Limerick WWTP Upgrade and Regional Bioresource Centre

EIAR CHAPTER 12 – BIODIVERSITY (MARINE)

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Formerly JB Barry Partners who became part of Egis in 2023

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GLOSSARY AND DEFINED TERMS

Acronym	Description
AA	Appropriate Assessment
AASR	Appropriate Assessment Screening Report
ACP	An Coimisún Pleanála
AD	Anaerobic Digestion
AGS	Aerobic Granular Sludge
AER	Annual Environmental Report
BOD	Biochemical Oxygen Demand
BC	Bioresource Centre
C	Carbon
CAFÉ	Clean Air for Europe Directive
CHP	Combined Heat and Power
DIN	Dissolved Inorganic Nitrogen
ECJ	European Court of Justice
EIAR	Environmental Impact Assessment Report
ELV	Emission Limit Value
EPA	Environmental Protection Agency
ESB	Electrical Supply Board
EU	European Union
FOG	Fats Oils and Grease
FST	Final Settling Tank
GHG	Greenhouse Gas
HGV	Heavy Goods Vehicle
MLPS	Main Lift Pumping Station
MCA	Multi-Criteria Analysis
MRP	Molybdate Reactive Phosphate
IDA	Industrial Development Agency
IFAS	Integrated Fixed-Film Activated Sludge
N	Nitrogen
NDP	National Development Plan
NHA	National Heritage Area
NIS	Natura Impact Statement
NPF	National Planning Framework
NSO	National Strategic Outcomes
NSS	National Spatial Strategy
NWSMP	National Wastewater Sludge Management Plan
P	Phosphorous
PE	Population Equivalent - The amount of wastewater received at a treatment plant (and its design capacity) is measured in units known as population equivalent (or PE). The wastewater received from all sources, e.g. industrial, tourism, commercial, residential, etc., is converted into these units, with one unit of PE representing the wastewater treatment load typically generated by a single person.
PFF	Pass Forward Flow
PFT	Picket Fence Thickener
pNHA	Proposed National Heritage Area

Acronym	Description
SEA	Strategic Environmental Assessment
SBR	Sequencing Batch Reactor
SHC	Sludge Hub Centre
SIA	Stable Isotope Analysis
SID	Strategic Infrastructure Development
Sludge	Solid by-products of wastewater
SPA	Special Protection Area
SS	Suspended Solids
UWWTD	Urban Wastewater Treatment Directive
WFD	Water Framework Directive
WWDA	Wastewater Discharge Authorisation
WWTP	Wastewater Treatment Plant
WSPS	Water Services Policy Statement
ZTV	Zone of Theoretical Visibility
PS	Pumping Station
QI	Qualifying Interest
RAS	Return Activated Sludge
RBC	Regional Bioresource Centre
RSES	Regional Spatial and Economic Strategy
SAC	Special Area of Conservation
TDS	Total Dry Solids
THP	Thermal Hydrolysis Process

DEPARTMENTS AND STAKEHOLDERS

Departments & Stakeholders	Acronym (where applicable)
An Coimisiún Pleanála	ACP
Department of Public Expenditure and Reform	DPER
Department of Climate Action, Communication Networks and Transport	CACNaT
Department of Communications, Climate Action and Environment – Changed in 2020	DCCAE
Department of Culture, Heritage and the Gaeltacht – Changed in 2020	DCHG
Department of Finance	DoF
Department of Housing, Planning and Local Government – Changed in 2020	DHPLG
Department of Housing, Local Government and Heritage	HLGaH
Environmental Protection Agency	EPA
Geological Survey Ireland	GSI
Group Water Schemes	GWS
Inland Fisheries Ireland	IFI
Irish Rail (Iarnród Éireann)	IR
Uisce Éireann	UÉ
Limerick City & County Council	LCCC
Local Authority	LA
National Monuments Service	NMS
National Parks & Wildlife Service	NPWS
National Roads Authority	NRA
National Transport Authority	NTA
Office of Public Works	OPW
Ordnance Survey Ireland	OSi
Southern Regional Assembly	SRA

12 MARINE BIODIVERSITY

12.1 Introduction

12.1.1 Purpose of this Report

This Environmental Impact Assessment Report (EIAR) for the Limerick Wastewater Treatment Plant Upgrade and Regional Bioresource Centre Project (hereafter referred to as the "Proposed Development") has been prepared by Egis on behalf of the applicant, Uisce Éireann (UÉ). The EIAR accompanies a planning application made directly to An Coimisiún Pleanála (ACP) under Section 37E of the Planning and Development Act 2000 (as amended). It has been completed in accordance with all relevant legislation and guidance, including the requirements set out in Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014, which amends Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the "EIA Directive").

This chapter of the EIAR has been written by AQUAFACT and specifically addresses marine biodiversity and sets out the purpose of assessing the likely significant effects of the Proposed Development on marine habitats and species. In particular, it evaluates the potential impacts on marine ecological receptors that may be affected directly or indirectly during the construction and operational phases of the project, including those related to effluent discharge, sediment disturbance, and stormwater overflow management.

The Proposed Development includes upgrades to the existing wastewater treatment plant (WWTP) capacity, sludge treatment facilities, and stormwater storage capacity. These works are proposed across two sites: the Limerick WWTP and the Corcanree Pumping Station (PS), both situated in an industrial area near Dock Road, Limerick. Existing land use at both locations involves wastewater treatment activities, with the WWTP discharging treated effluent to the Shannon Estuary, a sensitive marine environment.

This chapter forms part of a wider assessment of the environmental effects of the Proposed Development, with a particular focus on identifying, predicting, and mitigating any significant adverse impacts on marine biodiversity. The methodologies used in preparing this chapter follow best practice guidance and were informed by baseline ecological surveys, existing data sources, and consultations with statutory and non-statutory bodies. Scoping and screening exercises carried out prior to this EIAR and have helped shape the scope and focus of this marine biodiversity assessment.

12.1.2 Outline Project Description

The Proposed Development will cater for future population growth and industrial development in the area, in line with population projections for Limerick as set out in the National Planning Framework (NPF) Implementation Roadmap and the Southern Region Regional Economic Spatial Strategy (RSES). It will provide 20% Headroom allowance, in line with Uisce Éireann guidelines for large urban settlements. It will also ensure the WWTP continues to comply with requirements of the EPA Wastewater Discharge License (WWDL), Urban Wastewater Treatment Regulations (UWWTR) and other relevant Uisce Éireann Guidelines.

The initial upgrade works will cater for the +10-year growth projections, increasing to 285,000 PE including a future industrial committed load of 27,500 PE. There will be provision made in the civil infrastructural development of the plant (tank sizing and pipework) for the +25-year growth projections of 325,000 PE. However, a planning review will be required before any uplift above 285,000 PE can be instated.

A full description of the Proposed Development including the detailed design information is provided in Chapter 3 (The Proposed Development) of this EIAR.

12.2 Methodology

12.2.1 Study Area

The work requirements are split between Limerick WWTP and Corcanree Pumping Station (PS), both of which are situated on the banks of Limerick Dock, where the Lower River Shannon confluences with the Upper Shannon Estuary.

The proximity of the sites to the river are shown in Figure 12-1.

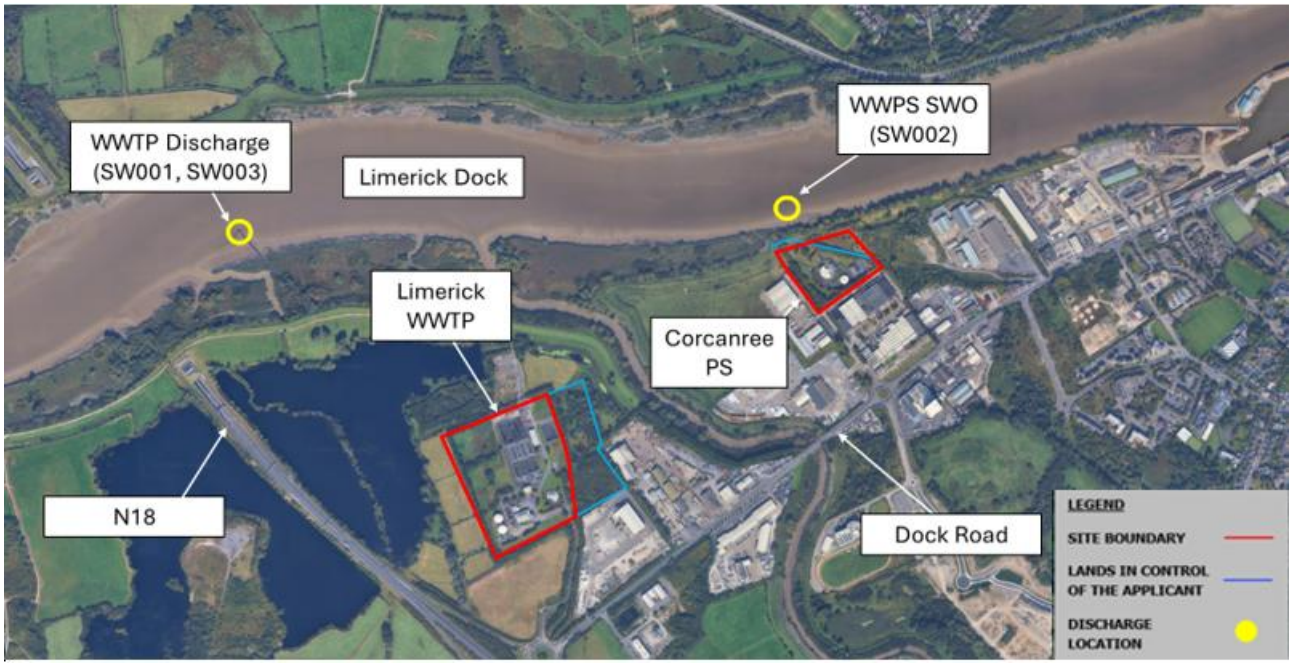

FIGURE 12-1 SITE LOCATION MAP

To characterise the estuarine biological environment in the vicinity of the sites, and to inform the assessment of potential ecological impacts associated with the proposed upgrade works, a series of targeted biological surveys were undertaken by AQUAFACT (Figure 12-2). These surveys focused on the intertidal and subtidal habitats of the Shannon Estuary in areas both upstream and downstream of the existing WWTP outfall.

