction works.

An addendum to the original study submitted as part of PA08.311233 application, of the potential impact of noise, by LGL Ecological Research Associates LTD (LGL), has found that in the absence of noise associated with jetty construction and vessel movements the only source of noise which could impact the underwater acoustics would be from onshore blasting during construction. Sound levels occurring in the water will be relatively low with the only predicted impact from blasting would be to pinniped species (seals) within 75 m from the shoreline. The LGL noise impact assessment report and addendum is presented in **Appendix A7A.4**, Volume 4.

7A.5.4.3 Receptors

Common Bottlenose Dolphin

Bottlenose dolphin use echolocation as their principal means of navigation, communication, foraging and predator avoidance. The individual monitors its surroundings by emitting sound waves and waiting for them to reflect off different objects (Weilgart, 2007; Ansmann, 2005; Potter and Delroy, 1998). The time taken for these pulses to return to the animal, as well as the characteristics of the reflected pulse, gives an indication of the distance and nature of the object. Light propagates poorly in the viscous and opaque marine environment and is absorbed within a few tens of metres (Potter and Delroy, 1998; Nowacek *et al*., 2007). Low frequency underwater sound may travel for hundreds of kilometres without losing intensity (Nowacek *et al*., 2007). In murky waters, the use of echolocation means that objects are often 'heard' before they are seen (Ansmann, 2005). This ability is extremely effective; bottlenose dolphin, can differentiate between two aluminium plates varying by just 0.23 mm and can detect objects up to 113 m away (Au, 2002). This level of precision is indicative of the importance of echolocation for foraging and navigation by some species of cetaceans.

The potential impacts of noise on marine mammals have been the subject of considerable research; reviews are provided by Richardson *et al*. (1995), Nowacek *et al*. (2007), Southall *et al*. (2007), Weilgart (2007) and Wright *et al*. (2007). If the frequency of anthropogenic noise overlaps with the frequencies used by marine mammals, this may reduce the animal's ability to detect important sounds for navigation, communication and prey detection (Weilgart, 2007). This is termed acoustic masking, which may occur anywhere within an organism's auditory range (Wright *et al*., 2007; Richardson *et al*., 1995). Masking of important vocalisations will result in increasing information ambiguity and, in extreme circumstances, may result in cetaceans being unable to orientate themselves or hunt/ evade predation in the marine environment (Wright *et al*., 2007).

Exposure to high energy noise emissions (e.g. piling, drilling, seismic noise) can result in non-recoverable auditory injury (termed Permanent Threshold Shift (PTS). Behavioural reactions to acoustic exposure are generally more variable, context-dependent, and less predictable than the effects of noise exposure on hearing or physiology. This is because behavioural responses to anthropogenic sound are dependent upon operational and environmental variables, and on the physiological, sensory, and psychological characteristics of exposed animals. It is important to note that the variables may differ (greatly in some cases) among individuals, of a species and even within individuals depending on various factors (*e.g.* sex, age, previous history of exposure, season, and animal activity). NOAA (2013) outline that noise can affect cetacean behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

Fish Species

Sound is perceived by fish through the ears and the lateral line (the acoustico-lateralis system) which is sensitive to vibration. Some species of fish such as salmon have a structure linking the gas filled swim bladder to the ear. The swim bladder is sensitive to the pressure component of a sound wave, which resonates as a signal that stimulates the ears. These species, therefore, usually have increased hearing sensitivity. Such species are considered to be more sensitive to anthropogenic underwater noise sources than species, such as lamprey, that do not possess a structure linking the swim bladder and inner ear.

It should be noted that the potential impact of noise on juvenile and adult fish in open water is considered to be minimal as they can readily move away from the noise source. Experiments on fry demonstrated balance problems resulting from exposure to an energy source, however, the effects were temporary with full recovery observed after a few minutes upon cessation of the noise (Kostyuchenko, 1971). Some studies of high energy seismic noise sources have also demonstrated fish's ability to acclimatise to noise associated with an energy source over time (*e.g.* Chapman and Hawkins, 1969).

Hearing in salmon is poor, the species responding only to low frequency tones (below 0.38 kHz). While there are no data available for hearing in lamprey, it is highly unlikely that they detect sound close to 10 kHz (Popper, 2005). The lamprey 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.

7A.5.4.4 Conclusion

In summary, the proposed construction and operational activities associated with the Proposed development will have minimal impact on ambient noise levels. The only source of noise which has the potential to impact on underwater acoustics would be from onshore blasting during the construction phase of the project. Sound levels will be low with the only predicted impact being on pinniped species within 75 m from the shoreline. Grey seals rarely occur in the Shannon Estuary, and harbour seals are uncommon. Thus, any effects from project activities are expected to be **Minor**, **Temporary**, and localized to the area immediately around the Proposed Development, with **No Long-Term** effects on marine mammal or fish populations.

7A.5.5 Impact Mechanism 3. Seabed Habitat Loss

7A.5.5.1 Relevant Receptors

- Habitats.

7A.5.5.2 Overview

Impact mechanism 3 is associated with the construction and operation phase.

Seabed habitat loss will occur as a result of the installation of a trenched water outfall across the shoreline into the Shannon Estuary.

The assessment of the potential impact of seabed habitat loss is undertaken here with respect to the Annex I habitats for which the Lower River Shannon SAC is designated. Specifically, the assessment considers the area of Annex I habitat lost relative to the full areal extent of the Annex I habitat within the SAC.

The proposed outfall overlaps Annex I habitats 1130 Estuaries and 1170 Reefs (see **Figure 7A.11** and **Figure 7A.13** respectively and **Figures F7.9** and **F7.10** in Volume 3). The width of the trench will be approximately 2 m while its total length through Annex I habitats is approximately 50 m. The outfall trench will be excavated above the low water mark using a hydraulic rock breaker mounted on a tracked excavator. This operation will be carried out in the dry at all times working above the tide during a suitable period of spring tides. Where the outfall extends beyond the low water mark into the estuary, excavation of rock will be undertaken using an expanding grout placed by divers into drilled holes to pre-split the rock to the required levels and facilitate its removal by long reach excavator bucket. Trenches excavated across the shoreline will be backfilled with concrete suitable for underwater use and the surface will be embedded with cobbles and stone excavated from the trench to minimise the visual impact. The excavated material will be removed from the foreshore and incorporated as part of the earthworks and landscaping for the Proposed Development. Below the low water mark, the trench will remain open, and the sides of the trench will be battered back to avoid creating a pocket for silt.

The Conservation Objectives[3], attributes and targets relating to the area of Annex I habitat 1130 Estuaries and 1170 Reefs within the SAC are presented respectively in **Table 7A.9** and **Table 7A.10** (NPWS, 2012).

[3] NPWS (2012) Conservation Objectives Series. Lower River Shannon SAC Site Code: 002165.

Table 7A.9: Annex I Habitat 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:

Annex I habitat	Measure	Target	Notes
1130 Estuaries	Habitat area	The permanent habitat area is stable or increasing, subject to natural processes.	Habitat area was estimated as **24,273ha** using OSi data and the Transitional Water Body area as defined under the Water Framework Directive

Table 7A.10: Annex I Habitat 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:

Annex I habitat	Measure	Target	Notes
1170 Reefs	Habitat area	The permanent habitat area is stable or increasing, subject to natural processes.	Habitat area was estimated as **21,421ha** from the 2010 intertidal and subtidal reef survey (Aquafact 2011a, 2011b)

7A.5.5.3 Loss due to Installation of Outfall Pipe

The disturbance of the seabed below the low water mark will be small, arising primarily from the excavation of the trench and clearing and levelling of the ground to install the outfall pipe.

The installation of the outfall pipe will result in the loss, until decommissioning, of approximately 90m^2 of Annex I habitat above the low water mark and 10m^2 below the low water mark. Loss of Annex I habitat Estuaries [1130] habitat is estimated to be approximately 100m^2, while the loss of Reef [1170] habitat is approximately 65m^2.

The approximate spatial extent of Annex I habitat lost is presented in **Table 7A.**. Installation of the pipe will result in the loss of 0.000041% and 0.000030% of the Annex I habitats 1130 Estuaries and 1170 Reefs respectively.

Table 7A.11: Loss of Annex I Habitat 1130 and 1170 due to Installation of Outfall Pipe

Annex I habitat	Habitat area within SAC[4]	Area of Annex I habitat lost pending decommissioning	% of Annex I habitat lost pending decommissioning
1130 Estuaries	24,273ha	100 m^2	4.1 x 10^{-5} %
1170 Reefs	21,421ha	65 m^2	3.0 x 10^{-5} %

The outfall pipe extends through one marine community type (MCT) of Annex I habitat 1130, namely subtidal sand to mixed sediment with Nucula nucleus community complex. The total extent of the marine community type within the Annex I habitat is estimated to be 4,196 ha. The installation of the outfall pipe will result in the loss, but reversible upon decommissioning, of approximately 10 m^2 of this community type. This equates to 0.0000238% of the community type within 1130 Estuaries.

[4] Estimates of habitat area taken extent from NPWS (2012) Conservation Objectives Series - Lower River Shannon SAC 002165 Version 1.0.

The spatial extent of the marine community type Fucoid-dominated intertidal reef community complex within Annex I habitat 1170 Reefs is estimated to be 1,294 ha. The installation of the outfall pipe will result in the loss of approximately 90 m^2 of this community type. This equates to 0.000695% of the community type within 1170 Reefs. The part of the trench that is installed in reef areas will be recolonised by reef flora and fauna assemblages and will be left in-situ following decommissioning.

During the decommissioning phase sections of the outflow pipe installed in soft sediment areas will be removed. The voids created will be left to refill naturally through sedimentation and sediment movement processes. The sediments will be naturally recolonised by the migration of flora and fauna from local sediments and the settlement of larvae, thereby allowing full recovery of the ecology within months or a few years after decommissioning.

7A.5.5.4 Assessment and Conclusion

The loss of habitat area due to the outflow is small and negligible as less than 99.999% of Annex 1 habitats 1130 Estuaries and 1170 Reefs will not be directly affected.

Similarly, the loss of marine community type of Annex I habitats 1130 Estuaries and 1170 Reefs is small and negligible.

The loss of habitat area or marine community type will not give rise to significant negative impacts to the functioning or conservation status of the habitats during the construction and operation stages of the Proposed Development.

Natural England commissioned an analysis of authoritative decisions which considered the scale of the effects on the area of a site or qualifying habitat feature that may be considered to result in significant effects (NECR205 2016). The proportion of the areas of Annex I habitats 1130 Estuaries and 1170 Reefs affected by the present project, pending decommissioning, are orders of magnitude less than the proportions of the areas of a habitat referenced by Natural England as being not significantly affected (NECR205 2016). Furthermore, given that the intertidal and subtidal surveys did not observe any rare, protected or unusual species, and those observed are known to occur widely, it can be concluded that the loss of habitat of this magnitude will have no impact on the structure and functioning of these Annex 1 habitats.

Nevertheless, following decommissioning, measures will be taken to reinstate the small areas of habitat lost.

7A.5.5.5 Conclusion

The loss of Annex I habitats 1130 Estuaries and 1170 Reefs of less than 99.999% relative to the total area of the habitats in the SAC is small and negligible.

The loss of this magnitude will have no impact on the structure and functioning of these Annex I habitats and on the integrity of the Lower Shannon Estuary SAC.

The likely impact on habitat is predicted to be **Neutral** and **Not Significant**.

Figure 7A.11: Proposed outfall relative to the Annex I Habitat 1130 Estuaries of the Lower River Shannon SAC

Figure 7A.12: Proposed outfall relative to the Annex I Habitat 1170 Reefs of the Lower River Shannon SAC

Figure 7A.13: Marine community types identified relative to marine community types within Annex I Habitats of the Lower River Shannon SAC

7A.5.6 Impact Mechanism 4. Discharge of Wastewater and Power Plant Process Heated Water Effluent

7A.5.6.1 Relevant Receptors

- Habitats.
- Marine Mammals.
- Fish.

7A.5.6.2 Assessment

Impact mechanism 4 is associated with the operation phase.

Overview

The proposed treated sanitary effluent discharge from the development was modelled discharging from the proposed nearshore outfall pipe located on the sea bed.

