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KING'S ISLAND FLOOD RELIEF SCHEME

King's Island Flood Relief Scheme
Environmental Impact Assessment Report
Volume 2 - EIAR Report

Final Report

December 2019

Comhairle Cathrach & Contae Luimnigh

Limerick City & County Council

OPW

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This report describes work commissioned by Limerick City & County Council as part of the King's Island Flood Relief Scheme. Emily Rick and Bernadette O'Connell of JBA Consulting, and Ken Leahy of Arup carried out this work.

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Purpose

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Abbreviations

AA	Appropriate Assessment
ACA	Architectural Conservation Area
CEMP	Construction Environment Management Plan
CFRAM	Catchment Flood Risk Assessment and Management
CTMP	Construction Traffic Management Plan
DEHLG	Department of Environment, Heritage and Local Government
DOECLG	Department of Environment, Community and Local Government
DHPLG	Department of Housing, Planning and Local Government (Formerly DECLG)
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
ESB	Electricity Supply Board
EU	European Union
FDL	Flood Defence Level
FRS	Flood Relief Scheme
IFI	Inland Fisheries Ireland
KER	Key Ecological Receptors
MCA	Multi-Criteria Analysis
MWASP	Mid-West Area Strategic Plan
NIAH	National Inventory of Architectural Heritage
NPF	National Planning Framework
NPO	National Policy Objective
NPWS	National Parks and Wildlife Service
NWRMs	Natural Water Retention Measures
OPW	Office of Public Works
PCD	Public Consultation Day
RBMP	River Basin Management Plan
SAC	Special Area of Conservation
SFRA	Strategic Flood Risk Assessment
SIFP	Strategic Integrated Framework Plan
SMR	Sites and Monuments Records
SOP	Standard of Protection
SPA	Special Protection Area

SUDS	Sustainable Urban Drainage System
WFD	Water Framework Directive
ZON	Zones of Notification

1 Introduction

1.1 Context and Project Background

King's Island lies in the heart of Limerick City and is surrounded by the waters of the River Shannon and the Abbey River, see Figure 1-1 Site Location Map overleaf.

Both rivers are tidal at this location and the island is historically susceptible to both tidal and fluvial flood risk. King's Island and the surrounding area was badly flooded in early 2014 when there was an extremely high tide that overtopped the embankments around the Island and caused them to fail in one location. Further flooding was experienced in 2016 as a result of another storm surge event in the Shannon Estuary. This flooding was confined to Merchants Quay, as the sandbags around the Island contained the tidal surge.

A major improvement on the existing temporary flood defences is required to reduce the frequency of extreme events which inundate the island. Accordingly, following a public competition, JBA Consulting/Arup, were commissioned by Limerick City & County Council (LCCC) to provide engineering and environmental services for the King's Island Flood Relief Scheme (the proposed FRS). This proposed flood relief scheme (FRS) will be designed to provide protection to properties in the study area from the 1 in 200-year tidal flood event (0.5% AEP event).

There are five stages in the project:

Stage I – Development of a number of flood defence options and the identification of a preferred Scheme.

Stage II – Planning & Detailed Design.

Stage III & IV – Tender & Construction.

Stage V – Project Close-Out (Handover to Client).

This Environmental Impact Assessment Report (EIAR) is produced as part of Stage II of the project. It follows on from work carried out to date and should be read in conjunction with the earlier Constraints Study[1], Options Assessment Report[2] and the EIAR Scoping Report[3].

1.2 Scheme Objectives

The overarching objective of the project is to:

"*…to assess, develop and design an appropriate viable, cost-effective and sustainable flood relief scheme which aims to minimise risk to human beings, the existing community, social amenity, environment and landscape character.*"

The scheme is to be developed primarily to protect the affected areas against fluvial and tidal flooding. In addition, consideration will be given to the potential impact of any flood relief scheme on groundwater and pluvial flood risk. The target standard of protection (SOP) is the 0.5% AEP tidal event.

1.3 Legislative basis of the Environmental Impact Assessment Report (EIAR)

The requirement for assessment of the effects of certain public and private projects on the environment is set out in European law.