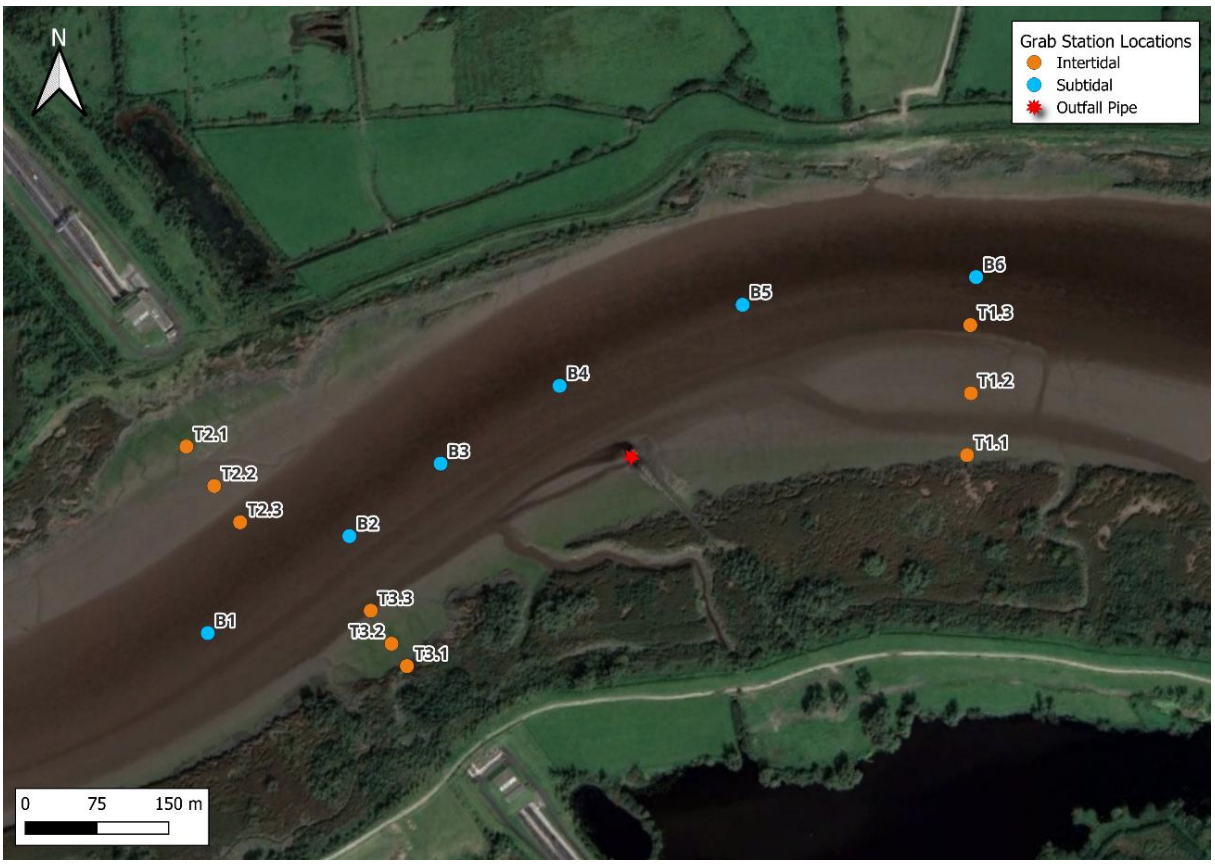

FIGURE 12-2: SUBTIDAL AND INTERTIDAL SAMPLING STATIONS FOR THE PROPOSED DEVELOPMENT.

The study area encompasses a section of the Shannon Estuary, a transitional waterbody of high ecological importance that supports a diversity of marine and estuarine habitats and species. The WWTP discharges into the upper estuarine zone near Limerick City, where salinity gradients, tidal influence, and freshwater input from the River Shannon combine to create dynamic and productive habitats. The estuarine system is also part of the Lower River Shannon Special Area of Conservation (SAC)(site code: 002165), designated under the EU Habitats Directive for its range of protected habitats, including mudflats, sandflats, estuaries, and saltmarshes, as well as for supporting populations of Annex II species such as *Tursiops truncatus* (bottlenose dolphin), *Margaritifera margaritifera* (Freshwater Pearl Mussel), *Lampetra fluviatilis* (river lamprey), *Petromyzon marinus* (sea lamprey), *Lampetra planeri* (Brook Lamprey), *Lutra lutra* (otter) and *Salmo salar* (Atlantic salmon).

Biological surveys included quantitative sampling of benthic communities in intertidal and subtidal zones, sediment analysis, and habitat mapping, to establish baseline ecological conditions. Sampling locations were strategically selected to capture spatial variability in community composition and sediment characteristics, both in proximity to the outfall and in control areas (B5, B6, T1.1, T1.2 and T1.3 removed from direct influence of WWTP discharges).

12.2.2 Relevant Legislation, Policy and Guidelines

European Legislation

- EIA Directive (2011/92/EU as amended by 2014/52/EU)
- EU Habitats Directive (92/43/EEC)
- EU Birds Directive (2009/147/EC)
- Water Framework Directive (2000/60/EC)
- EU Marine Strategy Framework Directive (2008/56/EC)

National Legislation

- Planning and Development Act 2000 (as amended)
- Wildlife Act 1976 and Wildlife (Amendment) Act 2000

- Fisheries (Consolidation) Act 1959 and amendments
- European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477/2011)

National and Regional Policy

- National Biodiversity Action Plan (NBAP) 2023–2030
- National Marine Planning Framework (NMPF) 2021
- Southern Region Regional Spatial and Economic Strategy (RSES)

Guidance Documents

- EPA Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (2022)
- CIEEM Guidelines for Ecological Impact Assessment in the UK and Ireland – Marine and Coastal (2018)
- NPWS – Guidance on Marine Natura Impact Statements (2012)
- European Commission Guidance on the Application of the EIA Directive (2017)

12.2.3 Appraisal Method for the Assessment of Impacts

The assessment of potential impacts of the Proposed Development on marine biodiversity has been undertaken in accordance with recognised best practice methodologies and relevant guidance, including those from the Environmental Protection Agency (EPA), the Chartered Institute of Ecology and Environmental Management (CIEEM), and the European Commission. The appraisal process is designed to identify, predict, and evaluate the likely significant effects of the project on marine ecological receptors during both the construction and operational phases.

Baseline Data Collection

Baseline information was gathered through a combination of desk-based review and field surveys, including:

Intertidal and subtidal habitat mapping, benthic infaunal community analysis and sediment and water quality assessments, along with a review of existing datasets, including National Parks and Wildlife Service (NPWS) site synopses, Marine Institute data, EPA water quality reports, and previous studies in the Shannon Estuary.

Receptor Identification and Sensitivity Analysis

Ecological receptors were identified based on their conservation status, functional role in the ecosystem, and potential exposure to impact pathways. These can be seen in Section 112.4.

Each receptor was assessed for its sensitivity and ecological value using criteria aligned with CIEEM guidance and adapted to marine environments.

Impact Identification and Characterisation

The potential impacts of the Proposed Development on marine biodiversity were identified for both construction and operational phases in Section 12.4.

Each impact was described in terms of its type (direct/indirect), duration (temporary/permanent), frequency, reversibility, and spatial extent (local/regional).

Impact Evaluation

The significance of identified impacts was evaluated using the following criteria:

- Positive or negative;
- Extent;
- Magnitude;
- Duration;
- Frequency and timing;
- Reversibility.

Significance levels were assigned in accordance with CIEEM's Ecological Impact Assessment (EcIA) framework (2018), which categorises effects as significant or not significant at international, national, regional, county, or local levels.

Mitigation and Monitoring

Where potentially significant adverse impacts were identified, appropriate mitigation measures were proposed to avoid, reduce, or compensate for such effects. This includes design-based mitigation, construction-phase best practices (e.g., silt control), and operational controls (e.g., effluent quality monitoring).

Monitoring strategies are also outlined to verify the effectiveness of mitigation and ensure compliance with environmental commitments during the life of the project.

Residual Impact Assessment

Following the designation of mitigation measures, the residual impacts were re-assessed to determine their significance. Only residual impacts considered significant (as per the EIA Directive) are carried forward into the cumulative impact assessment.

Cumulative Impacts and Interactions

Cumulative impacts were assessed by identifying other relevant projects, plans, and activities in the surrounding area that could, in combination with the proposed WWTP upgrade, result in significant environmental effects to marine biodiversity. This involved a review of current and planned developments, including those with overlapping temporal or spatial influence, such as nearby flood relief schemes, port expansion works, and land-use changes. The cumulative assessment followed best practice guidance, including EPA (2022) and EU EIA Directive methodologies.

12.2.4 Data Collection and Collation

AQUAFACT (APEM Group) was commissioned by Egis (formerly JB Barry & Partners), on behalf of Uisce Éireann, to undertake a biological assessment of the estuarine environment in the vicinity of Limerick Wastewater Treatment Plant (WWTP) prior to an upgrade of the facility.