The outfall pipe is also the discharge point for effluent from the Power Plant.

The parameters of interest modelled are temperature, biochemical oxygen demand (BOD), ammonia, total phosphorus (TP) and *E.coli.*

Modelling Assessment

Power Plant Process Heated Water Effluent

The Power Plant will generate several process water effluent streams. Some of the effluent streams will be collected and removed offsite and the remaining effluent streams will be pumped or fall by gravity to the effluent sump. Process water effluent leaving the effluent sump, will be continuously monitored for pH before discharging to the estuary via the storm water outfall pipe.

The automatic control system associated with the effluent sump will sound an alarm if the pH goes outside a pre-set range – typically 6 to 9. This will alert the operator to take corrective action to remedy the problem. If the pH continues to go outside the pre-set range, this will automatically close the discharge valve and open the associated re-circulation valve and will then start the re-circulation process during which period the sump will be dosed with either acid or caustic soda to return the pH to between 7 and 8. At this stage the automatic discharge valve will re-open and the re-circulation valve will close. A regular visual check on oils and greases will also be made in this sump to ensure that the discharge will be free of these contaminants before discharge. The process effluent in the sump will be monitored for compliance with the IE licence limits and then discharged, via the storm water outfall pipe, to the Shannon Estuary. **Table 7A.11** below summarises the Power Plant Process Effluent Sump Discharge.

Table 7A.11: Power Plant Process Effluent Sump Discharge

Parameter	Typical Range of Emissions (min. to max.)
Volume range	0 to 1,128m^3/day
pH	6 – 9
Temperature range	25^{0}C to 40°C
BOD	20 mg/l
Suspended Solids	30 mg/l
Total Dissolved Solids	5000 mg/l
Mineral Oil	20 mg/l
Total Ammonia (as N)	5 mg/l
Total Phosphorus (as P)	5 mg/l

Treated Sanitary Effluent Discharge

Sanitary effluent will be generated by the Power Plant. All sanitary effluent will be pumped or fall by gravity to a common wastewater treatment plant (WWTP) onsite. The effluent waste stream will be monitored for compliance with the licence limits and then discharged, via the storm water outfall pipe, to the Estuary.

A biological Wastewater Treatment System is proposed. It will be sized for a headcount of 67. **Table 7A.12** summarises the effluent stream generated from the WWTP and provides estimated quantities.

Effluent leaving the WWTP will be continuously monitored for pH before discharging to the estuary. The automatic control system associated with the WWTP will sound an alarm if pH falls outside of expected range. This will alert the operator to take corrective action to remedy the problem. If the problem continues to go outside the pre-set range, this will automatically close the discharge valve and effluent will be diverted to a holding tank.

Table 7A.12: Characteristics of WWTP Discharges

Parameter	Emission Limit Value
Volume	35m^3/day
pH	6 – 10
BOD	25 mg/l
Suspended Solids	35 mg/l
Ammonia (as N)	5 mg/l
Total Phosphorous (as P)	2 mg/l

Modelled Discharges

The modelled effluent was a combination of the treated sanitary effluent of 35m^3/day and the process effluent at a mean daily discharge of 778m^3/day and an instantaneous maximum hydraulic load of 1,128 m^3/day. This was modelled as a thermal discharge at 40^{o}C with the receiving waterbody ambient temperature of 12^{o}C (effluent at 20^{o}C above ambient). The various treated effluent concentrations are outlined in **Table 7A.11** and **Table 7A.14.**

The heated discharge from the processed waters was modelled at 28°C above ambient with the ambient at 12°C. The maximum and mean temperature envelope are presented in **Figure 7A.14** and **Figure 7A.15** over a full 15 day spring-neap-spring tidal period. These plots show very local rise in temperature at the outfall site having a maximum increase of 0.9135°C and mean increase at outfall site of 0.069°C. The maximum temperature increase reduces within 100 m of the discharge point to 0.171°C which is an insignificant impact. The heated plume rises and mixes in the water column due to a lower density than the receiving waters. At the outfall site the maximum temperature occurs at the seabed but within a short distance the plume is well mixed vertically.

E.coli was modelled from the sanitary discharge only using a conservative die-off rate of T_{90} = 36hours (winter conditions) at a secondary treated effluent concentration of 10^6 No./ 100ml and a discharge rate of 0.41l/s. The maximum and mean concentration envelopes for *E.coli* are presented in **Figure 7A.16** and **Figure 7A.17** over a complete spring-neap-spring tidal period. The highest concentration occurs in the receiving waters at the outfall site which is predicted to reach 1,458 No./ 100ml *E.coli* and within 100 m (mixing zone) this has reduced to 279 No./ 100ml. The tidal mean concentration over 15 days of tides is 102 No./ 100ml at the outfall site and significantly lower elsewhere. The predicted concentration plume shows no impact on Ballylongford and Glencloosagh Bays where shellfish activities are located.

BOD concentration was modelled at 9l/s at concentration of 20 mg/l from the process effluent and at 0.41 l/s at 25 mg/l from the sanitary effluent discharge. The maximum and mean concentration envelopes for BOD are presented in **Figure 7A.18** and **Figure 7A.19** over a complete spring-neap-spring tidal period. The highest concentration occurs in the receiving waters at the outfall site at a concentration of 0.692 mg/l BOD. The maximum BOD concentration within 100 m of the outfall site is 0.132 mg/l. The average BOD concentration in the receiving water at the outfall site is 0.048 mg/l.

The total ammonia discharge from the treated process water and treated sanitary water produces a maximum ammoniacal nitrogen concentration within the receiving waterbody of 0.1513 mg/l N and a mean concentration at the outfall site of 0.012 mg/l N, refer to **Figure 7A.20** and **Figure 7A.21**. The maximum Ammoniacal nitrogen concentration within 100 m of the outfall site is predicted to be 0.033 mg/l N.

The dispersion simulations show that the total phosphorus concentration from the treated process water and treated sanitary water produce a maximum concentration within the receiving waterbody of 0.167 mg/l P occurring at the outfall site and a mean concentration at the outfall site of 0.0117 mg/l P, refer to **Figure 7A.22** and **Figure 7A.23**. The maximum Total phosphorus concentration at 100 m from the outfall site is predicted to be 0.032 mg/l P.

7A.5.6.3 Conclusion

All of the above modelled water quality parameters are shown to easily satisfy the permissible limits set out in the surface water regulations (SI 272 of 2009 and amended regulations) and will not impact the water quality status or threaten the ecological health of the receiving Shannon Estuary waters. Consequently, it can be concluded there will be **No Significant** environmental impact from impact mechanism 4.

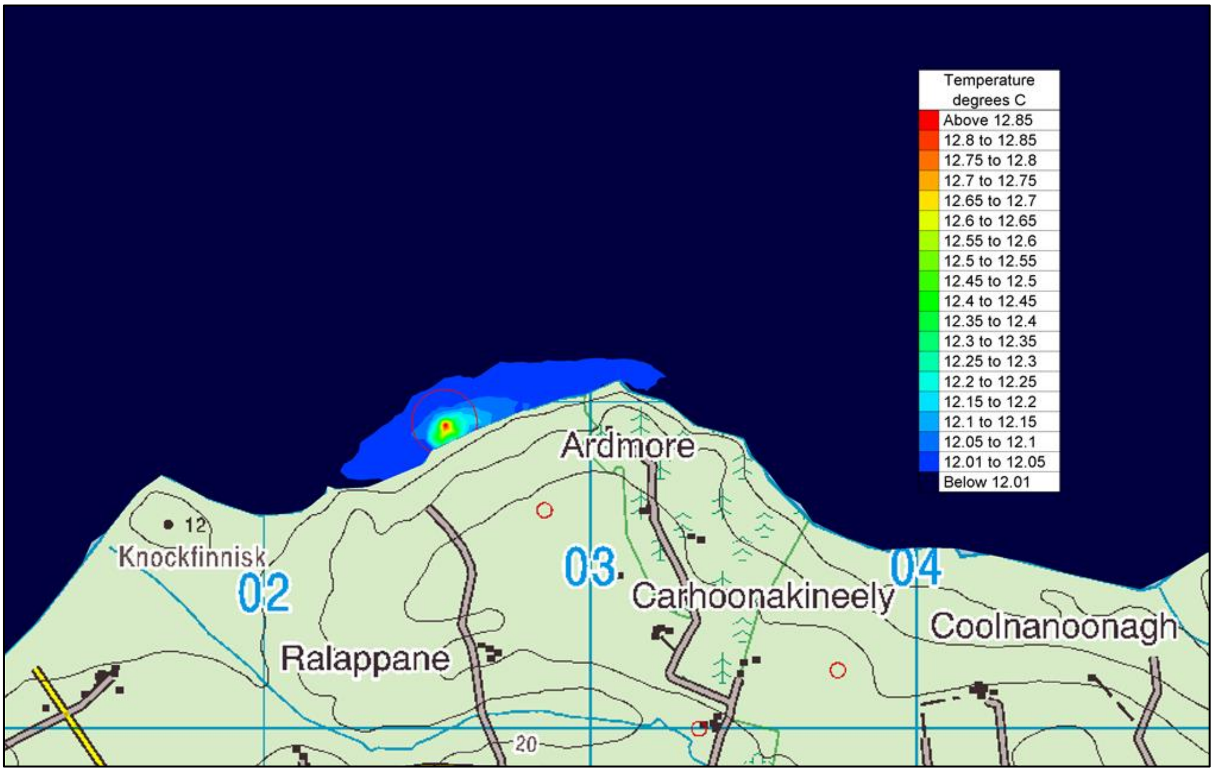

Figure 7A.14: Predicted Maximum Temperature Envelope over 15 Days for Spring-neap-spring Tide Simulation Modelling Effluent at 40°C and Ambient Temperature at 12°C

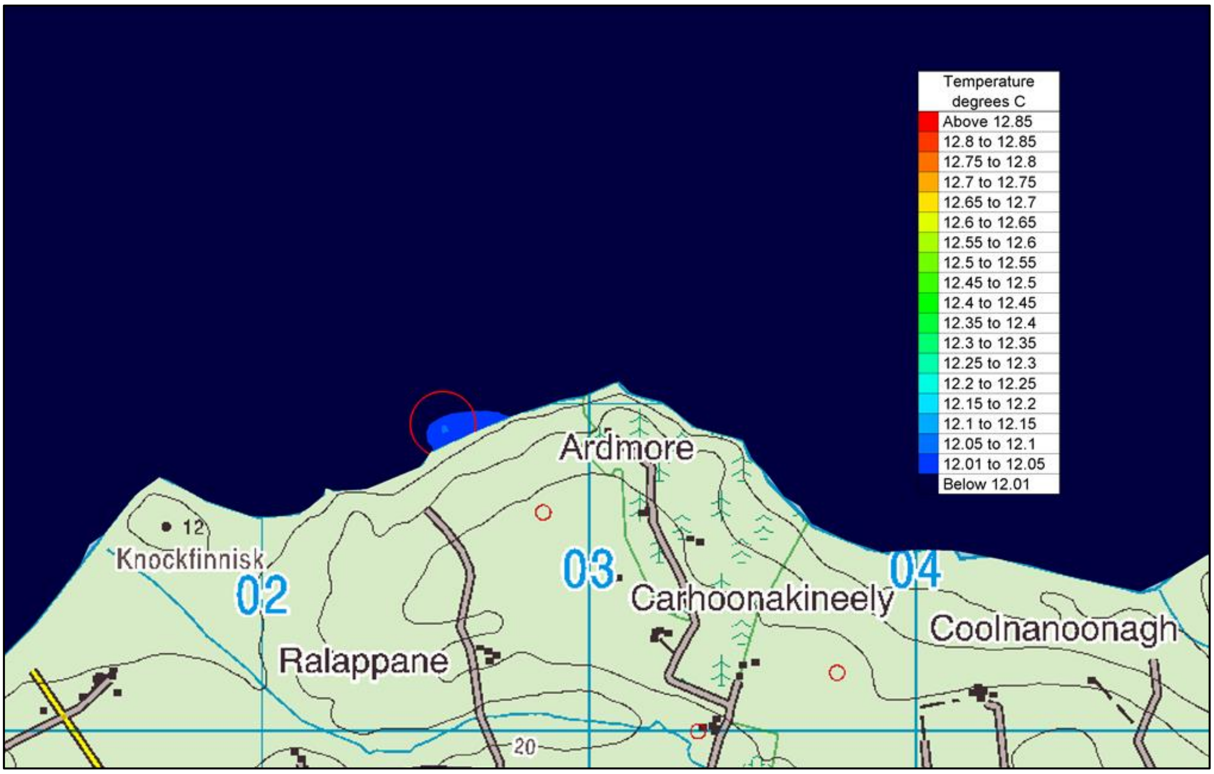

Figure 7A.15: Predicted Mean Temperature Envelope over 15 days for Spring-neap-spring Tide Simulation Modelling Effluent at 40 °C and Ambient Temperature at 12 °C