[1] Constraints Study for Flood Relief Scheme at King's Island, Limerick. V1 December 2015, JBA Consulting and Arup for Limerick City and County Council
[2] Options Assessment Report for Flood Relief Scheme at King's Island, Limerick. V5 August 2018, JBA Consulting and Arup for Limerick City and County Council
[3] EIAR Scoping Report for Flood Relief Scheme at King's Island, Limerick. V3 December 2018, JBA Consulting and Arup for Limerick City and County Council

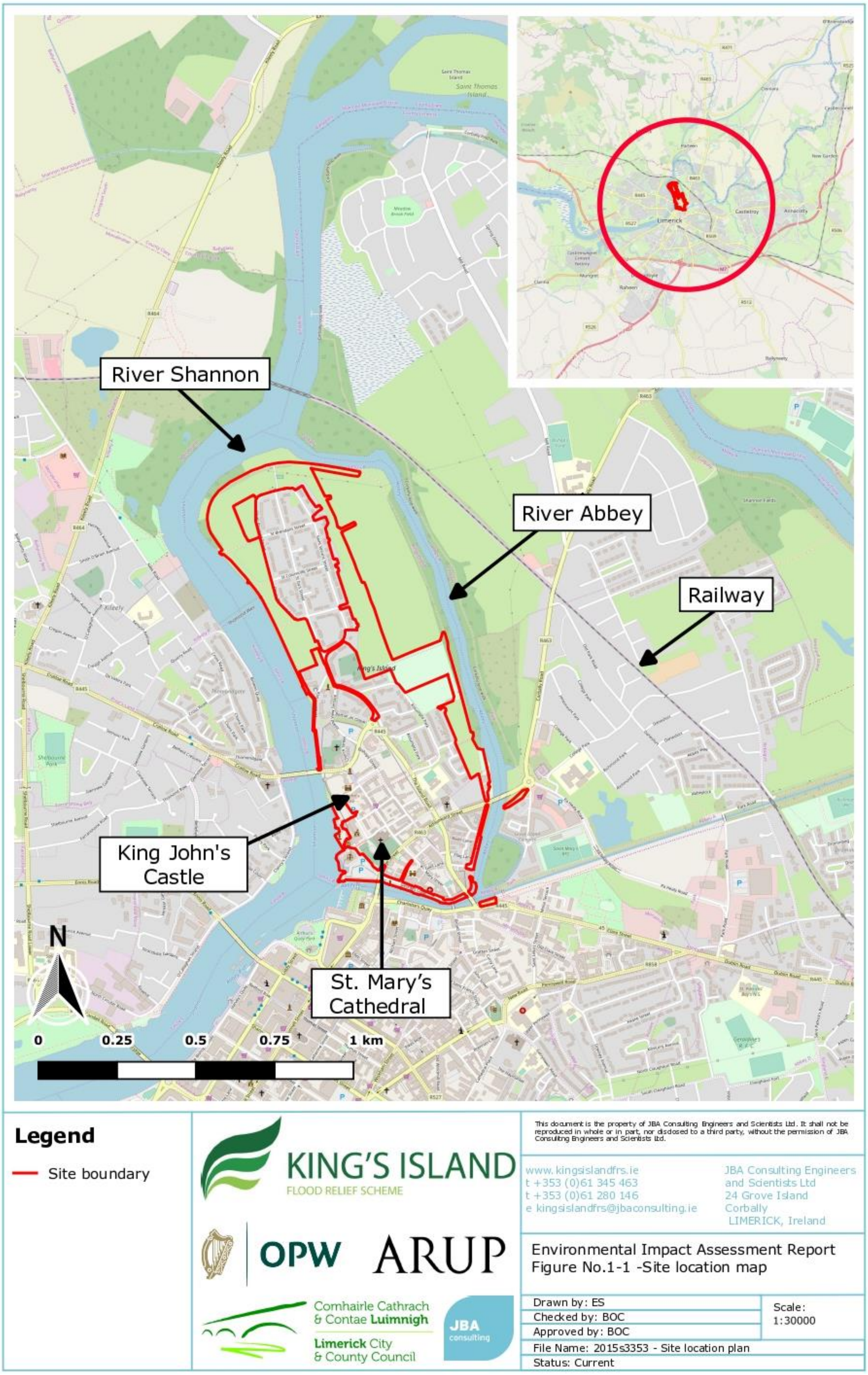

Figure 1-1. Site Location Map

European Council (EC) Directive No. 85/337/EEC[4] as amended by EC Directive No. 97/11/EC[5], EC Directive No. 2011/92/EU[6] and EC No. Directive 2014/52/EU[7] (hereafter collectively referred to as 'the EIA Directive') under Article 5(1): 'Where an environmental impact assessment is required, the developer shall prepare and submit an environmental impact assessment report.'

1.3.1 The EIA Directive

The EIA Directive is transposed into Irish law through the European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 (S.I. No. 296 of 2018). The new Regulations transpose the requirements of Directive 2014/52/EU, amending previous Directive 2011/52/EU, on the assessment of the effects of certain public and private projects on the environment (the EIA Directive) into planning law with effect from 1st September 2018.

The new Directive adapts a new title for environmental impact assessment as Environmental Impact Assessment Report. For the purposes of this assessment JBA will use the term Environmental Impact Assessment Report (EIAR) to describe the final report for this assessment.