Subtidal Survey

To carry out the subtidal benthic assessment of the study area in question, AQUAFACT sampled a total of 6 stations. Sampling took place on the 18th January 2024 from AQUAFACT's 6.8m Lencraft RIB. The weather on this day was clear and frosty. There was a force 1 north-westerly wind blowing. High water was at 12pm (5.32m) at Limerick Docks. The locations of all subtidal stations sampled can be seen in Figure 12-2. Table 2.1 in Appendix 12.1 (Estuarine Ecological Report) in Volume 4 of this EIAR shows the 6 subtidal stations' coordinates.

AQUAFACT has in-house standard operational procedures for benthic sampling, and these were followed for this project. Additionally, the NMBAQC report "Guidelines for processing marine macrobenthic invertebrate samples: a processing requirements protocols" (Worsfold and Hall, 2010) was adhered to.

A 0.025m^2 van Veen grab was used to sample each station, and two replicate grab samples were collected at each site. On arrival at each sampling station, the vessel location was recorded using DGPS (Lat/Long & ING). The grab deployment and recovery rates did not exceed 1 metre/sec and were <0.5 m/sec for the last 5 metres for water depths up to 30m and for the last 10m for depths greater than 30m.

A digital image of each sample (including sample label) was taken and its reference number entered in the sample data sheet. These images can be made available on request. The grab sampler was cleaned between stations to prevent cross contamination.

Each grab sample was carefully and gently sieved on a 1mm mesh sieve as a sediment water suspension for the retention of fauna. Great care was taken during the sieving process in order to minimise damage to taxa such as spionids, scale worms, phyllodocids and amphipods. The sample residue was carefully flushed into a pre-labelled (internally and externally) container from below. Each label contained the sample code and date.

The samples were stained immediately with Eosin-briebrich scarlet and fixed with 4% w/v buffered formaldehyde solution (10% w/v buffered formaldehyde solution for very organic mud).

An additional grab sample was collected at each station for sediment analysis (organic carbon and granulometry). Each sediment sample was placed in plastic sampling bags and labelled internally and externally. These samples were frozen (<-18ºC) as soon as possible after acquisition.

Sample Processing

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

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

The sediment granulometric analysis was carried out by AQUAFACT using the traditional granulometric approach. The traditional analysis involved the dry sieving of approximately 100g of sediment using a series of Wentworth graded sieves. The process involved the separation of the sediment fractions by passing them through a series of sieves. Each sieve retained a fraction of the sediment, which were later weighed, and a percentage of the total was calculated. Table 3.2 shows the classification of sediment particle size ranges into size classes. Sieves, which corresponded to the range of particle sizes were used in the analysis. Refer to Appendix 12.1 in Volume 4 of this EIAR for a detailed methodology of this procedure.

Intertidal Survey

AQUAFACT carried out 3 intertidal transects (T1 to T3) on the 18th January 2024. Table 2.3, Appendix 12.1 in Volume 4 lists the transect station locations. Transect 1 was upstream of the WWTP outfall and Transects 2 and 3 were downstream of the outfall on opposites banks of the river. Figure 12-2 illustrates their locations. The weather was clear and frosty. There was a force 1 north-westerly wind blowing. High water was at 12pm (5.32m) at Limerick Docks.

A grab survey was necessary to carry out the intertidal survey as the substrate was fine soft mud and it was not possible or safe to stand on the substrate at low water. Instead, the same procedure used for the subtidal benthic survey was employed. A 0.025m2 Van Veen grab was deployed from AQUAFACT's RIB at high water at each of the of the transects' locations (Upper Shore, Mid Shore and Lower Shore). Replicate grabs were collected at each station as well as an additional grab for sediment analysis. The grabs were preserved and returned to the lab for identification and analysis. The full methodology for the collection and analysis of grab samples is outlined in Appendix 12.1 in Volume 4 of this EIAR.

Analysis

Sediment Analysis

Sediment samples were analysed to determine organic content and granulometric composition. Organic content was measured as a percentage loss on ignition (LOI), which typically correlates with particle size—higher LOI values are generally associated with fine-grained sediments.

Grain size distribution was assessed using a combination of wet sieving for the <63 µm (silt-clay) fraction and dry mechanical sieving for coarser fractions, following the Wentworth scale. The sediment fractions were then classified using Folk's (1954) system.

Faunal Analysis

Benthic macrofauna samples were statistically analysed using PRIMER v6 software. Two main approaches were used:

Univariate Analysis included metrics such as species richness (S), total abundance (N), Margalef's Index (D), Pielou's Evenness (J), Shannon-Wiener Diversity Index (H'), and the Effective Number of Species (ENS). These indices provide a summary of biological diversity and community structure at each sampling station.

Multivariate Analysis was based on Bray-Curtis similarity matrices of square-root transformed species abundance data. Techniques such as Multidimensional Scaling (MDS), Hierarchical Agglomerative Clustering (HAC), and SIMPROF testing were used to explore patterns and groupings among stations. SIMPER analysis was applied to identify species contributing most to similarities within, and differences between, clusters.

These methods collectively provide a robust characterisation of the benthic communities and allow for assessment of ecological structure and potential impacts from the Proposed Development.

12.3 Baseline Environment

12.3.1 Current Baseline Environment

Figure 12-1 indicates the location of the Limerick WWTP and outfall within the Shannon Estuary area. The outfall is located in the Lower River Shannon SAC (site code: 002165) and River Shannon and River Fergus Estuaries SPA (Special Protection Area) (site code: 004077), specifically in a freshwater tidal area called Limerick Docks. The Limerick Docks water body comprises the main channel of the River Shannon as it passes through Limerick City as well as the Ballinacurra Creek on the south side of the city. The water body stretches from the bridge east of Corbally on Limerick's north side, down as far as Coonagh Point, just below the Limerick Tunnel on the N18. This water body covers a total area of 2.49km^2. Most of this water body is bordered by urban development (Kelly *et al.*, 2015).

12.1.1.1 Desk study

A comprehensive desk study was undertaken to contextualise the biological survey data and ensure consideration of key marine ecological receptors, habitats, invertebrates, fish, and marine mammals, within the Shannon Estuary, particularly in the vicinity of the Proposed Development.

Benthic Invertebrates and Sediment Characteristics

Soft-sediment communities in this upper estuary are dominated by organic-tolerant taxa, including oligochaetes (*Limnodrilus hoffmeisteri, Tubifex tubifex*), amphipods (*Gammarus spp., Corophium multisetosum*), and freshwater gastropods (*Potamopyrgus antipodarum*). Sediment analyses in the area indicate organic carbon levels between 2.6% and 6.8%, aligning with the expected range for organically enriched, low-salinity muds (AQUAFACT, 2011). These species assemblages are consistent with those documented in the SAC's estuarine biotopes and reflect resilience to moderate organic loading (AQUAFACT, 2011).

Fish Assemblages

Available fisheries survey data for the Shannon Estuary, including studies undertaken by Inland Fisheries Ireland (e.g. Kelly *et al.*, 2015; King *et al.*, 2011), provide a useful indication of the species assemblages present in the transitional waters, although it is noted that these datasets are now over ten years old and are therefore used here to provide general ecological context rather than a definitive representation of current conditions. These surveys recorded twenty-nine fish species in the Lower Shannon transitional zone, including resident estuarine species and EU Annex II diadromous species, Atlantic salmon (*Salmo salar*), river lamprey (*Lampetra fluviatilis*), sea lamprey (*Petromyzon marinus*), twaite shad (*Alosa fallax*), and the critically endangered European eel (*Anguilla anguilla*). Estuarine species such as sprat (*Sprattus sprattus*), common goby (*Pomatoschistus microps*), and thick-lipped grey mullet (*Chelon labrosus*) are also widespread. These species can utilise the upper estuary for critical life stages including spawning and nursery development. A total of 22 fish species were recorded in the Upper Shannon Estuary during the 2014 survey, with flounder (*Platichthys flesus*) being the most abundant

and widely distributed species, followed by sprat (*Sprattus sprattus*) and sand goby (*Pomatoschistus minutus*). Several new species were recorded in 2014, including Atlantic horse mackerel (*Trachurus trachurus*), brill (*Scopthalmus rhombus*), coalfish (*Pollachius virens*), and grey gurnard (*Eutrigla gurnardus*). In contrast, a few species previously observed in 2008, such as perch *(Perca fluviatilis*) and poor cod (*Trisopterus minutus*), were not recorded in 2014. Notably, the critically endangered European eel (*Anguilla anguilla*) was also captured during the 2014 survey (King *et al*., 2011). Thirteen fish species were recorded in Limerick Docks during the 2014 survey, with flounder being the most abundant and widespread, followed by smelt. Newly recorded species included lamprey sp., plaice (*Pleuronectes platessa*), sand goby, sprat, thick-lipped grey mullet, and the invasive dace (*Leuciscus leuciscus*). Species recorded in 2008 but absent in 2014 included common goby, pike, and salmon. The critically endangered European eel (*Anguilla anguilla*) was also recorded (King *et al*., 2011).

Marine Mammals

The Shannon Estuary supports a genetically distinct, resident population of common bottlenose dolphins (*Tursiops truncatus*), with abundance estimates between 114 and 145 individuals based on photo-identification and mark-recapture studies conducted in 2006–2008 (Englund *et al*. 2008; Berrow *et al*. 2010; Berrow *et al*. 2022). These dolphins consistently use the estuary, including areas adjacent to Limerick Docks, as core habitat and nursery grounds, with evidence of residency and calf presence (Englund *et al*. 2008; Shannon Dolphin Project, 2015). The Lower River Shannon SAC is one of ten SACs with bottlenose dolphins listed as QIs in Ireland, highlighting its international conservation significance (Englund *et a*l. 2008; de Bonis, 2022; Berrow *et al*. 2022).

Harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*) are regularly observed in the estuary, while larger cetaceans like minke whales (*Balaenoptera acutorostrata*) and occasional humpback whales (*Megaptera novaeangliae*) have been sighted in outer reaches, underscoring the ecological connectivity and diversity present (Marine Mammal Atlas; NPWS 2012a). This illustrates the broader value of the Shannon estuary beyond the primary study area.