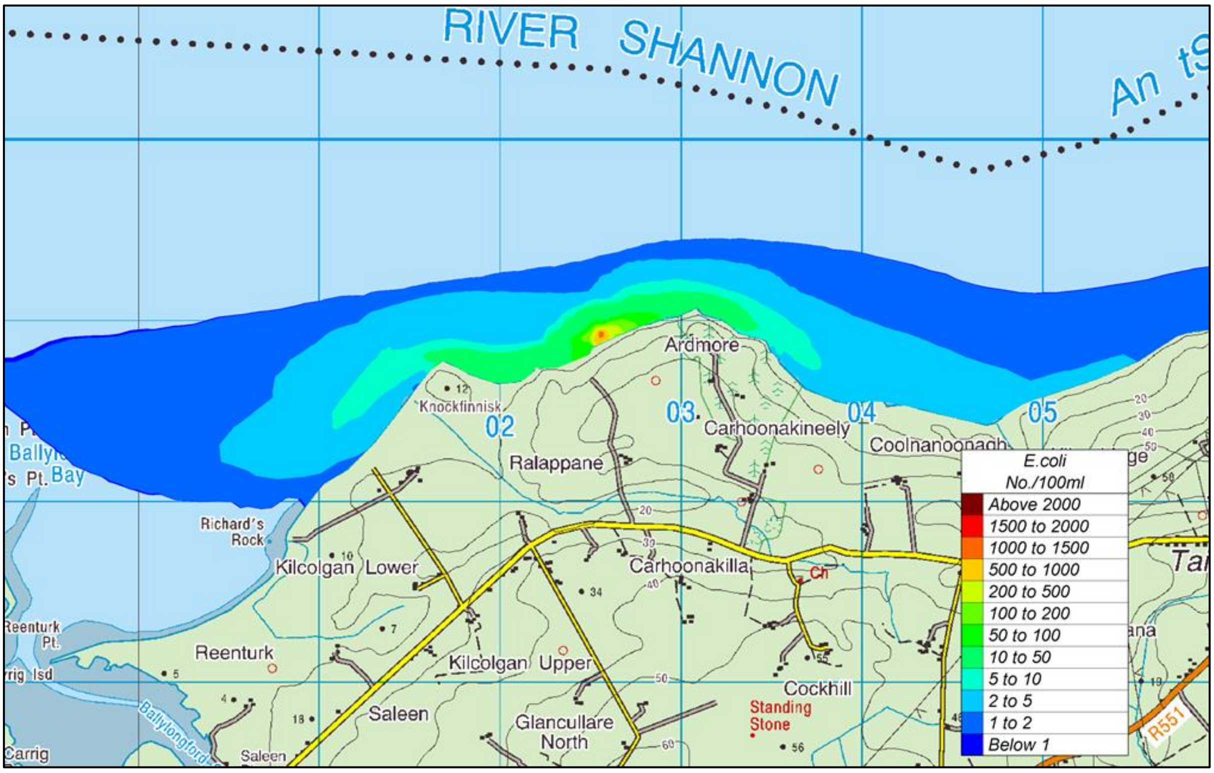

Figure 7A.16: Predicted Maximum *E.coli* concentration (No./ 100ml) Envelope over 15 Days for Spring-neap-spring Tide Simulation

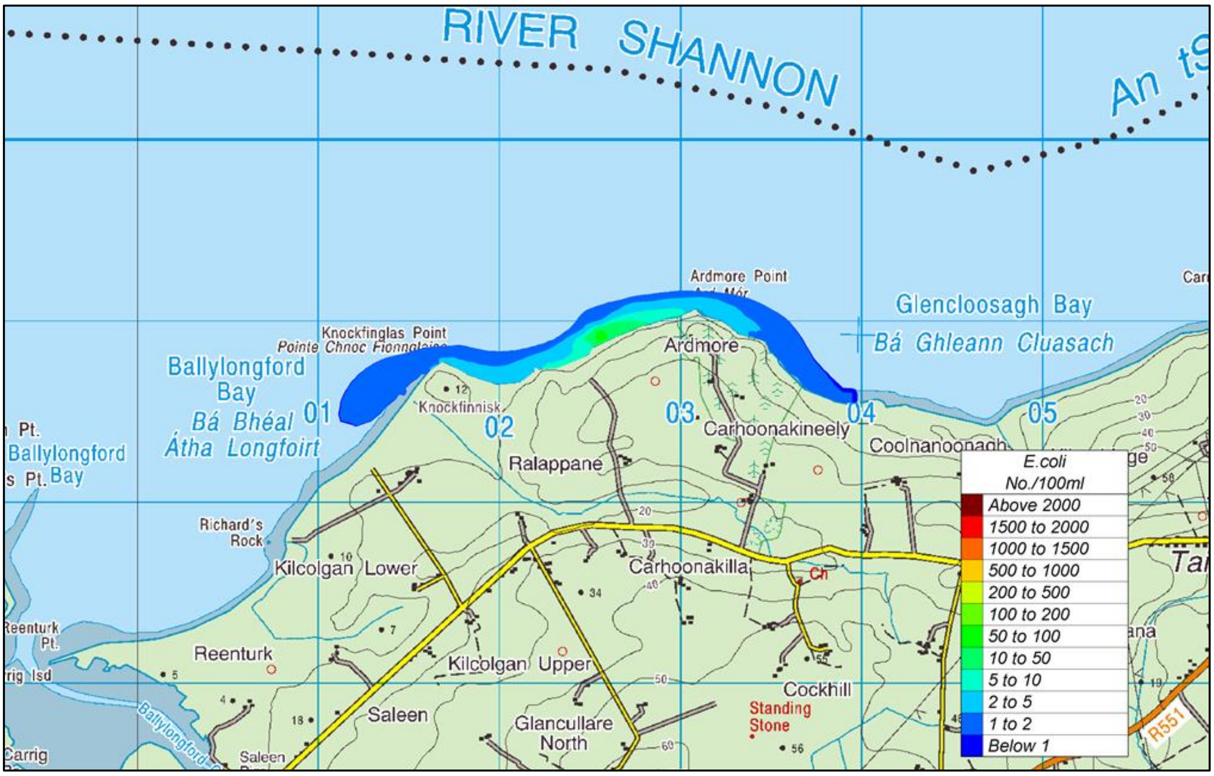

Figure 7A.17: Predicted Average *E.coli* Concentration (No./ 100ml) Envelope over 15 days for Spring-neap-spring Tide Simulation

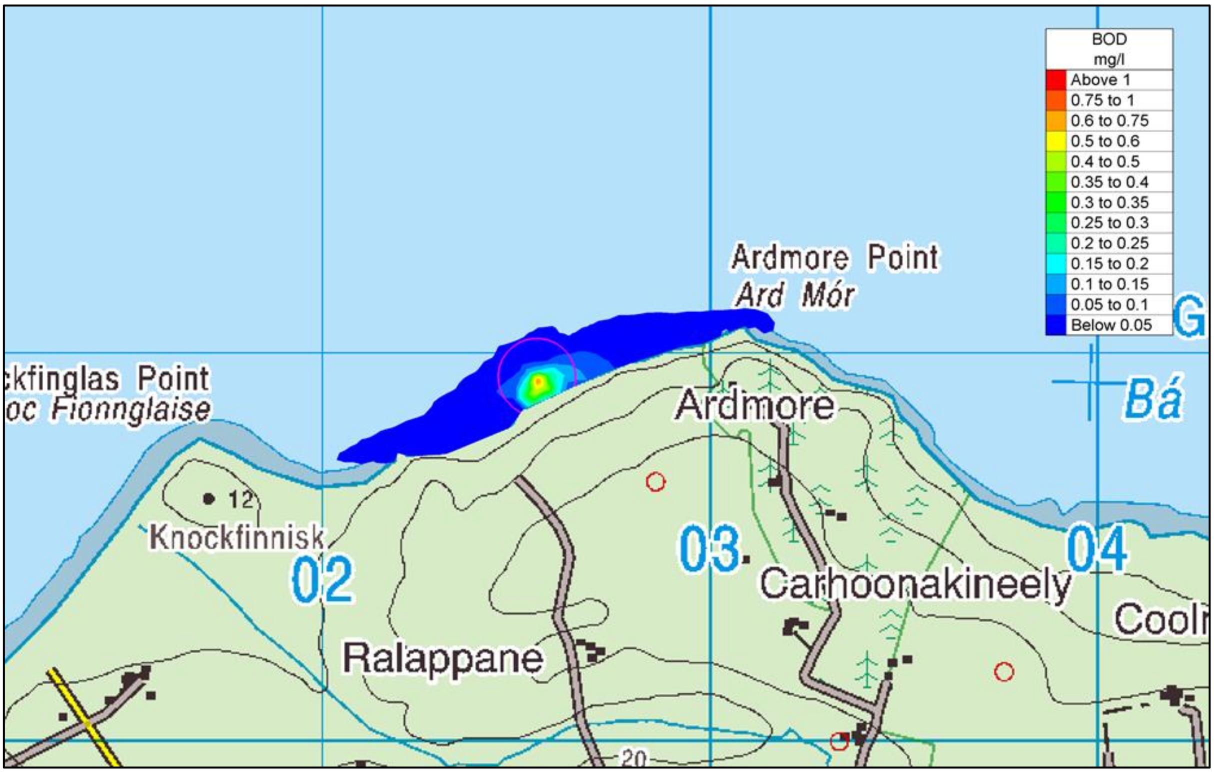

Figure 7A.18: Predicted Maximum BOD concentration (mg/l) Envelope over 15 days for Spring-neap-spring Tide Simulation

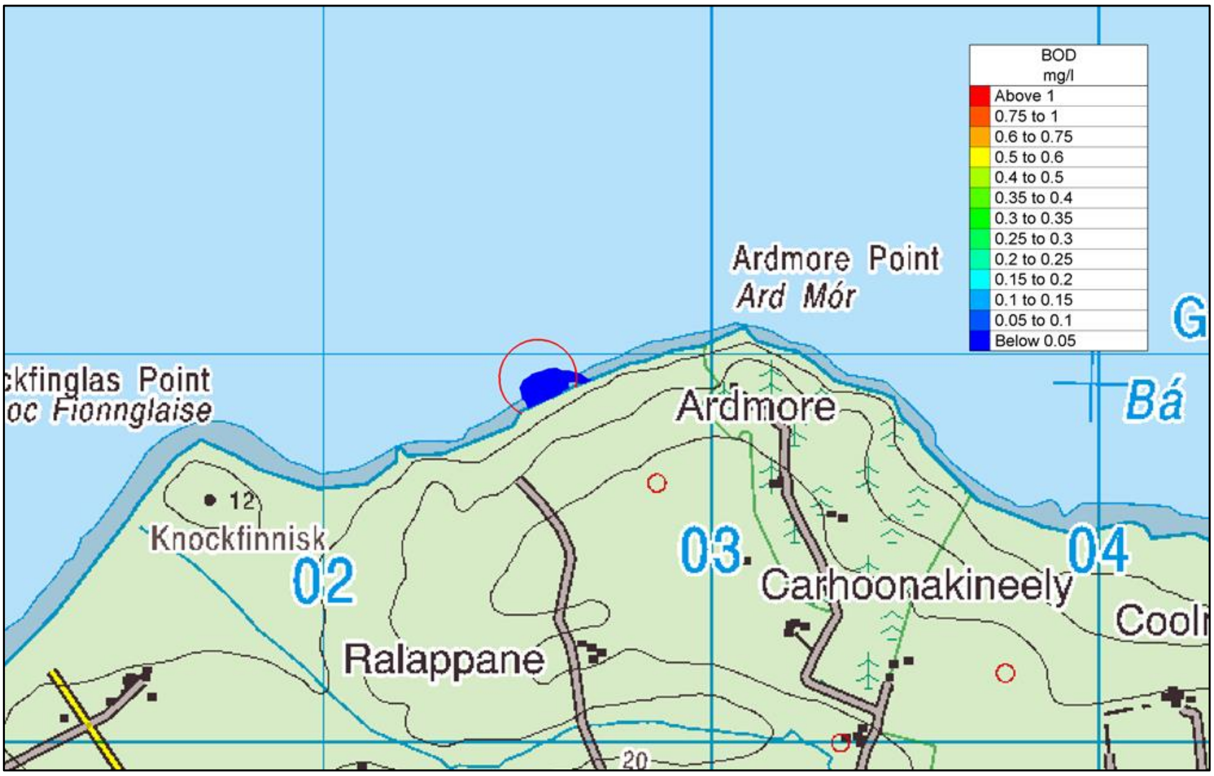

Figure 7A.19: Predicted Mean BOD Concentration (mg/l) Envelope over 15 days for Spring-neap-spring Tide Simulation