The new Directive is designed to "strengthen the quality of the environmental impact assessment procedure" and it notes that environmental issues, including natural resources, sustainability, biodiversity and climate change have become more important in policy making and must, therefore, be at the forefront of the environmental assessment and decision-making processes.

The EIAR will be undertaken in accordance with the requirements of Directive 2014/52/EU on the assessment of the effects of a development on the environment. The EIAR will also be undertaken in accordance with:

- EPA's Draft Guidance Note on the Preparation of Environmental Impact Statements (2015);
- EPA's Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (May 2017); and
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (August 2018).

1.4 Scope and Content of the EIAR

1.4.1 Initial Screening

A combined EIAR Screening and Scoping Opinion was carried out for the project by letter date 25th June 2019 and sent to An Bord Pleanála. The letter outlined that Limerick Council wishes to prepare a Planning Application to An Bord Pleanála, under Section 226(1), of the Planning and Development Act, 2000 (as amended), for the construction of a Flood Management Scheme for Kings Island, Limerick, where development is proposed to be carried out wholly or partly on the foreshore by a local authority that is a planning authority.

The prescribed classes of development and thresholds that trigger a mandatory Environmental Impact Assessment (EIA) are set out in Schedule 5 of the Planning and Development Regulations, 2001, as amended. A review of the classes of development requiring EIA was carried out to determine whether the proposed FRS falls into any of the development classes contained therein. The most relevant criterion is Class 10 of Part 2 of Schedule 5 which states:

10. Infrastructure projects

(f) (ii) Canalisation and flood relief works, where the immediate contributing sub-catchment of the proposed works (i.e. the difference between the contributing catchments at the upper and lower extent of the works) would exceed 100 hectares or where more than 2 hectares of wetland would be affected or where the length of river channel on which works are proposed would be greater than 2 kilometers. (S.I. No.600/2001- Planning and Development Regulations 2001)

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[4] EC Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment, *Official Journal of the European Union* No. L 175, 05/07/1985.
[5] EC Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment. *Official Journal of the European Union* No. L 073, 14/03/1997.
[6] EC Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of effects of certain public and private projects on the environment. *Official Journal of the European Union* L 26, 28/1/2012.
[7] EC Directive 2014/52/EU of 6 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment, *Official Journal of the European Union* No. L 124/1, 25/04/2014.

In the case of the proposed Flood Management Scheme for Kings Island, Limerick, the length of river channel on which works are proposed is 3.7km. An EIAR of the proposed scheme is therefore required to be prepared and submitted to support the planning application. The requirements in respect of Environmental Impact Assessment are contained within the Planning Act and these are described in more detail in Chapter 2 - Planning and Legislation Policy. Similar legal requirements in respect of Appropriate Assessment are also set out in the Planning Act and these are summarised in Chapter 5. A Natura Impact Statement will be submitted in support of the planning application.

1.4.2 Stages of the EIAR

The EIAR for the planning application has been undertaken in two stages. First a scoping assessment was undertaken in order to identify the key elements that would have the potential to result in impacts on the environs of the site. This scoping exercise also assisted in determining the nature and level of detail of information to be contained in the EIAR, in essence the scoping formed the terms of reference for the EIAR. The Scoping Report was circulated to statutory consultees and key stakeholders, the responses are summarised in Chapter 5.

The second stage of the EIAR is the assessment of effects of those subjects deemed necessary in the Scoping Report because of a potential significant change in the level of impact. The assessment of effects is reported in Chapters 6 to 16 of this document.

1.4.3 Structure of EIAR

The EIAR is comprised of the following volumes:

- Volume 1: The Non-Technical Summary;
- Volume 2: The EIAR (this volume) including Appendices;
- Volume 3 (A3 sized document) Figures; and
- Volume 4 (A3 sized document) Photomontages

The assessment follows the 'grouped format' as set out in the EPAs guidance document (2002):

- The baseline conditions for the environmental aspects are described;
- The effect of the proposed FRS on the environment is assessed and described; and
- Mitigation measures to remedy/reduce the significant impacts are given.

The structure of this EIAR is set out as follows:

1. Introduction
2. Legislation and Planning Policy
3. Constraints, Alternatives Considered, Options, Scoping
4. Description of Proposed FRS
5. Consultation
6. Population and Human Health
7. Material Assets incl Traffic, Utilities and Waste Management
8. Biodiversity
9. Surface and Groundwater
10. Soils and Geology
11. Noise and Vibration
12. Air Quality, Dust and Climate Change
13. Landscape and Visual
14. Cultural Heritage
15. Interaction between environmental aspects
16. Cumulative Impacts
17. Summary and Conclusion

Each environmental topic also addresses cumulative impacts as a result of nearby developments, which are further described in Chapter 16.