The otter (*Lutra lutra*) is listed as a Qualifying Interest of the Lower River Shannon SAC and is protected under Annex II of the EU Habitats Directive. Otters are known to occur throughout the Shannon Estuary and its tributaries, utilising both freshwater and coastal environments for foraging and resting (NPWS, 2012a). The species relies on a combination of good water quality, abundant prey, and undisturbed riparian or intertidal habitats for holts and resting places (Berrow *et al*., 2022).

Environmental Pressures and Historical Impacts

The Shannon Estuary is subject to several anthropogenic and natural pressures. Diffuse nutrient enrichment from agricultural catchment runoff is a dominant influence on sediment quality and benthic communities (AQUAFACT, 2011; Kelly *et al*., 2015). The 1929 Ardnacrusha hydroelectric scheme drastically altered flow regimes, reducing downstream river flows and affecting migratory fish passage (ESB, 2022). Shipping, dredging, and aquatic noise further impact habitat structure and dolphin behaviour, with increased vessel traffic potentially affecting mother-calf pairs (NPWS, 2012a). Despite improved municipal wastewater treatment over recent decades, sediment organic content remains elevated.

Bird Species

The River Shannon and River Fergus Estuaries SPA (site code: 004077) is a designated Special Protection Area under the EU Birds Directive (2009/147/EC), covering over 32,000 hectares of estuarine and intertidal habitats from the Fergus Estuary and Shannon Airport to Limerick City. It is one of Ireland's most important wetland complexes, supporting internationally significant numbers of wintering waterbirds, regularly exceeding 20,000 individuals (NPWS, 2015).

The SPA is designated for a wide range of species, including Light-bellied Brent Goose (*Branta bernicla hrota*), Golden Plover (*Pluvialis apricaria*), Dunlin (*Calidris alpina*), Black-tailed Godwit (*Limosa limosa*), and Redshank (*Tringa totanus*), among others. The intertidal mudflats and sandflats, rich in invertebrates, provide essential feeding and roosting grounds. Portions of the SPA extend into the vicinity of the Proposed Development outfall, where habitat is influenced by freshwater input and reduced salinity but may still support opportunistic feeding by some bird species (NPWS, 2012b).

The site's conservation objectives, as defined by the NPWS, aim to maintain the favourable conservation status of the bird species and wetland habitats present. Any potential impact from the Proposed Development, such as construction-related disturbance, hydrological changes, or alterations in water quality, must be assessed with regard to these objectives.

Freshwater Pearl Mussel

Freshwater pearl mussel (FPM) is a qualifying interest of the Lower River Shannon SAC; however, the proposed works at the WWTP are not expected to impact this species. The proposed development area lies within a tidal, modified section of the estuary, characterised by soft sediment substrates and elevated turbidity, which are unsuitable for freshwater pearl mussels. No populations occur locally, with the nearest known populations documented in the Mulkear River, a tributary of the Shannon, where FPM has historically been recorded in its upper reaches approximately 15–20 km upstream of the Proposed Development (NPWS, 2012c). More recently, a small number of individuals were reported downstream of Annacotty Weir (15 km upstream) in 2022 (O'Connor, 2022), indicating very limited and localised occurrence within the lower Mulkear catchment. Additionally, a designated area for freshwater pearl mussel lies downstream of the project in a separate, hydrologically distinct freshwater system (NPWS, 2012a). Given the lack of connectivity, unsuitable habitat, and physical separation, there is no plausible pathway for direct, indirect, or cumulative effects on freshwater pearl mussel populations or their designated habitat arising from the Proposed Development.

12.1.2.1 Field surveys

Biological surveys were conducted upstream and downstream of the Limerick Wastewater Treatment Plant (WWTP) outfall to characterise the estuarine environment in the Limerick Docks area where the Proposed Development is located. This area is a freshwater tidal zone with low and fluctuating salinity (ranging from 0.83 to 3.2 psu), typical of stressed estuarine transition zones where biodiversity is generally reduced compared to fully marine or freshwater habitats.

Subtidal Environment

Two distinct benthic community types were identified in the survey area. The subtidal stations support a community consistent with one of the seven Qualifying Interest (QI) benthic habitats of the Estuaries [1130] feature of the Lower Shannon SAC, specifically, the 'Estuarine subtidal muddy sand to mixed sediment with gammarids community complex'. This biotope typically occurs in the eastern SAC from Cock Rock to Scarlet Reach, including the Limerick Docks, in water depths between 2.5 m and 7 m (AQUAFACT, 2011).

The community was characterised by low species richness and abundance, in line with its classification as a naturally species-poor upper estuarine habitat. Dominant taxa included the oligochaetes *Tubifex tubifex* and *Limnodrilus* spp., the amphipods *Corophium multisetosum* and *Gammarus zaddachi*, and the gastropod *Potamopyrgus antipodarum*. These species reflect both the freshwater influence and the tolerant nature of fauna in organically enriched environments. Subtidal sediments were muddy sands or sandy muds, with organic carbon contents ranging from 3.66% to 6.78%, notably lower than those recorded in earlier surveys within this habitat in the SAC (AQUAFACT, 2011).

Intertidal Environment

The intertidal stations, both upstream and downstream of the WWTP outfall, did not align with any of the seven QI habitat types of the Estuaries [1130] feature but corresponded instead to the JNCC biotope SS.SMu.SMuVS.LhofTtub—*Limnodrilus hoffmeisteri, Tubifex tubifex* and *Gammarus* spp. in low salinity infralittoral muddy sediment (EUNIS Code A5.327). This habitat is commonly found in low-salinity muddy sediments in the upper reaches of estuaries.

Intertidal stations were dominated (>90% faunal abundance) by *Limnodrilus* spp. and *Tubifex tubifex*, both of which are oligochaetes known for their tolerance of organic enrichment and varying oxygen conditions. Secondary species included *Corophium multisetosum* and *Potamopyrgus antipodarum*. Organic carbon levels ranged from 2.59% to 5.31%, within the expected range for organically enriched upper estuarine sediments.

Comparative Observations

The densities of *Limnodrilus* spp. and *Tubifex tubifex* recorded in this study are substantially lower than those observed in historical surveys of similarly enriched upper estuarine environments such as the Forth Estuary (McLusky *et al.*, 1993) and the Schelde Estuary (Seys *et al.*, 1999), where organic carbon levels and oligochaete densities were significantly higher.

In the present study, *Limnodrilus* spp. reached a maximum density of 11,610 individuals/m^2 (T3.1) and *Tubifex tubifex* 10,397 individuals/m^2 (T2.1). This suggests moderate enrichment likely influenced by a combination of catchment-derived nutrient inputs and residual organic content in outfall discharges.

Overall Assessment

The surveyed benthic communities reflect a typical upper estuarine environment influenced by fluctuating salinity, sediment characteristics, and organic inputs. The subtidal community is a recognised QI habitat of the SAC and appears unaffected by the existing WWTP discharge, with biodiversity slightly higher than recorded in prior surveys, this is likely due to the presence of freshwater-tolerant taxa. The intertidal community is not a QI habitat and is composed of tolerant species that respond to organic enrichment but are not strictly dependent on it. Overall, the current benthic environment represents a stable, ecologically consistent upper estuarine condition within this part of the Lower Shannon Estuary.

12.3.2 Evolution of the Environment in the Absence of the Proposed Development

In the absence of the proposed upgrade to the Limerick Wastewater Treatment Plant (WWTP), it is expected that the current estuarine environmental conditions in the vicinity of the outfall will remain relatively stable over the short to medium term. The benthic communities observed, both subtidal and intertidal, are characteristic of a naturally stressed freshwater tidal estuary and exhibit ecological tolerance to fluctuating salinity, organic enrichment, and fine sediment conditions.

The subtidal benthic community, classified as part of the Qualifying Interest habitat 'Estuarine subtidal muddy sand to mixed sediment with gammarids community complex', is inherently species-poor and adapted to low-salinity, organically influenced conditions. The existing treated effluent discharge from the Limerick WWTP does not appear to be exerting a dominant or adverse influence on this habitat type. Without the Proposed Development, this community is expected to persist in its current form, governed primarily by natural estuarine dynamics and broader catchment-derived nutrient and sediment inputs.

Similarly, the intertidal benthic community, assigned to the non-QI JNCC biotope SS.SMu.SMuVS.LhofTtub, is dominated by oligochaetes such as *Limnodrilus hoffmeisteri* and *Tubifex tubifex*. These taxa are well adapted to organically enriched and low-salinity conditions, and their presence is more strongly influenced by diffuse pollution and siltation from the wider Shannon catchment than by the existing outfall discharge. In the absence of any intervention, this biotope is also expected to remain stable or evolve only gradually in response to broader catchment land use practices and natural estuarine variability.

Over the longer term, external pressures such as agricultural runoff, urban development in the Shannon catchment, and climate-driven changes in river flow or sea level may alter the organic loading, salinity gradients, and sediment dynamics within the estuary. However, the lack of change at the WWTP itself would not introduce any new pressures or alter the trajectory of ecological change already underway.

In conclusion, in the absence of the Proposed Development, no significant deviation from the current baseline biological or sedimentary conditions is anticipated. The natural variability associated with upper estuarine environments and continued influence of upstream nutrient and sediment inputs would remain the primary drivers of any future environmental changes in the study area.

12.4 Potential Impacts

12.4.1 Construction Phase

Construction works will take place entirely within the terrestrial footprint of the WWTP and Corcanree Pumping Station sites, more than 400 m from the nearest transitional waterbody and over 500 m from the main estuary channel. Activities will include excavation and piling to facilitate new infrastructure. Potential pathways for interaction with the estuarine environment therefore relate primarily to airborne noise, vibration, and surface water drainage connectivity rather than direct physical disturbance.