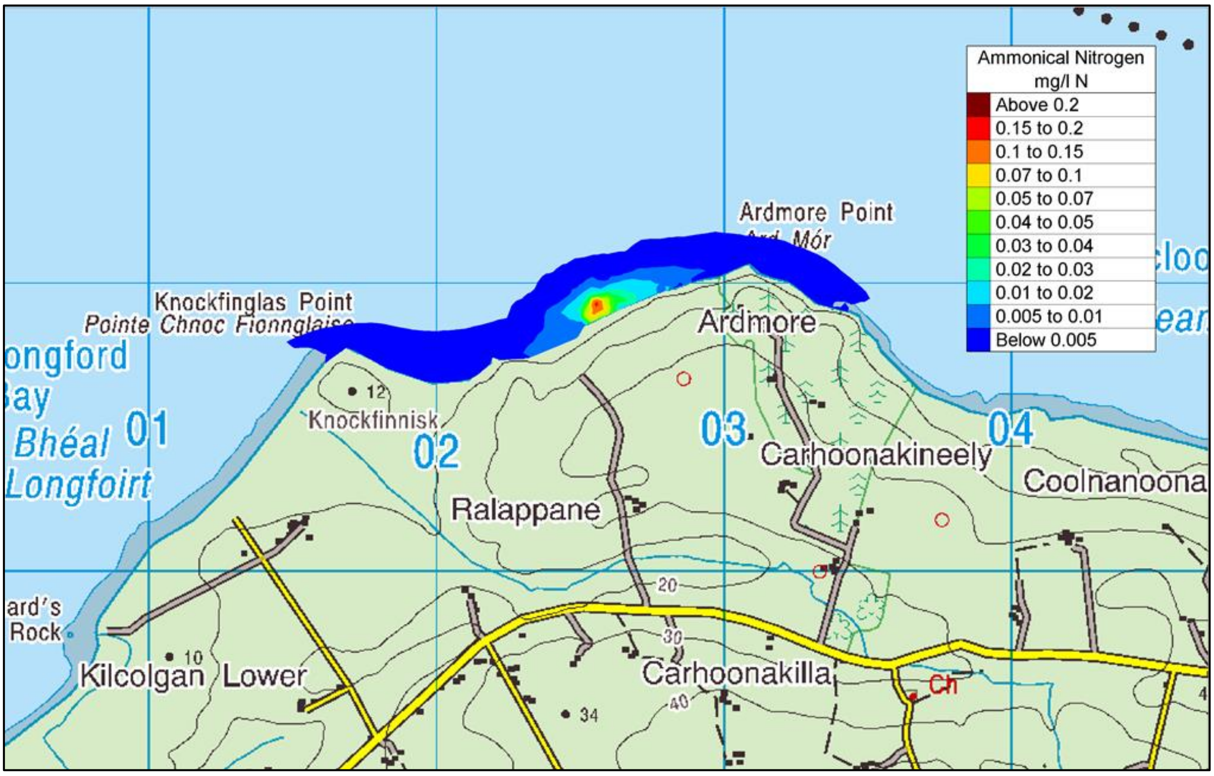

Figure 7A.20: Predicted Maximum Ammoniacal Nitrogen Concentration (mg/l N) Envelope over 15 days for Spring-neap-spring Tide Simulation

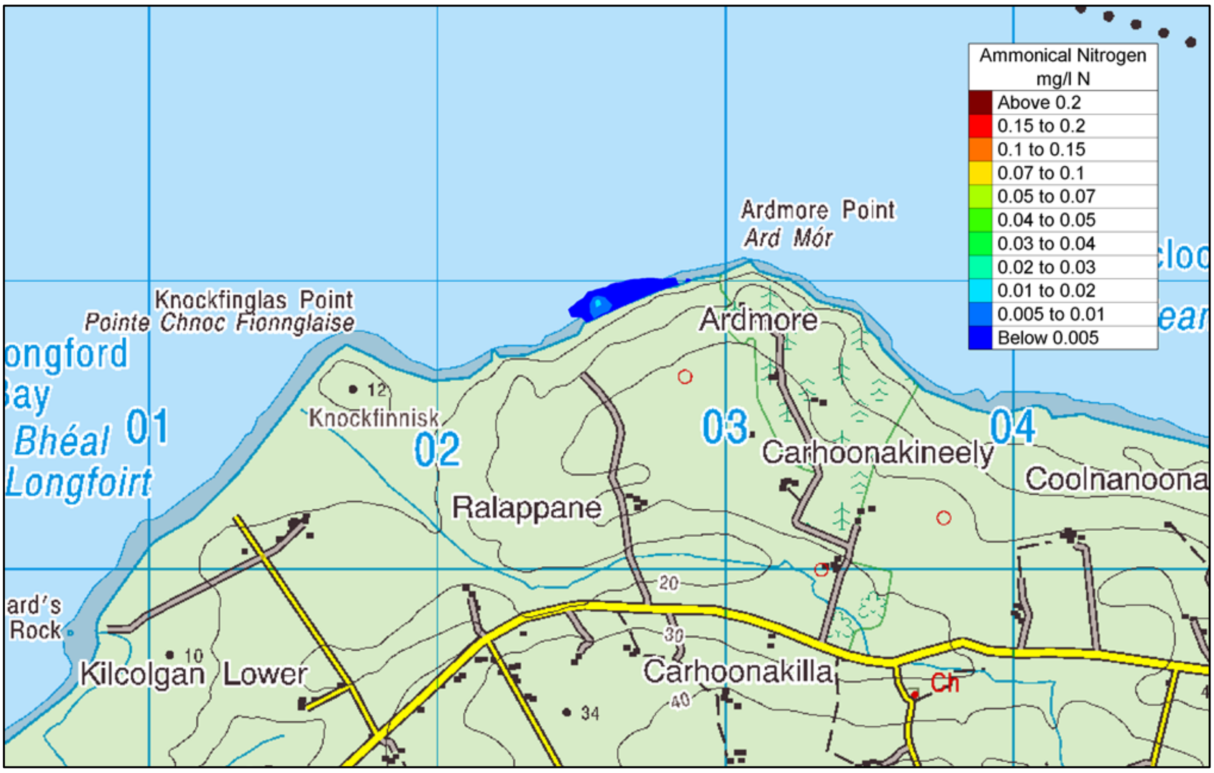

Figure 7A.21: Predicted Mean Ammoniacal Nitrogen Concentration (mg/l N) Envelope over 15 days for Spring-neap-spring Tide Simulation

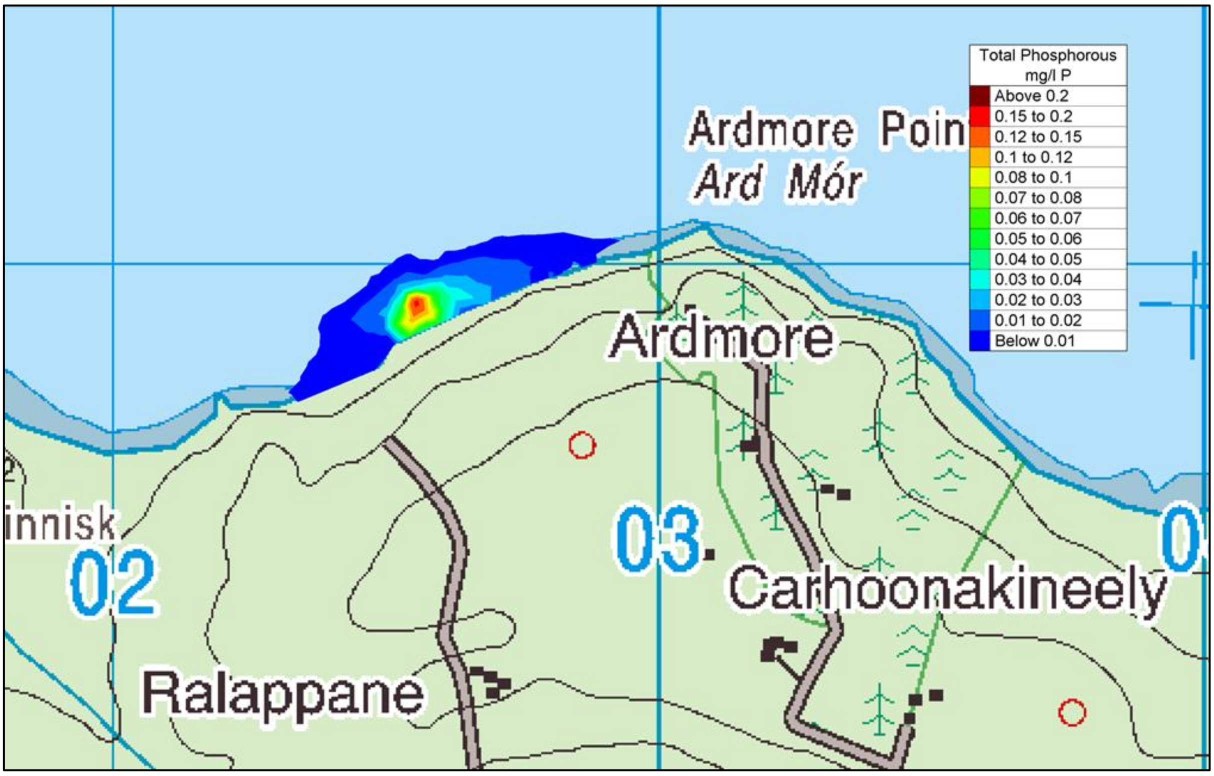

Figure 7A.22: Predicted Maximum Total Phosphorus Concentration (mg/l P) Envelope over 15 days for Spring-neap-spring Tide Simulation