1.4.4 Impact Classification Terminology

Table 1-1 below presents the Impact Classification Terminology as published in the EPA guidance document[8]. Standard definitions are provided in this glossary, which permit the evaluation and classification of the quality, significance, duration and type of impacts associated with a proposed FRS on the receiving environment. The use of standardised terms for the classification of impacts ensures that the EIAR employs a systematic approach, which can be replicated where appropriate across all disciplines covered in the EIAR. The consistent application of terminology facilitates the assessment of the proposed FRS on the receiving environment.

Each impact is described in terms of its quality, significance, extent, duration & frequency and type, where possible. A 'Do-Nothing' impact is also predicted in respect of each environmental theme in the EIAR. Residual impacts are also presented following any impact for which mitigation measures are prescribed. The remaining impact types are presented as required or applicable throughout the EIAR.

Table 1-1. Impact Classification Terminology (EPA, 2017)[8]

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 baseline 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
Extent & Context	Extent	Describe the size of the area, number of sites and the proportion of a population affected by an effect
	Context	Describe whether the extent, duration, or frequency will conform or contrast with established (baseline) conditions
Duration and Frequency	Momentary	Effects lasting from seconds to minutes
	Brief	Effects lasting less than a day
	Temporary	Effects lasting less than a year
	Short-term	Effects lasting one to seven years
	Medium-term	Effects lasting seven to fifteen years
	Long-term	Effects lasting fifteen to sixty years
	Permanent	Effect lasting over sixty years
	Reversible	Effects that can be undone, for example through remediation or restoration
	Frequency	Describe how often the effect will occur. (once, rarely, occasionally, frequently, constantly – or hourly, daily, weekly, monthly, annually)

[8] Environmental Protection Agency (August 2017) *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* (Draft)

Type	Indirect	Impacts on the environment, which are not a direct result of the project, often produced away from the project site or because of a complex pathway
	Cumulative	The addition of many minor or significant effects, including effects of other projects, to create larger, more significant effects.
	'Do Nothing'	The environment as it would be in the future should the subject project not be carried out
	Worst Case	The effects arising from a project in the case where mitigation measures substantially fail
	Indeterminable	When the full consequences of a change in the environment cannot be described
	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

1.5 EIAR Project Team

1.5.1 Statement on Competent Expertise

The EPA Guidelines[9] requires that "the introduction to the EIAR should include a list of the experts who have contributed to an EIAR, showing which parts of the EIAR they have worked on, their qualifications, experience and any other relevant credentials". The EIAR has been prepared by a multi-disciplinary team of environmental specialists as set out in Table 1-2 below.

Table 1-2. EIAR Team and Qualifications

Consultants	Experienced/Competent Expert and qualifications	EIAR Chapter
JBA Consulting 24 Grove Island, Limerick V94 312N Ireland	Emily Rick BSc (Env) Bernadette O'Connell BA (Hons) MSc CMLI	NTS 1. Introduction 3. Constraints, Alternatives Considered, Options, Scoping Stages 4. Description of Proposed FRS 5. Consultation 7. Material Assets: Utilities and Waste Management 13.Climate Change 15. Interaction between environmental aspects 16. Cumulative Impacts 17. Summary and Conclusion
	David Casey BSc MSc MCIWEM Emily Rick BSc (Env)	9. Surface and Groundwater 10. Soil and Geology
	Tanya Slattery BSc MSc (Res) Patricia Byrne BSc (Hons) PhD MCIEEM Hannah Mulcahy, B.Sc., M.Sc. Niamh Burke BSc (Hons) PhD CEnv MCIEEM	8. Biodiversity
	Elena Sorbo Cert M.Arch Bernadette O'Connell BA (Hons) MSc CMLI	13. Landscape and Visual
Coakley O'Neill Town Planning Ltd NSC Campus	Deirdre Kiernan BA(Hons) MRUP Aiden O'Neill BSc (Hons), DipTCP, MIPI	2. Legislation and Planning Policy

[9] Environmental Protection Agency (August 2017) *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* (Draft)

Mahon Cork T12 XY2N		
Arup Hartstonge House, Upper Hartstonge St, Limerick, V94 F8XE, Ireland	Niamh O'Regan BE CEng MIEI Daniel Garvey BA(Hons) MSc CEnv MIEnvSc CGeog FRGS	7. Material Assets: Traffic 11. Noise and Vibration
Moore Archaeological and Environmental Services Ltd. Corporate House Ballybrit Business Park, Galway	Declan Moore B.A. I.A.I.	14. Cultural Heritage
AONA Environmental Consulting Ltd. (Trading as Envest), Unit 8A, Northwest Business Park, Sligo	Mervyn Keegan BSc MSc Pg Dip	12. Air Quality