Benthic Communities and Sediment Disturbance

All construction activities will occur within the existing WWTP and Corcanree Pumping Station site boundaries, with no temporary outfalls or direct discharges to the Shannon Estuary during the construction phase. While deep excavations and enabling works (*e.g.*, cofferdams, dewatering systems) are required for structures such as the stormwater storage tank and AGS tanks, these will be confined to terrestrial areas and managed under a site-specific dewatering plan to prevent uncontrolled release. Consequently, there will be no physical disturbance of intertidal or subtidal sediments within the estuary. The estuarine biotopes identified in the baseline survey, such as the estuarine subtidal muddy sand with gammarid community complex and the intertidal *Limnodrilus hoffmeisteri–Tubifex tubifex* dominated community (AQUAFACT, 2011;), occur outside the construction footprint and will not be directly affected. In the absence of mitigation, the magnitude of potential impacts is considered low, with effects limited to the immediate area surrounding site drainage pathways where indirect connectivity to the estuary occurs (local extent). Any impact would be short-term and reversible, given the absence of direct in-water works or physical habitat loss, and the naturally tolerant nature of estuarine benthic assemblages in this part of the estuary. The probability of occurrence remains low due to the physical separation between the works footprint and subtidal habitats; however, without control measures, episodic increases in suspended sediment cannot be entirely ruled out. On this basis, the potential construction-phase impact on benthic communities, in pre-mitigation terms, is assessed as not significant."

Construction works may involve deep excavations and dewatering within the site boundaries, which could generate sediment-laden water if not properly managed. However, there is no dredging or in-stream excavation associated with the Proposed Development. Indirect risks, such as temporary increases in suspended solids from surface runoff during enabling works, will be controlled through the Surface Water Management Plan and best-practice sediment control measures. Given the naturally high suspended sediment loads in the Shannon Estuary and the sediment-tolerant nature of local benthic communities, the magnitude and spatial extent of any potential turbidity-related impact are considered negligible and confined to the terrestrial footprint (local extent). These effects would be short-term in duration and fully reversible once construction ceases. The probability of occurrence is low with mitigation in place, and the overall significance is assessed as not significant.

Fish Species

The estuary provides important habitat for a variety of fish species, including diadromous Annex II species such as Atlantic salmon (*Salmo salar*), river lamprey (*Lampetra fluviatilis*), and sea lamprey (*Petromyzon marinus*) (Kelly *et al.*, 2015; NPWS, 2012a). These species may be present seasonally in the vicinity of the outfall during outward migration as juveniles or upstream migration as adults to spawn in tributaries of the Shannon.

Potential impacts from construction activity include temporary noise and vibration emissions and localised increases in suspended sediment. However, based on the predictions presented in Chapter 9: Noise & Vibration, construction-related noise levels are not expected to exceed relevant threshold criteria at sensitive receivers and will remain well below levels associated with disturbance to aquatic fauna. Moreover, vibration modelling confirms that piling-related ground-borne vibration will attenuate to below detectable levels at the estuary margin and is therefore not anticipated to affect migratory fish behaviour or passage.

Any increase in suspended sediment will be spatially constrained to the works area, short-term in duration and reversible once construction ceases. Given the distance between the works footprint and the main estuary channel used by migratory fish, and the very low predicted vibration levels at receptor locations, the magnitude

of impact on fish species is assessed as low. Effects are expected to be localised and short-term, with a low probability of occurrence in the absence of direct in-water works. Accordingly, the potential impact on Annex II fish species during the construction phase is assessed as not significant.".

The project area is located within the WWTP and Corcanree Pumping Station site boundaries, with no in-river works proposed. Consequently, there is no potential for direct impacts to fish eggs or juveniles in the estuary. Indirect risks, such as sediment-laden runoff during construction, will be managed through the Surface Water Management Plan and best-practice controls outlined in the CEMP.

Marine Mammals

The Lower Shannon Estuary SAC supports a resident population of bottlenose dolphins, which have been observed using the estuary up to and beyond Limerick Docks (Englund *et al.*, 2008; Berrow *et al.*, 2022). Although the core range of this population tends to be further downstream, individuals may occasionally transit through or forage near the construction site. Otters are also present throughout the estuary, although no holts have been recorded within the immediate footprint of the proposed development.

Potential disturbance during construction primarily relates to increased human presence and general airborne noise associated with site operations at the WWTP and Corcanree Pumping Station. No in-river works are proposed, and the construction programme does not require night-time working. The construction strategy confirms that works are confined to land-based environments within an already industrialised and operational docklands setting, where existing vessel movements and anthropogenic activity occur routinely.

Underwater noise has been considered with reference to Chapter 10 (Noise & Vibration), which confirms that there are no planned impulsive underwater noise sources such as percussive piling, and that predicted ground-borne vibration will dissipate to below detectable levels before reaching the estuary. Airborne noise associated with construction plant will remain within established threshold criteria at identified receptors and is not predicted to produce levels that could adversely affect marine mammals using the outer estuary. On this basis, significant disturbance to bottlenose dolphins, otter, or seals is not anticipated.

Any behavioural responses, such as short-term avoidance of the immediate vicinity, would be localised, sporadic, and fully reversible. No auditory injury or masking effects are expected, given the absence of high-intensity underwater noise sources.

Accordingly, taking account of the construction strategy, the noise and vibration predictions, the absence of in-water works, and the existing industrial context, the magnitude of impact on marine mammals is assessed as low. Effects will be short-term and confined to the construction phase only (local extent) and reversible in nature. Based on the limited potential for disturbance and the lack of a direct underwater noise pathway, the probability of occurrence is considered low and the potential impact on bottlenose dolphins, seals and otter during the construction phase is assessed as not significant.

Water Quality

Short-term deterioration of water quality due to sediment-laden runoff or accidental release of contaminants (*e.g.*, hydrocarbons, cementitious materials) during construction poses a low but plausible risk to aquatic ecology. However, all works are confined to the WWTP and Corcanree Pumping Station site boundaries, with no in-stream activities proposed. The magnitude of any construction-related impact on estuarine water quality is considered low, with effects confined to terrestrial construction areas and indirect drainage pathways only (local extent). Any change would be short-term in duration and fully reversible once construction ceases, and the probability of occurrence is low given the absence of in-river works and the limited hydrological connectivity to the estuary. On this basis, potential impacts on water quality during the construction phase are assessed as not significant. The estuarine environment in this area already receives a complex mixture of organic and nutrient inputs from upstream agricultural sources (AQUAFACT, 2011; Kelly *et al.*, 2015). However, given that the construction footprint is approximately 0.5 km from the main estuary channel and all works are land-based with robust mitigation measures in place, the likelihood of acute pollution events causing fish kills or widespread invertebrate mortality is extremely low. Potential effects would be limited to accidental spills within the site, which will be managed through the Surface Water Management Plan and emergency response

procedures. Strict construction environmental management, including the implementation of a Construction Environmental Management Plan (CEMP), and spill prevention protocols (Section 12.5.1), will mitigate these risks.

TABLE 12-1: SUMMARY OF CONSTRUCTION PHASE IMPACTS ON MARINE BIODIVERSITY.

Receptor	Impact Type	Likely Significance	Mitigation Required
Benthic Invertebrates	Localised disturbance from construction activity and sediment mobilisation	Not significant (short-term; low magnitude; local extent; reversible)	Yes (CEMP)
Fish Species	Noise, turbidity, migration impact	Not significant (short-term; low magnitude; local extent; reversible)	Yes (Noise & vibration management; sediment & pollution control)
Marine Mammals	Noise disturbance	Not significant (short-term; negligible to low magnitude; local extent; reversible)	Yes (Good practice noise and site management; land-based works only)
Water Quality	Pollution, sediment resuspension	Not significant (short-term; low magnitude; local extent; reversible))	Yes (CEMP; spill prevention and response)

12.4.2 Operational Phase

Following completion of the Proposed Development, the operational phase is expected to result in improved discharge characteristics to the receiving waters. However, ongoing operation of the facility may continue to exert certain pressures on marine biodiversity, particularly in the freshwater tidal stretch of the Shannon Estuary into which treated effluent is released. This section assesses the potential operational impacts on benthic invertebrate communities, estuarine and migratory fish species, and protected marine mammals.

Effluent Discharge and Water Quality

The most significant operational interaction with the aquatic environment will be through the continued discharge of treated effluent into the estuary. Under the existing regime, the Limerick WWTP has been shown to contribute to nutrient and organic enrichment in the immediate receiving waters (AQUAFACT, 2011,). This influence, however, is superimposed upon substantial background loading from upstream agricultural runoff and diffuse urban sources in the Shannon catchment (Kelly *et al*., 2015; NPWS, 2012a).

A detailed assessment of predicted operational water quality conditions is presented in Chapter 16 (Water Environment) supported by 3D numerical hydrodynamic modelling (Royal HaskoningDHV, 2024). The modelling results indicate that operational discharges from the upgraded WWTP will lead to small and highly localised increases in nutrients and BOD concentrations relative to the existing baseline, with mixing zones restricted to the immediate vicinity of the outfall and no material deterioration of estuary-wide water quality or EQS status. Improved treatment standards further reduce the spatial extent and magnitude of water quality change near the outfall. Accordingly, any potential ecological effects on estuarine species and habitats are predicted to be not significant, with a low magnitude of change confined to the immediate mixing zone (local extent) and long-term in duration but readily assimilated within natural estuarine processes. These outcomes are based on modelling of the proposed operational scenario, which reflects improved effluent quality and the dispersive characteristics of the estuary.

Although the upgraded plant will discharge a higher total volumetric load, leading to small and spatially limited increases in nutrient concentrations in the immediate receiving waters, effluent quality will improve substantially, resulting in an overall reduction in pressure on the estuary and a neutral to slight positive operational effect at estuary scale.