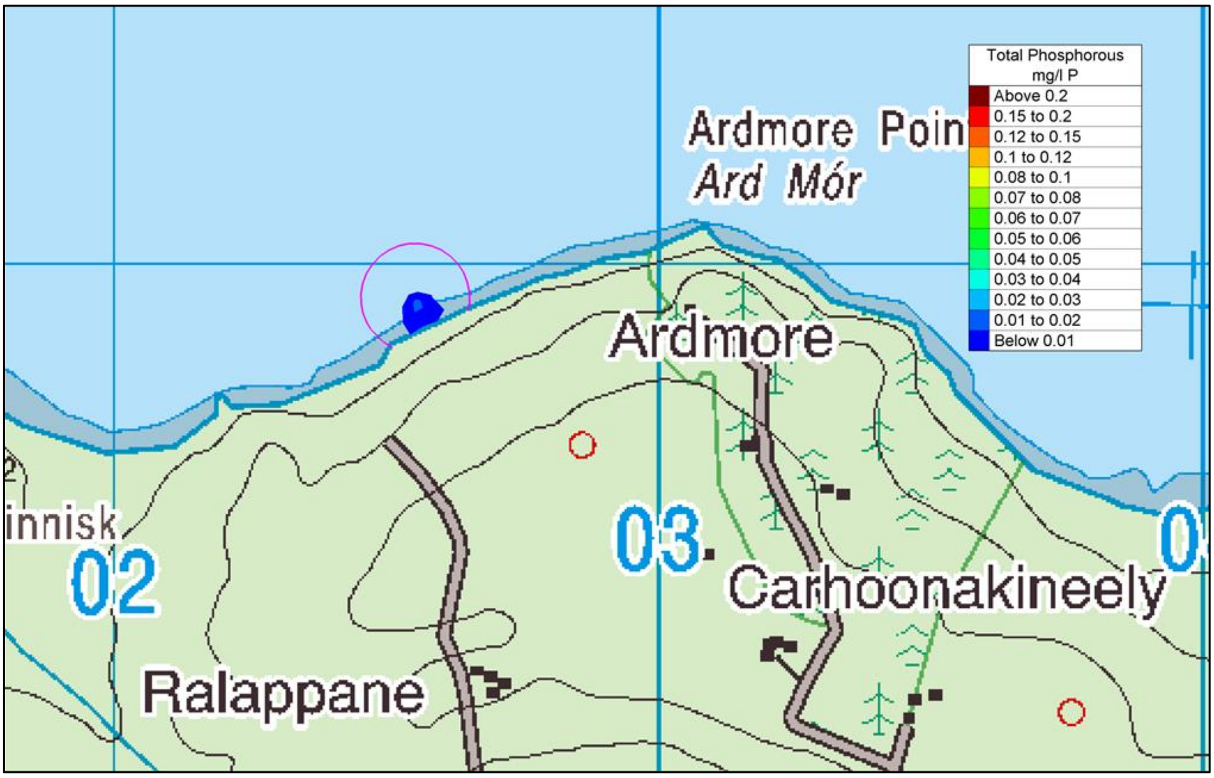

Figure 7A.23: Predicted Mean Total Phosphorus Concentration (mg/l P) Envelope over 15 days for Spring-neap-spring Tide Simulation

7A.5.7 Climate Change and Biodiversity

The EU Commission guidance document on integrating climate change and biodiversity into environmental impact assessment (EU Commission, 2013) aims to improve the way in which climate change and biodiversity are integrated into Environmental Impact Assessment. Key principles specified by the document when considering impacts include the following:

- Consider climate change at the outset.
- Analyse the evolving environmental baseline trends.
- Take an integrated approach.
- Seek to avoid biodiversity and climate change effects from the start.
- For biodiversity, EIA should focus on ensuring 'no net-loss'.
- Assess alternatives that make a difference in terms of climate change and biodiversity.
- Use ecosystem-based approaches and green infrastructure as part of the project design and/ or mitigation measures.
- Assess climate change and biodiversity synergies and cumulative effects which can be significant.

The potential effects from the Proposed Development on climate have been specifically addressed by **Chapter 15** (Climate). **No significant** interactions between the effects on biodiversity resulting from this development and climate change have been identified.

7A.5.8 Decommissioning

As described in **Chapter 02** (Desription of the Proposed Development), the Proposed Development is expected to have a design life of 25 years, but this could be extended by maintenance, equipment replacement and upgrades or by the transition of the Site to use hydrogen capability (which would be subject to a future planning application).

During decommissioning, measures would be undertaken by the Applicant to ensure that there would be no significant, negative environmental effects on the marine environment during the decommissioning phase. The decommissioning plan would incorporate measures to satisfy all regulatory requirements and to achieve targeted environmental goals. The decommissioning measures would have to be implemented to the satisfaction of the relevant consenting authorities. The impact of decommissioning will be **Temporary** and **Not Significant** Following the implementation of standard mitigation measures.

7A.6 Cumulative Impacts

The cumulative impacts of the Proposed Development and nearby consented projects in the vicinity of the Proposed Development are discussed below. A planning search of granted and pending planning applications made within the vicinity of the Proposed Development is presented in **Appendix A1.2,** Volume 4.

Applications in relation to smaller planning applications predominantly for extensions or alterations to existing dwellings are not considered to be relevant to the cumulative assessment within this EIAR, given their small scale. Therefore, only projects of sufficient size and scale that may potentially act cumulatively with the Proposed Development and are assessed herein.

7A.6.1 Summary of Schemes Considered in Cumulative Impact Assessment

7A.6.1.1 SLNG Strategic Gas Reserve Facility

The location of the Proposed Development is the subject of a SID pre-application for a Proposed Shannon Technology and Energy Park (STEP) Strategic Gas Reserve Facility (APB-319245-24) comprising of a floating storage and regasification unit (FSRU), jetty and access trestle, onshore receiving facilities, and all ancillary works.

A pre-application was submitted to An Bord Pleanála (ABP) on 8th March 2024, and a request for a pre-application consultation meeting is pending from the Board. The Proposed STEP Strategic Gas Reserve Facility (APB-319245-24) will include onshore facilities, jetty and FSRU which will extend into the Shannon Estuary at the north-east corner of the Site.

It is important to note the Power Plant (the Proposed Development) is not functionally dependent on the Strategic Gas Reserve Facility. The Strategic Gas Reserve Facility, Data Centre Campus, the High Voltage 220 kV and the Medium Voltage (10 / 20 kV) cables (discussed below) have been considered as part of the cumulative impact assessment within this chapter.

7A.6.1.2 SLNG Gas Pipeline

SLNG Gas Pipeline Planning permission exists for the development of a 26 km Natural Gas Pipeline which will facilitate connection from the Site to the GNI transmission network at Leahy's, located to the west of Foynes, Co. Limerick. The application was accompanied by an Environmental Impact Statement (EIS).. A revised assessment and an updated EIAR of the permitted pipeline will be included within the required future application to CRU for consent under Section 39A of the Gas Act 1976 (as amended).

7A.6.1.3 Data Campus

The Masterplan for the Shannon Technology and Energy Park (STEP) will integrate the Proposed Development and a (future) Data Centre Campus, **Figure F1.1**, Volume 3. Note – The potential future Data Centre Campus is not included in this application and will therefore be subject to a separate planning application.

It is important to note the STEP Power Plant (the Proposed Development) is not functionally dependent on the Data Centre. The Strategic Gas Reserve Facility, Data Centre Campus, the High Voltage 220 kV and the Medium Voltage (10 / 20 kV) cables have been considered as part of the cumulative impact assessment within this chapter.

7A.6.1.4 High Voltage 220 kV and Medium Voltage (10 / 20 kV) Power Transmission Networks

An application to connect to the national electrical transmission network via a 220 kV high voltage connection was submitted to EirGrid in September 2020. Shannon LNG executed a 600 MW 220 kV grid connection agreement with EirGrid for the Proposed Development on 14th April 2023. The exact route cannot be confirmed until the detailed design is completed and approved by Eirgrid and other stakeholders. This process is currently underway. The development of the grid connection will be subject to a separate planning application and associated EIAR by the Applicant once the precise connection details are known. This sequencing is standard and the connection details will be confirmed at a later date. The current proposal is that the connection point will be the ESBN / EirGrid Killpaddogue 220 kV substation which is located approximately 5 km east of the Site with connection provided via a 220 kV cable(s) under the L1010 road.

If the 220 kV grid connection is not available medium voltage (10/ 20 kV) grid connection will be used as a backup power supply. However, the connection is subject to a connection agreement with ESBN and will be considered under a separate planning application. The medium voltage (10 / 20 kV) and 220 kV power connections will be constructed in parallel with the Proposed Development but will be subject to separate planning design and planning applications. Further details on the proposed 220 kV and medium voltage power transmission networks can be found in **Section 2.3.12.1** of **Chapter 02** (Description of the Proposed Development).

7A.6.1.5 L1010 Road Works

Kerry Co. Co. are undertaking a widening scheme of the L1010 road which is to be completed prior to the start of the main construction elements but may overlap with the enabling works. It is therefore assumed that the L1010 works would be completed by Month 8 of the construction schedule, when work starts on the 220 kV substation. A high-level assessment of potential construction vehicles indicates that for the L1010 works there could be a maximum of eight two-way construction vehicle movements per hour, which is equivalent to approximately 96 two-way vehicles per day (over 12 hours). Staff trips are anticipated to be approximately 24 two-way trips and would arrive/depart outside of the peak hours.

The scheme will be constructed during the enabling works (the first seven months), which is outside of the peak construction period associated with the Proposed Development. This report has found that during peak construction the impact on the local road network is minimal. Taking into consideration that the L1010 works would not coincide with the peak months of construction associated with the Proposed Development, it is envisioned that this would not pose a significant impact on the surrounding road network.

In order to mitigate any impacts, Kerry Co. Co. will be responsible for developing and implementing a Construction Traffic Management Plan (CTMP) for the works.

7A.6.1.6 Construction Phase Impact

If works associated with these schemes (described above) in close proximity to the Proposed Development are concurrent with works at the Proposed Development, there is potential for cumulative impacts and effects on marine biodiversity features. Should this situation arise, construction activities will be planned and phased, in consultation with the construction management team for the Proposed Development.

The implementation of best practice standard construction environmental measures and the CEMP for the Proposed Development as detailed, no significant cumulative effects on biodiversity will result.

Discharges from both this project and the Proposed Development are governed by strict limits to ensure compliance with quality standards. **No Long-Term** cumulative impact on water quality will occur.

7A.6.1.7 Operational Phase Impact

Potential impacts from consented development elsewhere, combined with the potential impacts of the Proposed Development, could result in increased disturbance to sensitive fauna.

Potential effects to marine biodiversity from the Proposed Development range from slight to negligible and mitigation measures proposed to manage and control potential impacts during operation would further reduce the magnitude and significance of effects.

Potential impacts primarily relate to disturbance impacts from increase noise, activity and lighting at the Site. The Site is located in a largely rural area with little or no disturbance. Therefore, the cumulative operational effect from increased noise, activity and lighting of the Proposed Development and other consented or potential developments on marine biodiversity following mitigation is considered **Not Significant**.

7A.7 Mitigation and Monitoring Measures

7A.7.1 Construction Mitigation Measures and Best Practice

This will take into account measures presented in the CEMP regarding construction activities including any that are required to ensure no significant release of pollutants, sediment laden water, runoff chemicals or other waste material pollution into the nearby habitats, watercourses and waterbodies.

Measures will include standard construction best practice used to manage the risk of potential for loss of hydrocarbons such as diesel and hydraulic fluids. Careful supervision of construction operations and general construction practice will reduce the risk from impacts so that the likelihood of impacts is best described as low.

At a minimum the oil spill response equipment will include the following: absorbent mats, waste- bags, oil splash goggles, gloves and vinyl or rubber shoe covers to protect the user from the harmful effects of the spilled material.

Imported backfill material will be washed (cleaned) to remove fines and checked for invasive species before use.

Imported material to be used backfill will be stored on the Site; measures to avoid the release of sediment will be implemented (including silt fences).

Clean (washed) rock material will be used as rock protection to minimise the risk of introducing fine materials.

The implementation of general construction practice will ensure that the likelihood of pollution in a well-equipped, maintained and managed construction site is low.

7A.7.2 Underwater Noise Mitigation

To mitigate potential impact to marine mammal species Shannon LNG will implement relevant impact mitigation and monitoring measures:

- **Mitigation measures during blasting:** Whilst all blasting is land based there will be propagation of sound into the underwater environment. Thus, the standard mitigation measures for blasting will be adopted as a precautionary measure – qualified MMO, a 1000 m observation zone and an observation period of 30 minutes. As only single blasts will take place in each event (not a series), a soft-start is not included;

- **MMO training:** Use trained and experienced marine mammal observers – the guidance states this should be a visual observer who has undergone formal marine mammal observation and distance estimation training (JNCC MMO training course or equivalent) and also has a minimum of 6 weeks full-time marine mammal survey experience at sea over a 3-year period in European waters.
- **Monitoring:** The marine mammal monitoring programme, currently being undertaken by the Irish Whale and Dolphin Group (in the vicinity of the project using CPODs) will be continued into the construction phase for the validation of predictions (based on observations from other studies – see impact assessment) that any animals displaced from an area return after the construction activity stops.

7A.8 Do Nothing Scenario

A significant proportion of marine habitats and associated flora and fauna have been modified from their natural state by human activity. In the absence of the Proposed Development, it is expected that the marine environment would largely remain under the same regime. **No significant** changes are likely to occur, in the 'do nothing' scenario.

7A.9 Residual Impacts

Table 7A.13 provides a summary of residual risk of impact to marine ecology associated with each impact mechanism.