1.6 Limitations and Assumptions

The limitations and assumptions related to the proposed FRS are as follows:

- **Waste Management**- During the construction phase of the project, fill material will be imported into the site for the construction of the embankments in the northern part of the scheme. Approximately 2,200 linear metres of embankment will be formed. The material will comprise 93,900m^3 of inert engineering fill, 43,000m^3 of landscape fill (class 4) and 6,700m^3 of topsoil, totalling 143,600m^3. The nett import of material has been reduced by the sustainable reuse of suitable excavated material from around the island as part of other construction works. Existing topsoil stripped from underneath the proposed embankments will be stockpiled on site and reused to finish the proposed embankments. Other suitable excavated material will be reused on site in areas of general landscape fill. This ensures that export of material from site will be negligible and will only arise where unsuitable or contaminated ground is encountered. The EIAR has not specified the source of the imported fill material. Nationally there is a shortfall in licenced waste capacity[10], indicating a surplus of waste material including soil and Construction and Demolition (C&D) waste. It is therefore assumed that sourcing suitable material will not be problematic prior to commencement of construction process scheduled for Autumn 2020. The source of the fill material may be from outside the Limerick area as only two licenced soil recovery facilities will be in operation in the Southern Region in 2020, these are located in Kilkenny and Cork. Consideration of Waste is reported in Chapter 7 Material Assets.
- **Biodiversity-** As part of the measures to mitigate impacts on the Opposite-Leaved Pondweed found in the northern part of the scheme, LCCC will carry out enhancement works to two additional sites elsewhere in the County where Pondweed has been recorded. The enhancement plan for these measures is currently in development under the guidance of the Department of Culture, Heritage and the Gaeltacht (National Parks and Wildlife Services). Implementation of the plan is likely to take up to 3 years. This plan has been agreed with LCCC and NPWS and is discussed in further detail in Chapter 8 Biodiversity.
- **Cultural Heritage**- Archaeological testing is scheduled for Spring 2020, subject to a pending application for Ministerial Consent, to inform the detailed design stage and to better define the exact location and extent of the Limerick City Walls and other associated structures. The description of the existing archaeological environment for Cultural Heritage is based on archaeological monitoring of Site Investigations which were undertaken in two Phases during 2016. The first Phase took place at Verdant Place in January 2016 under Ministerial Consent C720 (E004645 & R000402). No archaeological remains were discovered during the archaeological monitoring. Phase 2 of the Site Investigations was

[10] RPS (2015) *Construction and Demolition Waste, Soil and Stone Recovery/Disposal Capacity Eastern Midlands Region / Connacht Ulster Region / Southern Region Waste Management Plans 2015 - 2021* Report (Figure 4-4 Capacity Shortfall Profile).Dublin City Council.

undertaken during May and June 2016 when a total of 34 trial pits were excavated around the perimeter of King's Island. Archaeological features were recorded in eight of the pits. The location of the pits in which archaeological features were encountered are presented in Chapter 14 of this EIAR.

1.7 Viewing and Purchasing the EIAR

Copies of this EIAR, the Non-Technical Summary (NTS) and all associated documentation will be available for viewing at the offices of Limerick City and County Council.

2 Legislation and Planning Policy

2.1 Introduction

This section of the Environmental Impact Assessment Report considers the proposed FRS in the context of national, regional and local planning policy, and the legislation governing the proposed works.

2.2 Site Description

King's Island is situated in the centre of Limerick City, the island is formed as the Abbey River diverts from the River Shannon before converging again at the Potato Market, at the south west point of the Island. Both rivers are tidal in this location, therefore the island is susceptible to both tidal and fluvial flooding.

The island is characterised by two distinct areas, the northern portion is known as St. Mary's Park, a residential development of two storey semi-detached dwellings and surrounded by large open fields that act as a natural buffer running along the river's edge. Embankments form part of the river walk around the northern boundary of the island and are viewed as part of the natural landscape. This predominantly residential quarter is identified as Flood Cell A for the purposes of this EIAR.

To the south is Englishtown, which runs along the south west of the island, and is regarded as the historic core of Limerick City, home to cultural buildings like St. Mary's Cathedral and St. John's Castle and also includes restaurants, businesses and some residential dwellings built along the water's edge and is generally considered the more urban area of the island. Flood defence works are visible within the area, these include lengths of both formal and informal flood defences in the form of quay walls. However, there are no defences in place at the Potato Market or civic buildings on Merchant's Quay. For the purposes of this report the southern commercial area has been identified as Flood Cell B.