Benthic monitoring data indicate that the existing communities downstream of the discharge point are dominated by opportunistic oligochaete taxa such as *Limnodrilus spp.* and *Tubifex tubifex*, which are tolerant of high organic content and low oxygen conditions (Budd, 2003). Hydrodynamic and water quality modelling for the upgraded WWTP indicates that future changes in BOD and nutrient concentrations will be small and spatially restricted to the immediate mixing zone, with no wider deterioration in estuary-scale water quality (Royal HaskoningDHV, 2024). While local reductions in organic loading may support a gradual shift towards more diverse and sensitive benthic assemblages close to the outfall, the extent of measurable change is likely to remain limited by the prevailing freshwater tidal conditions, background estuarine variability, and substantial upstream nutrient inputs.

Based on the design objectives and modelling results presented in Chapter 3 (The Proposed Development), the operational phase of the upgraded WWTP is expected to improve effluent quality and reduce storm overflow frequency, thereby enhancing compliance with the Urban Wastewater Treatment Directive. The proposed AGS process and sludge treatment upgrades will increase treatment efficiency and resilience to peak flows, while the new stormwater storage tank will significantly reduce untreated discharges to the estuary (from approximately 300 spills per year to fewer than 20, as per DAP modelling). Consequently, effluent-related impacts during operation are assessed as not significant, with a low magnitude of change confined to the immediate mixing zone (local extent), long-term in duration but readily assimilated within natural estuarine processes. No adverse effects are predicted on designated benthic community types or the conservation features of the Lower Shannon Estuary SAC.

Fish Species and Habitat Quality

Fish species present in the estuary, including Annex II migratory species such as Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), and river lamprey (*Lampetra fluviatilis*), may benefit from improved water quality and lower organic loading in the estuarine waters Kelly *et al.*, 2015; NPWS, 2012a). Reduced nutrient and suspended solids concentrations can enhance dissolved oxygen levels and reduce the risk of hypoxic events, particularly during warmer months.

While the freshwater tidal zone in which the discharge occurs is not known to support key spawning habitats, it functions as a migratory corridor for diadromous fish species. Hydrodynamic and water quality modelling indicates that any operational changes in nutrient and BOD concentrations will be of low magnitude and confined to the immediate mixing zone (local extent), with no measurable alteration of estuary-wide conditions relevant to fish movement or habitat use. Potential adverse effects associated with thermal enrichment or changes in flow regime are not predicted during operation. The upgraded WWTP will continue to discharge via the existing outfall pipe, contributing only a very small proportion of overall Shannon Estuary flow, such that the discharge cannot influence flow patterns. In addition, no material temperature differential is expected between treated effluent and receiving waters, and thermal effects are therefore considered to be of negligible magnitude.

Overall, the operational discharge is predicted to have a not significant effect on fish species, with a low magnitude of change limited to the local mixing zone, long-term in duration and readily assimilated within natural estuarine processes. The probability of adverse effects is low given the dispersive capacity of the estuary and the absence of predicted change in ecological conditions relevant to migratory behaviour.

Marine Mammals

The operational discharge occurs within the Lower Shannon Estuary SAC, which is designated for the protection of a resident population of bottlenose dolphins. While the core range of the population is concentrated further downstream, dolphins are known to occasionally travel into the upper estuary including the Limerick WWTP area (Berrow *et al.*, 2010; Berrow *et al.*, 2022).

Operational discharges have the potential to influence marine mammals indirectly through changes in prey availability or habitat conditions. Hydrodynamic and water quality modelling undertaken for the upgrade indicates that any post-upgrade changes in nutrient and BOD concentrations will be of low magnitude and confined to the immediate mixing zone (local extent), with no measurable alteration of estuary-wide water

quality or ecological status (Royal HaskoningDHV, 2024). Accordingly, no change in prey abundance or distribution is anticipated and the probability of adverse effects is low.

Otters, which are also a Qualifying Interest of the SAC, are unlikely to be affected given the absence of disturbance to shoreline habitats used for foraging or resting and the lack of any predicted change to prey resources

No underwater noise generation or other direct operational pathways (*e.g.*, vessel activity or physical barriers) are associated with the upgraded WWTP. On this basis, the potential impact on bottlenose dolphins, seals and otter during the operational phase is assessed as not significant.

Invasive Species

The operational discharge of treated effluent is not expected to create new pathways for the introduction of non-native invasive species. Hydrodynamic and water quality modelling undertaken for the WWTP upgrade indicates that predicted changes in BOD, DIN and MRP concentrations will be small in magnitude and confined to the immediate mixing zone, with no wider alteration in estuary-scale water quality or chemical status (Royal HaskoningDHV, 2024). The upgraded WWTP will therefore not produce the type or scale of environmental change that could create more favourable conditions for invasive aquatic species. Zebra mussel (*Dreissena polymorpha*), already present within the Shannon catchment (Minchin et al., 2002), is primarily associated with high-clarity, low-turbidity freshwater systems; no change to turbidity, salinity or nutrient status of this magnitude is predicted.

Accordingly, the probability of conditions becoming more favourable for opportunistic or invasive species as a result of the upgraded discharge is considered to be low, as any water quality changes will be of low magnitude and confined to the immediate mixing zone (local extent), with no predicted alteration of estuary-wide ecological conditions.

Monitoring of the treated effluent outfall and associated storm water overflows (SWOs) will continue under existing regulatory requirements. The WWTP upgrade, including stormwater storage capacity and treatment process improvements, will reduce overflow frequency and improve effluent reliability, further lowering the likelihood of episodic water quality variation.

Overall, the potential impact on invasive species during operation is assessed as not significant, with effects, if present, being long-term, localised, readily assimilated within natural estuarine processes and of low probability given the absence of a viable mechanism for habitat or community change.

Hydrodynamic and water quality modelling indicates that operational changes in nutrient and BOD concentrations will be low in magnitude and confined to the immediate mixing zone, with no measurable alteration of estuary-wide ecological conditions. As such, no significant adverse effects on benthic assemblages, migratory fish species, otter, bottlenose dolphin, or other estuarine receptors are predicted.

TABLE 12-2: SUMMARY OF OPERATIONAL PHASE IMPACTS ON MARINE BIODIVERSITY.

Receptor	Impact Type	Likely Significance	Mitigation / Management
Benthic Invertebrates	Exposure to treated effluent within the local mixing zone	Not significant (long-term; low magnitude; local extent; low probability)	Effluent quality controls
Fish Species	Continued exposure to treated effluent	Not significant (long-term; low magnitude; local extent; low probability)	Compliance with discharge licence; routine monitoring
Marine Mammals	Indirect exposure through prey or habitat conditions	Not significant (long-term; low magnitude; local extent; low probability)	Standard operational management only
Invasive Species	Conditions favouring colonisation	Not significant (long-term; low magnitude; local extent; very low probability)	Operational management and licence controls only

12.5 Mitigation Measures

12.5.1 Construction Phase

To minimise potential adverse impacts on marine biodiversity during the Construction Phase of the Limerick WWTP Upgrade Project (Table 12-1), a suite of targeted mitigation measures will be implemented. These measures are aligned with best practice guidance, ecological sensitivities identified in the survey area, and statutory obligations under the EU Habitats and Birds Directives.

Mitigation measures will be implemented through the CEMP, which will be developed into a detailed CEMP by the appointed contractor. The CEMP will set out comprehensive procedures to avoid or minimise environmental risk during construction, including measures relating to surface water management, noise and vibration, dust, traffic, waste and emergency response. All construction works will be undertaken in accordance with this plan and with relevant legislation and guidance.

The CEMP will define roles and responsibilities, including a suitably qualified Environmental Manager (EM) responsible for overseeing environmental performance, monitoring compliance, and implementing corrective actions where required. The CEMP will be a live document, subject to regular review and update throughout the construction phase in accordance with project requirements and regulatory conditions**.**

Sediment Control and Water Quality Protection

A Construction CEMP has been prepared and submitted as part of the planning application (Appendix 4.1 in Volume 4). The CEMP will incorporate all relevant mitigation measures identified in this EIAR and the Natura Impact Statement, including measures to prevent sediment-laden runoff and pollution from entering surface water drainage pathways connected to the estuarine environment.

The CEMP will set out detailed procedures for surface water management, including the implementation of appropriate sediment control measures (*e.g.* silt fencing, settlement systems and controlled drainage), pollution prevention measures, and site-specific emergency response protocols. These measures will ensure that any potential for sediment mobilisation or contaminant release during construction is appropriately controlled.

Although the site is approximately 0.5 km from the main Shannon Estuary channel, there are surface water drains throughout the WWTP and Corcanree Pumping Station sites that discharge to the adjacent lake and Ballinacurra Creek. Settlement ponds or silt traps will be employed in all areas where surface water runoff may occur. Discharges from construction areas will comply with the Environmental Quality Standards (EQS) for turbidity and suspended solids. Continuous monitoring is not anticipated but may be deployed if risk levels require heightened control.

All excavation groundwater and surface water runoff will be fully contained and managed in a controlled system. No uncontrolled discharge to ground, drainage features or the receiving environment will be permitted. Water arising from dewatering will be collected in lined sumps and treated, for example by settlement tanks or equivalent treatment, prior to discharge. Final treated water will be required to achieve a suspended solids concentration of less than 35 mg/L prior to discharge. Dewatering infrastructure, including sumps, pumps, pipework and tanks, will be inspected weekly and following significant rainfall events, with records maintained.

All construction materials and stockpiles will be stored within designated compound areas and away from site drainage points to prevent sediment or contaminant runoff to adjacent watercourses.