Impact Mechanism 1 Release of Pollutants During Construction

The release of pollutants during construction has the potential to impact water quality, habitats, fish and marine mammals. In sufficient quantities pollutant released during the construction phase have the potentially to impact water quality, contaminate the seabed sediments, and directly impact flora and fauna. Standard construction best practice mitigation measures to prevent release of sediments, chemicals and pollutants during construction will ensure there is **No Significant** risk of impact to receptors.

Impact Mechanism 2 Underwater Noise

The relevant receptors are marine mammals and fish.

To mitigate potential impact to marine mammal species during the construction phase Shannon LNG will implement relevant impact mitigation and monitoring measures as summarised in **Section 7A.7.2**.

Impact Mechanism 3 Seabed Habitat Loss

The installation of a trenched water outfall across the shoreline into the Shannon estuary will result in negligible loss of habitats relative to the total area of the habitats and will not result in significant effects. The loss of habitat is small and **Negligible** and the effects are reversible with recovery following decommissioning of the Propopsed Development.

Impact Mechanism 4 Discharge of Wastewater and Power Plant Process Heated Water Effluent

Water quality parameters satisfy the permissible limits set out in the surface water regulations and will not impact the water quality status of the receiving Shannon Estuary waters. Consequently, it can be concluded there will be **No Significan**t environmental impact.

Potential Impact of Identified Impact Mechanisms to Aquaculture Activities

Aquaculture activity in the SAC and SPA relates to the production of shellfish (oysters and mussels). The main aquaculture activity involves the cultivation of Pacific oysters (*Crassostrea gigas*) on trestles in intertidal areas. The mussel culture includes subtidal suspended (longlines) and bottom culture. The majority of the sites are contained in inner Poulnasherry Bay where aquaculture activity has been carried out for many years. There are aquaculture applications in outer Poulnasherry Bay and there are existing and proposed aquaculture activities in the Carrigaholt, Rinevella, Ballylongford / Bunaclugga and Aughinish / Foynes areas of the Shannon Estuary. In addition, there are three areas within the Shannon Estuary covered by Fishery Orders. While these Orders do not come under the remit of the Department of Agriculture, Food and Marine, they are included as part of the in-combination assessment.

Impact mechanisms associated with the Proposed Development that have potential to directly impact water quality and indirect impact to aquaculture activities is Impact Mechanism 4. Wastewater discharge and Power Plant Process Heated Water Effluent. Hydrodynamic and dispersion modelling study concluded that change to water quality parameters are within permissible limits set out in the surface water regulations and will not impact the water quality status of aquaculture areas. Consequently, it can be concluded there will be **No Significant** impact.

7A.10 Summary

Impacts on the marine ecological environment as a result of the Proposed Development are summarised as follows:

- The marine elements of the Proposed Development overlap with the Lower River Shannon SAC and the River Shannon and River Fergus Estuaries SPA.
- The risk of pollutants being discharged during the construction phase of the project is low and the implementation of the construction best practice measures in the CEMP will further reduce this risk. Following implementation of mitigation measures there will be **No Adverse Impacts** on designated sites overlapping with the elements of the Proposed Development.
- The potential impact of noise pollution is greatly reduced in the current proposal with the main source of noise pollution coming from onshore blasting during the construction phase of the project. This will have very limited spatial impact (within 10s of meters) on sensitive species such as seals. During the construction phase the Proposed Development will implement relevant impact mitigation and monitoring measures in relation to marine mammals to ensure no potential impact to marine mammals.
- The loss of habitat due to the installation of the trenched water outfall is **Negligible** and will not result in significant effects or impact on the structure and ecological functioning and integrity of the Lower River Shannon SAC. The minor, almost **Imperceptible,** effects are reversible with recovery following decommissioning of the Proposed Development.

- Wastewater and Power Plant process heated water effluent discharged from the Proposed Development will be diluted and quickly dispersed and will not impact the water quality status of the highly dynamic environment of the lower Shannon Estuary.

Table 7A.13: Summary

Proposed Development Stage	Aspect/ Impact Assessed	Receptor (greatest importance)	Impact Quality	Impact Significance (Prior to Mitigation)	Impact Duration and Frequency	Mitigation and Monitoring Measures (the Proposed Development design embedded environmental controls and all mitigation and monitoring measures detailed herein are included in the CEMP)	Significance rating (Following Mitigation)	EIAR Chapter Reference
Construction Phase	Impact Mechanism 1 Release of pollutants during construction	Marine habitats of the Lower River Shannon SAC)	Negative	Significant	Short-term	Standard construction best practice mitigation measures to prevent release of sediments, chemical and pollutants during construction (see **Section 7A.7.1** and the CEMP included in **Appendix A2.3**, Vol. 4).	Not significant	**Section 7A.5.3**
Construction Phase	Impact Mechanism 1 Release of pollutants during construction	Marine Mammals (including Bottlenose dolphin species of the Lower River Shannon SAC)	Negative	Significant	Short-term	Standard construction best practice mitigation measures to prevent release of sediments, chemical and pollutants during construction (see **Section 7A.7.1** and the CEMP included in **Appendix A2.3**, Vol. 4).	Not significant	**Section 7A.5.3**
Construction Phase	Impact Mechanism 1 Release of pollutants during construction	Fish populations of estuary including fish of the Lower River Shannon SAC)	Negative	Significant	Short-term	Standard construction best practice mitigation measures to prevent release of sediments, chemical and pollutants during construction (see **Section 7A.7.1** and the CEMP included in **Appendix A2.3**, Vol. 4).	Not significant	**Section 7A.5.3**
Construction Phase **and** Operation Phase	Impact Mechanism 2 Underwater noise	Fish of the Lower River Shannon SAC)	Negative	Not Significant	Short-term	None	-	**Section 7A.5.4**
Construction Phase	Impact Mechanism 2 Underwater noise	Marine Mammals (including Bottlenose dolphin species of the Lower River Shannon SAC)	Negative	Significant	Medium-term	Chapter 07A summarises standard mitigation required to minimise the risk potential impact to marine mammal species as outlined in DAHG, 2014: • Marine mammal observation period of 30 minutes minimum prior to start (or re-start after a break of 30 minutes) • A gap of at least 30 minutes required between last observation of a marine mammal and start of operations; • For any source, including equipment testing, exceeding 170 dB re: 1µPa @1 m an	Not significant	**Section 7A.5.4**

Proposed Development Stage	Aspect/ Impact Assessed	Receptor (greatest importance)	Impact Quality	Impact Significance (Prior to Mitigation)	Impact Duration and Frequency	Mitigation and Monitoring Measures (the Proposed Development design embedded environmental controls and all mitigation and monitoring measures detailed herein are included in the CEMP)	Significance rating (Following Mitigation)	EIAR Chapter Reference
						appropriate ramp-up procedure (i.e. 'soft-start') must be used. This should be a minimum of 20 minutes and no longer than 40 minutes; • MMOs must be dedicated to and engaged solely in monitoring an operator's implementation of the NPWS technical guidance. A sufficient number of MMO personnel must be assigned to ensure that the role is performed effectively. Avoidance of observer fatigue is essential; and • Use trained and experienced marine mammal observers – the guidance states this should be a visual observer who has undergone formal marine mammal observation and distance estimation training (JNCC MMO training course or equivalent) and also has a minimum of 6 weeks full-time marine mammal survey experience at sea over a 3-year period in European waters. • Whilst all blasting is land based there will be propagation of sound into the underwater environment. Thus, the standard mitigation measures for blasting will be adopted as a precautionary measure – qualified MMO, a 1000 m observation zone and an observation period of 30 minutes. As only single blasts will take place in each event (one blast per day), a soft-start is not included; and • The marine mammal monitoring programme, currently being undertaken by the Irish Whale and Dolphin Group (in the vicinity of the project using CPODs) will be continued into the construction phase for the validation of predictions (based on observations from other studies – see impact assessment) that		

Proposed Development Stage	Aspect/ Impact Assessed	Receptor (greatest importance)	Impact Quality	Impact Significance (Prior to Mitigation)	Impact Duration and Frequency	Mitigation and Monitoring Measures (the Proposed Development design embedded environmental controls and all mitigation and monitoring measures detailed herein are included in the CEMP)	Significance rating (Following Mitigation)	EIAR Chapter Reference
						any animals displaced from an area return after the construction activity stops.		
Construction Phase **and** Operation Phase	Impact Mechanism 3 Seabed habitat loss	Annex I habitats 1130 Estuaries and 1170 Reefs of the Lower River Shannon SAC	Neutral	Not Significant	Reversible Effects	Negligible loss of habitat pending decommissioning of the development and natural recolonisation of reinstatement of the affected habitat areas.	Not significant	**Section 7A.5.5**
Operation Phase	Impact Mechanism 4 Discharge of Wastewater and Power Plant Process Heated Water Effluent	Habitats (including marine habitats of the Lower River Shannon SAC)	Negative	Not Significant	Long-term	None	-	**Section 7A.5.6**
Operation Phase	Impact Mechanism 4 Discharge of Wastewater and Power Plant Process Heated Water Effluent	Marine Mammals (including Bottlenose dolphin species of the Lower River Shannon SAC)	Negative	Not Significant	Long-term	None	-	**Section 7A.5.6**
Operation Phase	Impact Mechanism 4 Discharge of Wastewater and Power Plant Process Heated Water Effluent	Fish populations of estuary including fish of the Lower River Shannon SAC)	Negative	Not Significant	Long-term	None	-	**Section 7A.5.**6

7A.11 References

Ansmann, 2005; The Whistle Repertoire and Acoustic Behaviour of Short-Beaked Common Dolphins, *Delphinus delphis*, around the British Isles, with Applications for Acoustic Surveying. MSc Thesis School of Biological Sciences, University of Wales, Bangor.

Arai, T., Kotake, A., and McCarthy, T. K. (2006) Habitat use by the European eel *Anguilla anguilla* in Irish waters. Estuarine, Coastal and Shelf Science 67 (2006).

Au, W.W.L., (2002). Echolocation. In Perrin, W.F., Würsig, B. and Thewissen, J.G.M. (eds.). Encyclopedia of Marine Mammals. pp. 358-367. Academic Press, San Diego.

Baker, I., J. O'Brien, K. McHugh, and S. Berrow. 2018. Female reproductive parameters and population demographics of bottlenose dolphins (*Tursiops truncatus*) in the Shannon Estuary, Ireland. Mar. Biol. 165:15. doi:10.1007/s00227-017-3265-z.

Baker, I., O'Brien, J., McHugh, K., Ingram, S. and Berrow, S. (2018b). Bottlenose dolphin (*Tursiops truncatus*) social structure in Shannon Estuary, Ireland, is distinguished by age, area and female-male associations. Mar. Mamm. Sci. 34(2):458-487.

Barker, J. and Berrow, S. (2015). Temporal and spatial variation in group size of bottlenose dolphins (*Tursiops truncatus*) in the Shannon Estuary, Ireland. Biology & Environment Proceedings of the Royal Irish Academy 116(B)(1).

Barnthouse, L. (2013). Impacts of entrainment and impingement on fish populations: A review of the scientific evidence Environmental Science & Policy. 31, 149-156.

Berrow, S., O'Brien, J. and O'Connor, I.. 2012. Identification and rating of important areas for bottlenose dolphins. Prepared for the Shannon Dolphin and Wildlife Foundation as part of the Strategic Integrated Framework Plan for the Shannon Estuary. July 2012.

Berrow, S., Regan, S. and O'Brien, J. (2020) Bottlenose Dolphin Monitoring at the site of the proposed Shannon LNG Terminal. Report to New Fortress Energy. Irish Whale and Dolphin Group. 29 pp.

Berrow, S.D. (2009). Winter distribution of bottle-nosed dolphins (*Tursiops truncatus* (Montagu)) in the inner Shannon Estuary. Irish Nat. J. 2009:35-39.

Berrow, S.D. (2012). Abundance Estimate of Bottlenose Dolphins (*Tursiops truncatus*) in the Lower River Shannon candidate Special Area of Conservation, Ireland. Aquatic Mammals, 38(2), 136–144. https://doi.org/10.1578/am.38.2.2012.136.