The road connections from the Island to the rest of Limerick City are located on the southern half of the Island; there are four main access routes, one from Thomond, one from Corbally, and two from the City Centre. There is limited access to St. Mary's Park with only one main entrance from Island Road. Roundabout onto St. Ita's Street, disconnecting it from the rest of the island.

2.3 The Need for Proposed Project

King's Island is surrounded by the River Abbey and River Shannon, both of which are influenced by the tide and therefore highly susceptible to tidal and fluvial flooding. King's Island and the surrounding area was badly flooded in early 2014 when there was an extremely high tide that overtopped the embankments around the Island and caused them to fail in one location. Further flooding was experienced in 2016 as a result of another storm surge event in the Shannon Estuary. This flooding was confined to Merchants Quay, the sandbags around the Island contained the tidal surge.

As the island is highly susceptible to flood events, major improvements to the existing temporary flood defences are required to reduce impacts and frequency of extreme events which inundate the island. JBA Consulting and Arup have been commissioned by Limerick City & County Council (LCCC) to provide the engineering and environmental services, which are the subject of this EIAR, and to deliver the King's Island Flood Relief Scheme.

The proposed FRS will be managed effectively with the correct measures. In the absence of the proposed FRS works flooding will persist and possibly worsen over time. The residual impacts of continuous flooding will damage and devalue properties in the area and affect long term regeneration plans for King's Island and its environs.

It is intended the works will enhance and fortify the existing measures in place and be able to withstand the likely increased frequency and severity of future flooding events. The works have been designed and developed with a primary focus to protect the affected areas against fluvial and tidal flooding. The scheme proposed herein is designed to provide protection to properties in the study area from the 1 in 200 year tidal flood event.

Support for enhanced flood protect is encouraged under the National Planning Framework, regional and local objectives, and further supported under European Union Policy for flood risk assessment and management. These objectives and goals are set out in section 2.4 and 2.5.

2.4 European Union (EU) Law and Policy

2.4.1 EU 'Floods' Directive 2007

The EU Directive on the assessment and management of flood risk, often referred to as the 'Floods Directive', came into force in 2007 and works in tandem with the Water Framework Directive for the protection of water quality.

The requirements of the EU 'Floods' Directive, have been implemented in Ireland as the assessment and management of floods through the Catchment Flood Risk Assessment and Management (CFRAM) Programme. Under CFRAM the Office of Public Works has published a series of documents and policies and plans that set out measures flood risk and the most at-risk communities. CFRAM recommends a proactive approach to flood risk and protection.

In terms of major Flood Relief Schemes, works are typically designed and built to a standard that protects against the 1 in 100 year flood event, and for coastal areas the 1 in 200 year flood event. As King's Island is highly susceptible to tidal flooding the 1 in 200 year standard is considered appropriate for these works. Consistent with the Directive, the proposed FRS is defined to provide protection to properties in the study area from the 1 in 200 year tidal flood event.

In addition, King's Island is detailed within the Flood Risk Management Plan for the Shannon Upper and Lower River Basin, this is set out in detail in section 2.5. The plan sets out specific details in relation to flood risk management for the southwest region to meet Ireland's obligations under the 2007 EU 'Floods' Directive.

2.5 Planning Legislation and Policy Provisions

This section sets out the relevant guidance and policy objectives that have been considered in relation to the proposed flood defence works at King's Island. Firstly, this section considers the legislation governing the Irish planning system, specifically as it relates to flood management works, then moving on to discuss the broad level national strategic objectives, guidelines and policies adopted by the Irish Government in relation to spatial development, physical infrastructure and climate change agreements. Secondly, this section provides an overview of the regional context of the proposed works, and lastly will consider local objectives and development standards as indicated within the city development plan.

2.5.1 The Planning and Development Act 2000 (as amended), and the Planning and Development Regulations 2001, as amended

The Planning and Development Act 2000 (as amended) forms the basis of the Irish planning system, setting out the detail of for planning guidelines, obtaining planning permission and the process for Environmental Impact Assessment.

Limerick Council wishes to prepare a Planning Application to An Bord Pleanála, under Section 226(1), of the Planning and Development Act, 2000 (as amended), for the construction of a Flood Management Scheme for Kings Island, Limerick.

The prescribed classes of development and thresholds that trigger a mandatory Environmental Impact Assessment (EIA) are set out in Schedule 5 of the Planning and Development Regulations, 2001, as amended. The most relevant criterion is Class 10 of Part 2 of Schedule 5 which states:

10. Infrastructure projects

(f) (ii) Canalisation and flood relief works, where the immediate contributing sub-catchment of the proposed works (i.e. the difference between the contributing catchments at the upper and lower extent of the works) would exceed 100 hectares or where more than 2 hectares of wetland would be affected or where the length of river channel on which works are proposed would be greater than 2 kilometres (S.I. No.600/2001- Planning and Development Regulations 2001).