Existing drainage features within and adjacent to the construction areas will be identified and clearly demarcated prior to the commencement of works. Localised silt fencing and other sediment control measures will be installed at points where construction activities interface with drainage pathways or where there is a risk of sediment migration. Exposed soils will be minimised through sequencing of works and areas not actively under construction will be stabilised as soon as practicable. Stockpiles will be located within the active construction footprint and managed using bunding, covers or temporary stabilisation to prevent erosion and runoff. Sediment control measures will be inspected weekly, and following significant rainfall events, with any

damaged or ineffective controls repaired promptly. Where reasonably possible, bulk earthworks will be undertaken during drier periods to reduce sediment generation.

Construction materials, stockpiles, plant and hazardous substances will not be stored in areas identified as being at risk of flooding. Where relevant, temporary flood protection and containment measures will be deployed if weather forecasts or water levels indicate increased flood risk, and drains, sumps and pumping systems will be maintained to prevent uncontrolled release.

Noise and Vibration Management

Construction activities will be carried out in accordance with standard good practice controls to minimise noise and vibration, including the use of modern, well-maintained plant; avoidance of unnecessary engine idling; implementation of noise barriers where required; and adherence to site working hours. Predicted noise and vibration levels are well below thresholds at sensitive estuarine receptor locations, and no underwater noise mitigation is required, as there will be no in-water piling, percussion, excavation or other impulsive noise sources.

Pollution Prevention Measures

Refuelling, plant maintenance, and fuel or chemical storage will take place within designated bunded areas located at least 10 m from drainage features and outside mapped flood zones. Oils and fuels will be stored in bunded tanks with 110% retention capacity. No refuelling will take place within 10 m of the excavation perimeter or drains, and vehicles will not be left unattended during refuelling.

All machinery will use biodegradable hydraulic oils where possible and be subject to daily inspection for leaks.

A Spill Response Plan will be in place, including staff training and spill kits on site.

Cementitious and other hazardous materials will be handled in designated areas with controlled washout procedures to prevent discharge to drainage pathways.

The contractor will comply with relevant Control of Substances Hazardous to Health (COSHH) and Safety, Health and Welfare at Work (Chemical Agents Regulations) requirements.

Monitoring and Ecological Supervision

Baseline ecological and water quality conditions have been established through surveys and modelling undertaken to inform this EIAR. Construction-phase monitoring will therefore focus on verifying the effectiveness of mitigation measures and ensuring compliance with environmental requirements, rather than reproducing baseline datasets.

Monitoring and inspection will be undertaken by the Contractor under the supervision of the Environmental Manager, with support from suitably qualified ecological or aquatic specialists where required.

This will include:

- weekly inspections of drainage controls, sediment control measures, dewatering systems, fuel and chemical storage areas, and spill response equipment;
- additional inspections following significant rainfall events or where there is an increased risk of sediment mobilisation or pollutant release; and
- routine visual checks to confirm that no visible sediment-laden runoff or contamination is entering drainage pathways connected to Ballinacurra Creek or the Shannon Estuary.

Targeted water quality monitoring (*e.g.* turbidity or suspended solids measurements) will be undertaken where there is a risk of discharge to drainage pathways, including during dewatering activities or where control measures are compromised.

Where monitoring or inspections identify ineffective controls, elevated turbidity, or any evidence of pollutant release, corrective actions will be implemented immediately, including repair or replacement of control

measures, modification of working methods, and, where necessary, temporary cessation of relevant construction activities.

All inspections, monitoring results, incidents and corrective actions will be recorded and reported through the project's environmental compliance reporting procedures in accordance with the CEMP.

Conclusion

With the implementation of these mitigation measures, the Construction Phase of the Limerick WWTP upgrade is expected to have no significant negative residual impacts on marine biodiversity, including benthic invertebrates, migratory fish, and marine mammals. By implementing best practice construction methods, avoiding works during ecologically sensitive periods, maintaining strict pollution prevention controls, and ensuring ongoing environmental monitoring, the risk of significant adverse effects to benthic communities, fish populations, and marine mammals can be effectively mitigated.

12.5.2 Operational Phase

Operational mitigation measures are limited, as the upgraded WWTP will operate under an existing regulatory framework and discharge licence designed to protect water quality, estuarine habitats, and ecological receptors. The assessment concludes that operational effects are not significant (Table **12-2**), reflecting the low magnitude and localised extent of predicted water quality change within the mixing zone and the absence of any pathway for adverse effects on benthic communities, fish, marine mammals.

Compliance with Discharge Quality Standards

The Proposed Development will operate under a valid EPA Wastewater Discharge Licence (WWDL) and must adhere to the Urban Waste Water Treatment Regulations (UWWTR) (2001), as well as relevant European Directives (e.g. Water Framework Directive, Habitats Directive).

Effluent monitoring will be carried out routinely for key parameters, including Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Ammonia, Total Nitrogen (TN), and Phosphorus, to ensure compliance with emission limit values (ELVs).

The inclusion of advanced nutrient removal (e.g. nitrogen and phosphorus) and sludge treatment via Thermal Hydrolysis Process (THP) will help reduce the eutrophication risk downstream of the discharge point.

Hydrodynamic and water quality modelling indicates that future changes in nutrient and BOD concentrations will be of low magnitude and confined to the immediate mixing zone (local extent), with no measurable alteration of estuary-wide conditions.

Outfall Management

The existing 1.1 km outfall pipe to the Shannon Estuary will continue to be used, but flow balancing and operational adjustments will ensure a more even distribution of treated effluent, minimising the potential for acute localised water quality effects.

Effluent will be designed to remain within acceptable salinity thresholds to prevent deleterious changes in oligohaline benthic communities, particularly within the intertidal habitats dominated by *Tubifex tubifex* and *Limnodrilus* spp.

Ongoing Water Quality Monitoring

Operational water quality within the estuary is already subject to routine monitoring at established sampling locations. This programme will continue following the WWTP upgrade, providing an ongoing means of tracking estuarine water quality and compliance with relevant standards. Monitoring data will allow any unexpected changes in key parameters, including nutrients and dissolved oxygen, to be identified and addressed through the plant's operational management framework, if required.

Fish and Marine Mammal Protection

Although the WWTP operates under tertiary treatment, accidental deterioration in effluent quality could have effects on sensitive fish species such as salmonids and lamprey. To address this:

- A trigger-response protocol will be implemented whereby any exceedance of discharge licence emission limit values (ELVs) for key parameters (*e.g.* ammoniacal nitrogen, BOD, suspended solids) will result in immediate investigation by the WWTP operator, in accordance with site Environmental Management System procedures. This will include identification of the cause of the exceedance and implementation of appropriate corrective operational measures. Compliance with ELVs will be regulated and enforced by the Environmental Protection Agency (EPA) under the site discharge licence.
- In addition, any unexpected deterioration in receiving water quality, as identified through routine monitoring, will prompt review of plant performance and operational controls by the WWTP operator.
- In consultation with Inland Fisheries Ireland (IFI), an emergency response procedure will be implemented by the WWTP operator to minimise potential impacts on fish populations in the event of an effluent management failure, including notification procedures and implementation of corrective actions.

Stormwater overflows and operational reliability

The provision of a new stormwater storage tank, combined with enhanced process efficiency, will significantly reduce the frequency and duration of stormwater overflows. Storage capacity and automated controls will allow flows to be attenuated and returned to the treatment process following storm events. These measures will reduce the volume of partially treated effluent discharged to the estuary during extreme rainfall, further supporting the protection of receiving water quality.

Maintenance and Emergency Response

- All pumping, treatment, and monitoring equipment will be maintained on a strict preventive maintenance schedule to reduce the risk of leaks or untreated discharges.
- A SCADA-based automation and alarms system will provide real-time data to operators and enable rapid shutoff or rerouting in case of process malfunction.
- A site-specific Environmental Management Plan (EMP) will outline mitigation and containment strategies for potential spillages, system overloads, or mechanical failures.

Conclusion

With the implementation of these mitigation measures, the Operational Phase of the Limerick WWTP upgrade is expected to have no significant negative residual adverse impacts on marine biodiversity, including benthic invertebrates, migratory fish, and marine mammals. The improved treatment processes and increased capacity are expected to result in a neutral to slight positive effect on the ecological status of the estuarine receiving waters over the long term.

12.6 Residual Impacts

12.6.1 Construction Phase

The potential impacts of the Construction Phase of the Proposed Development were identified in Table 12-1. Following implementation of the mitigation measures described in Section 12.5, residual impacts on estuarine and marine biodiversity from the construction phase are predicted to be not significant.

Localised and short-term disturbance to benthic communities may occur where surface water drainage pathways convey small amounts of suspended sediment during groundworks; however, the magnitude of change will be low, effects will be confined to the terrestrial works area (local extent), and any disturbance will be short-term and fully reversible. Benthic assemblages recorded in the estuarine environment are characterised by oligochaete species tolerant of variable sediment conditions, and temporary change in the vicinity of the outfall, if present, is not expected to materially alter community composition or ecological functioning.

Potential effects on fish and marine mammals, including brief behavioural avoidance associated with airborne construction noise or increased human activity, are likewise predicted to be low in magnitude, local in extent, and temporary in duration. Noise and vibration predictions confirm that levels will remain well below disturbance thresholds at estuarine receptors, and no in-water works or impulsive noise sources are proposed.

No habitat loss, barrier effects or morphological change will occur, and no adverse effects on the qualifying interests or integrity of the Lower Shannon Estuary SAC are anticipated.

Overall, with mitigation in place, residual effects during the construction phase are assessed as not significant (low magnitude, local extent, short-term duration, fully reversible and low probability).

12.6.2 Operational Phase

The potential impacts of the operational phase of the proposed development were identified in Table 12-2. Residual effects arising during the operational phase relate primarily to the continued discharge of treated effluent to the Shannon Estuary. Hydrodynamic and water quality modelling confirms that any changes in nutrient and BOD concentrations will be low in magnitude and confined to the immediate mixing zone (local extent), with no measurable alteration of estuary-wide ecological conditions. As such, the discharge is not expected to alter habitat structure, ecological functioning, or prey availability for protected fish or marine mammal receptors, nor affect the integrity or conservation objectives of the Lower Shannon Estuary SAC.