Berrow, S.D. (2020a). Bottlenose dolphin monitoring at the site of the proposed Shannon LNG Terminal – progress report to NFE. Rep. to New Fortress Energy. Irish Whale and Dolphin Group. 31 October 2020. 2 p.

Berrow, S.D. (2020b). Bottlenose dolphin monitoring at the site of the proposed Shannon LNG Terminal – progress report to NFE. Rep. to New Fortress Energy. Irish Whale and Dolphin Group. 27 November 2020. 2 p.

Berrow, S.D. (2020c). Bottlenose dolphin monitoring at the site of the proposed Shannon LNG Terminal – progress report to NFE. Rep. to New Fortress Energy. Irish Whale and Dolphin Group. 31 December 2020. 2 p.

Berrow, S.D. (2021a). Bottlenose dolphin monitoring at the site of the proposed Shannon LNG Terminal – progress report to NFE. Rep. to New Fortress Energy. Irish Whale and Dolphin Group. 31 January 2021. 1 p.

Berrow, S.D. (2021b). Bottlenose dolphin monitoring at the site of the proposed Shannon LNG terminal – progress report to NFE. Rep. to New Fortress Energy. Irish Whale and Dolphin Group. 28 February 2021. 3 p.

Berrow, S.D. (2021c). Bottlenose dolphin monitoring at the site of the proposed Shannon LNG Terminal – progress report to NFE. Rep. to New Fortress Energy. Irish Whale and Dolphin Group. 31 March 2021. 1 p.

Berrow, S.D., Regan, S. and O'Brien, J. (2020). Bottlenose dolphin monitoring at the site of the proposed Shannon LNG Terminal. Rep. to New Fortress Energy. Irish Whale and Dolphin Group. 29 p.

Blázquez, M., Baker, I., O'Brien, J. and Berrow, S.D. (2020). Population viability analysis and comparison of two monitoring strategies for Bottlenose dolphins (*Tursiops truncatus*) in the Shannon Estuary, Ireland, to inform management. Aquatic Mamm. 46(3):307-325.

Bracken, F. S. A., Rooney, S. M., Kelly-Quinn, M., King, J. J., Carlsson, J 2018. Identifying spawning sites and other critical habitat in lotic systems using eDNA “snapshots”: A case study using the sea lamprey Petromyzon marinus L.Ecology and Evolution, 1, Pages 553-567

Brown, P. and Worbey., R. (2020). Shannon LNG Terminal NRA Update. Vs1. Report No 18UK1448 prepared by Marine and Risk Consultants Ltd. for Shannon Foynes Port Company.

Brown, P. and Worbey., R. (2020). Shannon LNG Terminal NRA Update. Vs1. Report No 18UK1448 prepared by Marine and Risk Consultants Ltd. for Shannon Foynes Port Company.

Casper, B. M., M.B. Halvorsen, T.J. Carlson, and A.N. Popper. 2017. Onset of barotrauma injuries related to number of pile driving strike exposures in hybrid striped bass. J. Acoust. Soc. Am. 141(6), 4380–4387. https://doi.org/10.1121/1.4984976.

Casper, B.M. and D.A. Mann. (2006). Evoked potential audiograms of the nurse shark (*Ginglymostoma cirratum*) and the yellow stingray (*Urobatis jamaicensis*). Envir. Biol. Fish. 76:101-108.

Casper, B.M. and D.A. Mann. (2007). The directional hearing abilities of two species of bamboo sharks. J. Exp. Biol. 210:505-511.

Casper, B.M. and D.A. Mann. (2009). Field hearing measurements of the Atlantic sharpnose shark *Rhizoprionodon terraenovae*. J. Fish Biol. 75:2768-2776.

Casper, B.M., P.S. Lobel, and H.Y. Yan. (2003). The hearing sensitivity of the little skate, Raja erinacea: a comparison of two methods. Envir. Biol. Fish. 68:371-379.

Chapman, C.J. and Hawkins, A.D. (1969). The Importance of Sound in Fish Behaviour in Relation to Capture by Trawls. FAO Fish Report 62, 717 – 729.

Chartered Institute of Ecology and Environmental Management (CIEEM) (2019) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, Version 1.1.

CIEEM. (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal.

Cronin, M. A., Jessopp M. J. and Del Villar, D. (2011) Tracking grey seals on Irelands’ continental shelf Report to National Parks & Wildlife Service, Department of Arts, Heritage and Gaeltacht November 2011 Coastal & Marine Research Centre University College Cork Ireland.

Cronin, M. Jessopp, M. Reid, D. (2010) Seals and fish stocks in Irish waters. Study note to the Directorate General for Internal Policies, Policy Department B: Structural and Cohesion Policies, Fisheries. European Parliament, Brussels.

Cronin, M., Duck, C., Ó Cadhla, O., Nairn, R., Strong, D. & O’Keeffe, C. (2004). Harbour seal population assessment in the Republic of Ireland: August 2003. Irish Wildlife Manuals No. 11. National Parks & Wildlife Service, Department of Environment, Heritage and Local Government., 7 Ely Place, Dublin 2, Ireland. 34 pp.

DAHG – NPWS. (2012) Department of Arts, Heritage and the Gaeltacht – National Parks and Wildlife Service Marine Natura Impact Statements in Ireland Special Areas of Conservation, A Working Document.

DAHG (2014). Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters.
https://www.npws.ie/sites/default/files/general/Underwater%20sound%20guidance_Jan%202014.pdf.

Dawson H., Quintella B., Almeida P., Treble A. and Jolley J. (2015). The Ecology of Larval and Metamorphosing Lampreys. In: Docker M. (eds) Lampreys: Biology, Conservation and Control. Fish & Fisheries Series, vol 37. Springer, Dordrecht. https://doi.org/10.1007/978-94-017-9306-3_3.

DEHLG (2009). Appropriate Assessment of Plans and Projects in Ireland Guidance for Planning Authorities (Revised 2010).

EC (2021). National Energy & Climate Plan (NECP) 2021-2030, European Commission.

EC. (2001). Managing Natura 2000 Sites: The provisions of Article 6 of the Habitats Directive 92/43/EEC.

EC (2002). Assessment of plans and projects significantly affecting Natura 2000 sites.

EC (2018). Managing Natura 2000 sites. The provisions of Article 6 of the Habitats Directive 92/ 43/ EEC Commission Notice (2018).

EC (2018). Managing Natura 2000 sites. The provisions of Article 6 of the Habitats Directive 92/43/EEC Commission Notice (2018).

EMODnet. (2021). https://www.emodnet-humanactivities.eu/view-data.php.

Englund, A., Ingram, S. and Rogan, E. (2007). Population status report for bottlenose dolphins using the Lower River Shannon SAC, 2006 – 2007. Final report to the National Parks and Wildlife Service, Ireland, pp37.

Englund, A., Ingram, S. and Rogan, E. (2008). An updated population status report for bottlenose dolphins using the lower river Shannon SAC in 2008. Final Report to the National Parks and Wildlife Service, 34pp.

Environmental Protection Agency (2021). EPA Geoportal. http://gis.epa.ie/.

EPA (2022). Guidelines on the Information to be Contained in Environmental Impact Assessment Reports'

EU (2013). Guidelines on Climate Change and Natura 2000: Dealing with the impact of climate change on the management of the Natura 2000 Network of areas of high biodiversity value.

EU (2017). Guidance on the preparation of the EIA Report (Directive 2011/ 92/ EU as amended by 2014/ 52/ EU).

Federal Register. (2012). 77:8650. https://www.govinfo.gov/content/pkg/FR-2012-04-14/pdf/2012-2940.pdf.

Gallagher, T., N.M. O'Gorman, S.M. Rooney, and J.J. King. 2020 National Programme: Habitat Directive and Red Data Book Species Summary Report 2018. Inland Fisheries Ireland. 89 p.

Garagouni, M. (2019). Habitat preferences and movement patterns of bottlenose dolphins at various spatial and temporal scales. Ph.D. thesis. University College Cork, Ireland. 173pp.

Gargan, P, Stafford, T., Økland,F., Thorstad, E. (2015). Survival of wild Atlantic salmon (Salmo salar) after catch and release angling in three Irish rivers. Fisheries Research 161 10.1016/j.fishres.2014.08.005.

Greenwood, M.F.D., 2008. Fish mortality by impingement on thecooling-water intake screens of England's largest direct-cooled power plant. Marine Pollution Bulletin 6, 723–739.

Hadderingh, R.H. and Jager, Z. (2002). Comparison of fish impingement by a thermal power station with fish population in the Ems Estuary. Journal of Fish Biology 61: 105-124.

Henderson, P.A. (1999). Stepping back from the brink: estuarine communities and their prospect British Wildlife 11: 85-91.

IFI. (2016). Guidelines on Protection of Fisheries during Construction Works in and adjacent to Waters. Inland Fisheries Ireland.

Igoe, F., Quigley, D. T. G., Marnell, F., Meskell, E., O'Connor, W., Byrne, C. The Sea Lamprey Petromyzon marinus (L.), River Lamprey Lampetra fluviatilis (L.) and Brook Lamprey Lampetra planeri (Bloch) in Ireland: General Biology, Ecology, Distribution and Status with Recommendations for Conservation. Biology and Environment: Proceedings of the Royal Irish Academy Vol. 104B, No. 3, Threatened Irish Freshwater Fishes (Dec., 2004).

Ingram SN (2000) The ecology and conservation of bottlenose dolphins in the Shannon estuary, Ireland. PhD thesis, University College Cork, Ireland

Ingram, S.N and Rogan, E. (2003). Bottlenose dolphins (*Tursiops truncatus*) in the Shannon Estuary and selected areas of the west-coast of Ireland. Report to the National Parks and Wildlife Service.

Ingram, S.N., Rogan, E. (2002). Identifying critical areas and habitat preferences of bottlenose dolphins *Tursiops truncatus*. Mar. Ecol. Prog. Ser. 244:247-255.

Kastelein, R.A., R. Gransier, M.A. Marijt, and L. Hoek. 2015. Hearing frequency thresholds of harbor porpoises (Phocoena phocoena) temporarily affected by played back offshore pile driving sounds. J. Acoust. Soc. Am. 137(2):556-564.

Kastelein, R.A., L. Helder-Hoek, J. Covi, and R. Gransier. 2016. Pile driving playback sounds and temporary threshold shift in harbor porpoises (Phocoena phocoena): Effect of exposure duration. J. Acoust. Soc. Am. 139(5):2842-2851.

Kelly, F. and King, J. (2001).A Review of the Ecology and Distribution of Three Lamprey Species, Lampetra fluviatilis (L.), Lampetra planeri (Bloch) and Petromyzon marinus (L.): A Context for Conservation and Biodiversity Considerations in Ireland.

Kelly, F.L., Connor, L., Matson, R., Feeney, R., Morrissey, E., Coyne, J. and Rocks, K. (2015) Sampling Fish for the Water Framework Directive - Summary Report 2014. Inland Fisheries Ireland, Citywest Business Campus, Dublin 24, Ireland.

Kennedy, M. 1948 Smelt in the Shannon. Irish Naturalists' Journal 9, 151-2.

Kennedy, R. J., Campbell, W., Gallagher,Derek EvansRiver lamprey present an unusual predation threat to Atlantic salmon smolts in Lough Neagh, Northern Ireland

Kerry Co. Council (KCC). (2013). Biodiversity Actions 2008 - 2012 - Kerry County Council

Kerry Co. Council (KCC). (2018). Kerry County Development Plan- Strategic Environmental Assessment 2015-2021.

Kerry County Council (KCC) (2015). County Development Plan 2015 – 2021.

King, J.L., Marnell, F., Kingston, N., Rosell, R., Boylan, P., Caffrey, J.M., FitzPatrick, Ú., Gargan, P.G., Kelly, F.L., O'Grady, M.F., Poole, R., Roche, W.K. & Cassidy, D. (2011) Ireland Red List No. 5: Amphibians, Reptiles & Freshwater Fish. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

Kostyuchenko, L.P. (1971). Effects of Elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea. Hydrobiological Journal 9, 45 - 48.

Kostyuchenko, L.P. (1971). Effects of Elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea. Hydrobiological Journal 9, 45 - 48.

Laist, D., Knowlton, A., Mead, J.G., Collet, A.S. and Podestà, M. (2001). Collisions between ships and whales. Marine Mammal Science, 17.