The requirements in respect of Environmental Impact Assessment are contained within the Planning Act and these are described in detail in Chapter 1.

2.5.2 National Policy

National Planning Framework [NPF] 2040

The NPF is the successor document to the NSS and sets out a framework of policy objectives to help Ireland achieve its long-term sustainable goals. The strategic plan focuses on integrating Ireland's economic development, spatial planning, infrastructure planning and social considerations. It promotes environmentally focused planning at local level to tackle climate change and the implementation of appropriate measures to mitigate existing issues.

The plan aims to align itself with the UN Sustainable Development Goals, by ensuring that the decision process will safeguard the needs of future generations. These objectives are integrated as part of the National Strategic Outcomes [NSOs] in areas such as climate action, sustainable cities and innovation and infrastructure.

National Strategic Outcome 9 outlines the urgency of upgrading and investing in water management and environmental resources. In which it states;

Coordinate EU Flood Directive and Water Framework Directive implementation and statutory plans across the planning hierarchy, including national guidance on the relationship between the planning system and river basin management. Local authorities, DHPLG, OPW and other relevant Departments and agencies working together to implement the recommendations of the CFRAM programme will ensure that flood risk management policies and infrastructure are progressively implemented.

Flood relief measures are further highlighted under Section 9 of the NPF, titled Protecting Conserving and Enhancing our Natural Capital. It is envisioned that planning will play a vital role in mitigating development in inappropriate or vulnerable areas and will aid the delivery and design of necessary infrastructure in our towns and cities.

National Policy Objective 41b emphasises the importance of flood relief works as part of the national agenda for climate adaption.

National Policy Objective (NPO) 41b

In line with the collective aims of national policy regarding climate adaptation, to address the effects of sea level changes and coastal flooding and erosion and to support the implementation of adaptation response in vulnerable areas.

The proposed FRS works which will deliver flood relief works to protect the city from flood events is approved within NPO 41b.

Limerick City is identified as key growth city in the NPF, in this respect section X of the plan outlines the importance of regeneration works for encouraging growth in Limerick City. The proposed works are consistent with these policy objectives to facilitate future development growth for Limerick City.

The Planning System and Flood Risk Management 2009

The Office of Public Works [OPW] in conjunction with the Department of Environment, Heritage and Local Government [DEHLG] published a set of guidelines in relation to flood risk management. Subject to which the plan advocates a proactive approach to prevent flooding from occurring. This includes, for example, adopting general policies for protection, improve or restore floodplains and the upgrading of flood barriers. Under these guidelines Planning Authorities have a key role in the delivery of effective measures, policies and infrastructure to minimise the risk of flooding.

In this regard, the proposed FRS by Limerick City and County Council acknowledges the key role of the Council in minimising flood risk.

Climate Change Sectoral Adaptation Plan for Flood Risk Management, 2015

Sets out the policy on climate change adaptation of the OPW, the lead agency for flood risk management in Ireland, based on a current understanding of the potential consequences of climate change for flooding and flood risk in Ireland, and the adaptation actions to be implemented by the OPW and other responsible Departments and agencies in the flood risk management sector. A revised statutory Sectoral Adaptation Plan will be prepared under the 2018 National Adaptation Framework

Our Sustainable Future: Framework for Sustainable Development

The paper sets out the national vision to enhance Ireland's sustainable future, sets out the challenges and targets to be adhered to. In terms of flood management and flood risk assessment, the framework acknowledges this as one of the largest challenges to be addressed in the coming years. As most cities and towns on the island have developed along rivers and coastal areas, the majority of urban centres are exposed to flood risk. As national economic prosperity is heavily reliant on the success of cities, the adoption of flood relief and protection is vital for future growth and will require the integration of comprehensive infrastructure as part of the built environment.

The proposed FRS, which will provide flood relief in King's Island, Limerick City, is aligned with this policy.

National Climate Change Policy 2007-2012

Developed as part of a wider Climate Change Strategy and to address our obligations under EU Directive for Climate Action, the plan sets out a commitment to regulate development in flood risk areas and to also consider the adaption of proactive initiatives for flood prevention. The development of which was overseen by the OPW to develop the flood risk and flood management strategy.

The proposed FRS for King's Island is detailed in the flood management plan for the Shannon Upper and Lower River Basin.