Minor residual effects may occur at a very local scale close to the outfall where slight changes in water quality indicators may be detectable. However, these changes will remain well within the estuary's assimilative capacity and within licensed emission limits. Benthic communities within the receiving area comprise species tolerant of organic enrichment, and no measurable change in composition or abundance is predicted. No adverse long-term effects on estuarine or migratory fish, marine mammals, or benthic fauna are anticipated.

Overall, residual effects during operation are assessed as not significant (low magnitude, local extent, long-term duration, readily assimilated within natural estuarine processes and low probability).

12.7 Cumulative Impacts and Interactions

In accordance with the requirements of the EIA Directive and associated guidance, an assessment of cumulative impacts and interactions has been undertaken. This section considers how the Proposed Development, when combined with other past, present or reasonably foreseeable projects and plans, may result in significant effects on the receiving environment, particularly with regard to marine biodiversity and Natura 2000 sites, including the River Shannon and River Fergus Estuaries SPA and the Lower River Shannon SAC.

12.7.1 Plans

Plans that could interact collectively with the project include:

- Limerick Development Plan 2022-2028;
- Clare County Development Plan 2023–2029; and
- Strategic Integrated Framework Plan for the Shannon Estuary 2013-2020.

These plans support sustainable development and promote integrated management of the marine environment. They are not expected to result in any negative in-combination effects on the conservation objectives of the Natura 2000 sites.

12.7.2 Projects

Aquaculture and Fisheries

The closest aquaculture site is located over 25Km downstream from the Proposed Development. Ireland's marine atlas shows the closest fishing ground is pot fishing for shrimp over 44Km downstream of the Proposed Development.

SFPC Foynes Port Capacity Extension (An Bord Pleanála ref: 301561; MARA Ref: LIC230014);

The approved development involves the extension of port infrastructure at Foynes to support increased operational capacity and future industrial use. Key components of the project include:

- Construction of a new open-piled jetty with a 116.5 m suspended concrete deck, linking the existing West Quay to the East Jetty.
- Installation of quayside infrastructure such as fenders, mooring bollards, safety ladders, toe rails, and lighting columns.
- Structural upgrades and remedial works to the ends of the existing West Quay and East Jetty to enable integration with the new jetty.
- Relocation of the existing small craft pontoon and walkway, currently situated between the West Quay and East Jetty, to a new position on the western side of the West Quay wall.
- All necessary supporting site development works (e.g. maintenance dredging - Foreshore licence: FS006975 and Dumping at Sea permit: S0009-03).

In addition, the development includes a phased expansion of the port estate over approximately 33.95 hectares of adjoining land to the east. This area will be prepared to accommodate serviced industrial plots for marine-related industries, port-centric logistics, and supporting infrastructure, delivered in line with a comprehensive development framework for the expanded site.

Moneypoint Hub Project (An Bord Pleanála refs 319080, 307798; MARA Ref: MARA Ref: LIC230008)
The proposed Moneypoint Hub Project is a strategic transformation of the existing ESB coal-fired power station at Moneypoint, Co. Clare, into a green energy hub designed to support Ireland's decarbonisation goals and the Shannon Estuary Economic Taskforce recommendations. Key components of the project include:

- Development of onshore renewable energy generation and battery storage infrastructure, including substations and associated grid connection infrastructure.
- Construction of offshore renewable energy support infrastructure, such as facilities for assembly and maintenance of offshore wind turbine components.
- Provision of hydrogen production and storage facilities, forming part of a long-term vision to establish a hydrogen supply chain and refuelling hub.
- Upgrades and repurposing of existing industrial land and port infrastructure at Moneypoint to facilitate energy transition technologies.
- Surveys and assessments authorised under a Marine Survey Licence granted by MARA (Ref: LIC230008), supporting the offshore elements of the project.

The project is expected to result in increased marine traffic and industrial activity in the Shannon Estuary, particularly during construction phases. While located downstream of the Limerick WWTP, shared estuarine receptors such as migratory fish species, marine mammals, and water quality could be subject to cumulative environmental pressures when considered in combination with other development in the estuary.

Aughinish Alumina Ltd Expansion and Operations (EPA Industrial Emissions Licence Reg. No. P0035-07; MARA Ref: LIC230004)
Aughinish Alumina Ltd operates a major alumina refinery on Aughinish Island, Co. Limerick. The operation is regulated under an Industrial Emissions (IE) licence issued by the EPA, with recent permissions also granted for marine survey and dredging activities. Key components relevant to cumulative impacts include:

- Ongoing import and export of materials (e.g. bauxite and alumina) via the deepwater berth at Aughinish, contributing to vessel traffic and estuarine activity.
- Operation of the bauxite residue disposal area (BRDA), including engineered containment, leachate management, and long-term environmental monitoring.
- Abstraction and discharge of seawater for processing and cooling purposes, with potential influences on thermal and chemical characteristics of the receiving waters.
- Periodic maintenance dredging activities, permitted under MARA Licence LIC230004, to ensure navigational depth at the facility's berthing areas.

- Recent environmental infrastructure upgrades and modifications submitted to the EPA and local planning authorities, aimed at improving environmental performance and operational efficiency.

Cumulatively, activities at Aughinish Alumina contribute to the industrial and hydrodynamic pressures on the estuarine environment. When considered alongside other regional projects, including the proposed WWTP upgrade, there is potential for interaction in relation to water quality, sediment transport, noise disturbance, and aquatic species movement within the Shannon Estuary.

Gas Networks Ireland Strategic Gas Emergency Reserve Project (An Bord Pleanála Ref: PA08.322568; MARA Ref: MUL240034)

This strategic development, proposed by Gas Networks Ireland, involves the construction and operation of a liquefied natural gas (LNG) floating storage and regasification unit (FSRU) at a jetty in the Shannon Estuary, Co. Limerick. The project forms part of the national energy security strategy to ensure resilience of gas supply in emergency scenarios. The development is designated as strategic infrastructure under the Planning and Development Acts. Key components include:

- Installation of an FSRU vessel, moored permanently at the existing jetty in the estuary, capable of storing and regasifying LNG for injection into the national gas network.
- Development of onshore pipeline infrastructure and connection facilities to link the FSRU with the existing transmission system.
- Ancillary marine works including temporary moorings, marine survey activities, and navigational safety measures.
- Permission for marine survey activities under MARA Licence MUL240034.
- Supporting infrastructure such as control buildings, utility connections, and access roads within the Shannon Integrated Framework Plan (SIFP) industrial area.

The proposed project introduces a new industrial activity with the potential for significant in-combination effects with other estuarine developments. Key cumulative considerations include increased vessel movements, underwater noise, habitat disturbance, and potential water quality impacts.

Limerick City and Environs Flood Relief Scheme (ABP Ref: 312559)

The proposed development involves the implementation of a comprehensive flood relief scheme designed to mitigate flooding in Limerick City and its surrounding environs. The key elements of the scheme include:

- Construction of new flood embankments and walls along key stretches of the River Shannon and other watercourses within Limerick City.
- Enhancement of existing flood defences to increase resilience to extreme flood events.
- Installation of flood gates, sluices, and other water control infrastructure at critical locations.
- Implementation of flood mitigation works at strategic areas, including properties, roadways, and infrastructure vulnerable to flooding.
- Construction of improved stormwater drainage systems to manage floodwater runoff.
- Modifications to various bridges and other structures to facilitate floodwater flow management.

The scheme aims to reduce the risk of flooding to over 1,000 properties and significant infrastructure in Limerick City. An Environmental Impact Assessment Report (EIAR) and Natura Impact Statement (NIS) have been prepared to evaluate the potential environmental impacts, including effects on local habitats, species, and water quality.

Conclusion

The assessment of cumulative impacts and interactions has considered the Proposed Development in the context of relevant regional plans and a range of existing and proposed developments within the Shannon Estuary. While each project has distinct objectives, construction timelines, and environmental controls, overlapping receptors such as water quality, estuarine habitats, migratory fish species, and marine mammals present potential for in-combination effects, particularly in relation to increased vessel activity, underwater noise, sediment disturbance, and hydrodynamic alteration.

However, with appropriate mitigation measures applied at project level, adherence to regulatory requirements, and ongoing environmental monitoring, the potential for significant adverse cumulative effects is considered low. The scale and location of the proposed WWTP upgrade, in conjunction with the nature of the receiving environment and distance from other large-scale developments, further reduce the likelihood of synergistic or additive impacts. Ongoing coordination between agencies and project proponents remains critical to ensuring that any residual or unforeseen cumulative impacts are identified and managed in a timely and integrated manner.

Overall, no cumulative or in-combination effects on marine biodiversity are predicted, and cumulative impacts are assessed as not significant

12.8 Difficulties encountered in Compiling Information

No major difficulties were encountered in the preparation of this chapter. However, some considerations around knowledge gaps are included as part of this section. While comprehensive benthic and water quality datasets exist for parts of the River Shannon Estuary, there is a relative scarcity of historical marine ecological data specifically within the Limerick Docks area and in the immediate vicinity of the WWTP outfall. Most previous studies have focused on more downstream or coastal areas of the Shannon Estuary, which made direct comparison with historical baselines difficult.

Data on the distribution and abundance of mobile marine species (such as migratory fish and marine mammals) within the freshwater tidal section of the Shannon Estuary is limited. While studies such as Berrow *et al*. (2010; 2022) and Kelly *et al*., 2015, provide broader ecological data in the area, information specific to usage of the Limerick Dock area by these species is scarce. This required inference based on wider estuary data and habitat suitability.

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