Langford, T.E.L., 1983. Electricity Generation and the Ecology of Natural Waters. Liverpool University Press, Liverpool.

Levesque, S., Reusch, K., Baker, I., O'Brien, J. and Berrow, S. (2016). Photo-identification of bottlenose Dolphins (*Tursiops truncatus*) in Tralee Bay and Brandon Bay, Co. Kerry: A case for SAC boundary extension. Biol. Environ. 116B(2). https://doi.org/10.3318/BIOE.2016.11.

LGL. (2021). Impact assessment of potential acoustic effects of Shannon LNG construction and operation activities on marine mammals and fish in the Shannon Estuary, Ireland. 47 pps.

Mann, D.A., D.M. Higgs, W.N. Tavolga, M.J. Souza, and A.N. Popper. (2001). Ultrasound detection by clupeiform fishes. J. Acoust. Soc. Am. 109(6): 3048-3054.

Mann, D.A., Z. Lu, and A.N. Popper. (1997). A clupeid fish can detect ultrasound. Nature 389(6649):341.

Mann, D.A., Z. Lu, M.C. Hastings, and A.N. Popper. (1998). Detection of ultrasonic tones and simulated dolphin echolocation clicks by a teleost fish, the American shad (Alosa sapidissima). J. Acoust. Soc. Am. 104(1): 562-568.

McCarthy, T K., Frankiewicz, P., Cullen, P., Blaszkowski, M., O'Connor, W., Doherty, D. (2008) Long-term effects of hydropower installations and associated river regulation on River Shannon eel populations: mitigation and management. Hydrobiologia (2008) 609:109–124 DOI 10.1007/s10750-008-9395-z

McCarthy, T. K., Cullen, P. and O'Connor, W. (1999). The biology and management of River Shannon eel populations. Fisheries Bulletin (Dublin) 17, 9-20.

McMahon, T. and Quirke, J. 1992. Chemical observations in the water column and sediments of Galway Bay and the Shannon Estuary. Lough Beltra workshop, 1988.

Mirimin, L., Miller, R., Dillane, E., Berrow, S. D., Ingram, S., Cross, T. F. and Rogan, E. (2011). Fine-scale population genetic structuring of bottlenose dolphins in Irish coastal waters. Animal Conservation, 14, 342–353.

Moriarty, C. (1999) Strategy for the development of the eel fishery in Ireland. Marine Institute, Fisheries Research Centre, Abbotstown, Dublin 15 Fisheries Bulletin No. 19 – 1999.

NECR205 2016. Natural England Commissioned Report NECR205 Small-scale effects: How the scale of effects has been considered in respect of plans and projects affecting European sites – a review of authoritative decisions.

National Biodiversity Data Centre. (2021). Biodiversity Maps. http://maps.biodiversityireland.ie.

NOAA, (National Oceanic and Atmospheric Administration). (2013). Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals.

NOAA, (National Oceanic and Atmospheric Administration). (2013). Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals.

Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33, 411 - 497.

Nowacek, D.P., Thorne, L.H., Johnston, D.W. and Tyack, P.L., (2007). Responses of cetaceans to anthropogenic noise. Mammal Review 37, 81 – 115.

Nowacek, D.P., Thorne, L.H., Johnston, D.W. and Tyack, P.L., (2007). Responses of cetaceans to anthropogenic noise. Mammal Review 37, 81 – 115.

NPWS. (2013). Site Synopsis. Lower River Shannon SAC Site Code: 002165. https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY002165.pdf.

NPWS. (2015) Site Synopsis. River Shannon and River Fergus Estuaries Special Protection Area Site Code: 004077. https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY004077.pdf.

NPWS. (2021). Maps and Data. http://www.npws.ie/mapsanddata/.

NRA (2009). Guidelines for assessment of ecological impacts of National Road Schemes. National Road Authority

Ó Cadhla, and Strong D. (2007). Grey seal moult population survey in the Republic of Ireland, 2007. Report to National Parks & Wildlife Service, Department of Arts, Heritage and Gaeltacht November 2011 Coastal & Marine Research Centre University College Cork Ireland.

O'Brien, J.M., Beck, S., Berrow, S.D., André, M., van der Schaar, M., O'Connor, I. and McKeown, E.P. (2016). The use of deep water berths and the effect of noise on bottlenose dolphins in the Shannon Estuary SAC. p. 775783 In: The effects of noise on aquatic life II, Springer, New York, NY. 1292 p.

O'Brien, J.M., Beck, S., Berrow, S.D., André, M., van der Schaar, M., O'Connor, I. and McKeown, E.P. (2016). The use of deep water berths and the effect of noise on bottlenose dolphins in the Shannon Estuary SAC. p. 775783 In: The effects of noise on aquatic life II, Springer, New York, NY. 1292 p.

OPR (2021). Office of the Public Regulator Practice Note PN01. Appropriate Assessment Screening for Development Management https://www.opr.ie/wp-content/uploads/2021/03/9729-Office-of-the-Planning-Regulator-Appropriate-Assessment-Screening-booklet-15.pdf.

OSPAR Commission (2008). Biodiversity Series: Literature Review on the Impacts of Dredged Sediment Disposal at Sea. ISBN 978-1-906840-01-3. Publication Number 362/2008.

OSPAR Commission (2009). Biodiversity Series: JAMP assessment of the environmental impact of dumping of wastes at sea. ISBN 978-1-906840-73-0. Publication Number: 433/2009.

Popper, A.N. (2005). A review of hearing by sturgeon and lamprey. Prepared for U.S. Army Corps of Engineers by Environmental Bioacoustics LLC.

Popper, A.N. (2005). A review of hearing by sturgeon and lamprey. Prepared for U.S. Army Corps of Engineers by Environmental Bioacoustics LLC.

Popper, A.N. and R.R. Fay. (1993). Sound detection and processing by fish: critical review and major research questions. Brain Behav. Evol. 41(1):14-38.

Popper, A.N. and R.R. Fay. (2011). Rethinking sound detection by fishes. Hearing Res. 273(1-2):25-36. Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S, Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, M.B. Halvorsen, S. Løkkeborg, P.H. Rogers, B.L. Southall, D.G. Zeddies, and W.N. Tavolga. 2014. Sound exposure guidelines for fishes and sea turtles. A technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer Briefs in Oceanography. ASA Press—ASA S3/SC1.4 TR-2014. 75 p.

Popper, A.N., A.D. Hawkins, O. Sand, and J.A. Sisneros. 2019. Examining the hearing abilities of fishes. J. Acoust. Soc. Am. 146. doi:10.1121/1.5120185.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S, Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, M.B. Halvorsen, S. Løkkeborg, P.H. Rogers, B.L. Southall, D.G. Zeddies, and W.N. Tavolga. (2014). Sound exposure guidelines for fishes and sea turtles. A technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer Briefs in Oceanography. ASA Press—ASA S3/SC1.4 TR-2014. 75 p.

Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S, Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L., Halvorsen, M.B., Løkkeborg, S., Rogers, P.H., Southall, B.L., Zeddies, D.G. and Tavolga. W. (2014). Sound exposure guidelines for fishes and sea turtles. A technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer Briefs in Oceanography. ASA Press—ASA S3/SC1.4 TR-2014. 75 p.

Potter, J. and Delroy, E. (1998). Noise sources in the sea and the impact for those who live there.

Putland, R.L., J.C. Montgomery, and C.A. Radford. (2019). Ecology of fish hearing. J. Fish Biol. 95(1): 39-52.

Quigley, D.T.G. and Flannery 1996 Endangered freshwater fish in Ireland. In A. Kirchhofer and D. Hefti (eds), Conservation of endangered. Freshwater Fish in Eurpe

Rajagopal, S., Jenner, H., Venugopalan, V. (2012) Operational and Environmental Consequences of Large Industrial Cooling Water Systems

Richardson, W.J., Greene, C.R.G. jr., Malme, C.I. and Thomson, D.H. (1995). Marine Mammals and Noise. Academic Press, San Diego, 576 pp.

Rogan, E., Garagouni, M., Nykänen, M., Whitaker, A and Ingram, S. (2018). Bottlenose dolphin survey in the Lower River Shannon SAC, 2018. School of Biological, Earth and Environmental Sciences, University College Cork, Ireland 2. School of Biological and Marine Science, University of Plymouth, England Report to the National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht November 2018.

Rogan, E., Garagouni, M., Nykänen, M., Whitaker, A and Ingram, S. (2018). Bottlenose dolphin survey in the Lower River Shannon SAC, 2018. School of Biological, Earth and Environmental Sciences, University College Cork, Ireland 2. School of Biological and Marine Science, University of Plymouth, England Report to the National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht November 2018.

Ryan, D. Coyne, J. Corcoran, W. Robson, S. and Roche, W. (2018). Fish Stock Survey of Transitional Waters in the Shannon International River Basin District – Limerick Dock, Shannon Upper, Shannon Lower, and Fergus Estuaries 2017. Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24, Ireland.

Silva, S., Barca, S., Vieira-Lanero, R., Cobo, F. (2019). Upstream migration of the anadromous sea lamprey (Petromyzon marinus Linnaeus, 1758) in a highly impounded river: Impact of low-head obstacles and fisheries. Aquatic Conservation: Marine and Freshwater EcosystemsVolume 29, Issue 3 p. 389-396

Sini, M.I., S.J. Canning, K.A. Stockin, and G.J. Pierce. 2005. Bottlenose dolphins around Aberdeen harbour, north-east Scotland: A short study of habitat utilization and the potential effects of boat traffic. J. Mar. Biol. Assoc. UK 85(6):1547-1554.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, Greene R.L. Jr., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack., P.L. (2007) Marine mammal noise exposure criteria: initial scientific recommendations. Aquat. Mamm. 33(4):411-522.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, Greene R.L. Jr., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack., P.L. (2007) Marine mammal noise exposure criteria: initial scientific recommendations. Aquat. Mamm. 33(4):411-522.

Turnpenny A.W.H. and Nedwell J.R. (1994). The effects of marine fish, diving mammals and birds of underwater sound generated by seismic surveys. Subacoustich Report FCR 089/94. Available from: www.subacoustech.com.

Turnpenny, A. (1988). Fish impingement at estuarine power stations and its significance to commercial fishing. Fish Biology 33, 103-110.

Turnpenny, A.W.H. and Horsfield, A. (2011).International fish screening techniques. International Fish Screening Conference (2011 : Lyndhurst, UK).

Turnpenny, A.W.H., Taylor, C.J.L., 2000. An assessment of the effect of the Sizewell power stations on fish populations. Hydroecologie Applique´12, 87–134.

Wall, D., Murray, C., O'Brien, J., Kavanagh, L., Wilson, C., Glanville, B., Williams, D., Enlander, I., Ryan, C., O'Connor, I., McGrath, D., Whooley, P. and Berrow, S. (2013) Atlas of the distribution and relative abundance of marine mammals in Irish offshore waters: 2005 – 2011. Irish Whale and Dolphin Group.

Weilgart, L.S. (2007). The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology 85, 1091 - 1116.

Weilgart, L.S., Wintle, B.A., Notarbartolo-di-Sciara, G. and Martin, V. (2007). Do Marine Mammals Experience Stress Related to Anthropogenic Noise? International Journal of Comparative Psychology, 2007, 20, 274-316.

Wheeler, A. (1969). The fishes of the British Isles and northwestern Europe. 613pp. London. MacMillan.

Woodward, J. L. and Pitbaldo, R. (2010). LNG Risk Based Safety: modelling and consequence analysis. John Wiley & Sons. https://www.wiley.com/en-us/LNG+Risk+Based+Safety%3A+Modeling+and+Consequence+Analysis-p-9780470317648.

Wright, A.J., Aguilar Soto, N., Baldwin, A.L., Bateson, M., Beale, C., Clark, C., Deak, T., Edwards, E.F., Fernández Rodríguez, A., Godinho, A., Hatch, L., Kakuschke, A., Lusseau, D., Martineau, D., Romero, L.M., Weilgart, L., Wintle, B., Notarbartolo di Sciara, G. Martin, V. 2007. Do marine mammals experience stress related to anthropogenic noise? Int. J. Comp. Psychol. 20:274-316.

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