2.5.3 Regional Policy

Mid-West Area Strategic Plan (MWASP) 2012-2030

The aim of the strategic plan is to facilitate and inform the implementation of the statutory processes, the constituent Planning Authorities of the Mid-West Region (Clare County Council, Limerick City and County Councils and North Tipperary County Council) and the Mid-West Regional Authority have developed a non-statutory, 20-year, integrated land-use and transport strategy for the region. This will provide evidence base which can inform transport and planning policy and infrastructure investment decisions in the Region to 2030. The MWASP was prepared to secure the following overall objective:

- Prioritisation of investment in the region;
- Strengthening the Limerick/Shannon Gateway;
- Create and support a well-defined hierarchy of settlement;
- Deliver the required transport infrastructure to meet the Plan objective; and
- Provide economic review and direction of the religion

The plan recognises the corridor of the River Shannon as the most important emerging tourism asset in the region, the three main areas: the Shannon Estuary, Lough Derg, and lower/mid River Shannon. The plan highlights the potential in the corridor from activity-based tourism, including boating, angling, wildlife, watching and walking, all supported by a network of small attractive villages with good local roads and access.

In terms of delivering and implementation, the plan acknowledges that appropriate flood risk and mitigation measures must be delivered these objectives, in this respect the works proposed at King's Island are consistent with the objectives of the plan.

Strategic Integrated Framework Plan for the Shannon Estuary

The Strategic Integrated Framework Plan (SIFP) for the Shannon Estuary is an inter-jurisdictional land and marine based framework plan to over see development and management of the Shannon Estuary. The plan seeks a balanced approach to facilitate economic growth and delivering careful protection for the natural environment.

SIFP MRI 1.3

Flood Risk

All proposals for development within the Strategic Development Locations identified above, should examine in detail the potential risks from fluvial and coastal flooding as well as sea level rise, to ensure the location and design of future development uses within these locations:

- *Pay due regard to available information on flooding and the outcome of the Shannon CFRAM study;*
- *Is appropriate for the level of flood risk identified at detailed planning and design stage;*
- *Does not increase flood risk elsewhere;*
- *Provides the appropriate level of flood protection where development in flood prone areas is deemed appropriate or justifiable; and*
- *Proposals should pay due regard to the Guidelines produced by the DOECLG and OPW for Planning Authorities 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities'.*

In this respect, the proposed works are consistent with the policy outlined in the plan and deliver appropriate flood relief measures.

Draft Regional Spatial & Economic Strategy, Southern Region

The Draft Regional Spatial and Economic Strategy [RSES] for the Southern Region was published in late November 2018 and is anticipated will be adopted in 2019. The plan provides a long term regional level strategic plan for physical growth, economic investment and social development for the Southern Region and seeks to align national goals set out in the NPF with local considerations, subject to which flooding is identified as key challenge facing cities and towns in the region.

The RSES supports measures that address climate action, as outlined in the NPF, these will include Renewable Energy, Sustainable Transport and Climate Resilience through Flood Defence. The latter to also provide for Flood Risk Management and to help reduce vulnerability in known flood zones.

The plan will also ensure the delivery and implementation of the Shannon Upper and Lower River Basin Management Plan.

RPO 4

Population Growth and Environmental Criteria

Increased population growth should be planned having regard to environmental criteria including:

• *The assimilative capacity of the receiving environment;*

• *The proximity of European Sites and the potential for impact on the conservation objectives and qualifying interests; and*

• *Areas that have potential to flood.*

RPO 7

Holistic Approach to Delivering Infrastructure

Ensure investment and delivery of comprehensive infrastructure packages to meet growth targets that prioritises the delivery of compact growth and sustainable mobility in accordance with NPF objectives to include the following: Water services, digital, green infrastructure, transport and sustainable travel, community and social, renewable energy, recreation, open space amenity, climate change adaptation and future proofing infrastructure including Flood Risk management measures, environmental improvement, arts, culture and public realm.

RPO 52

Tourism and the Environment

Development of new or enhanced tourism infrastructure and facilities should include an assessment of the environmental sensitivities of the area including an Environmental Impact Assessment (EIA); Appropriate Assessment (AA) and Strategic Flood Risk Assessment (SFRA) if required in order to avoid adverse impacts on the receiving environment. Where such tourism infrastructure or facilities are developed, the managing authority/ agency should ensure that effective monitoring protocols are put in place to monitor and assess the ongoing effect of tourism on sensitive features with particular focus on natural, archaeological and built heritage assets.

RPO 108

Floods Directive

It is an objective to support, at a regional level, the implementation of the Floods Directive to manage flood risks. It is an objective to encourage collaboration between Local Authorities, OPW and other relevant Departments and agencies to implement the recommendations of the CFRAM programme to ensure that flood risk management policies and infrastructure are progressively implemented.

RPO 109

Flood Risk Management Objectives

a. It is an objective to ensure that the flood risk management objectives as set out in the Flood Risk Management Plans are fully considered in the development of planning policy and decision making by Local Authorities so that flood risk is a key driver in the identification of suitable locations for new development, considering the CFRAM flood maps and other flood maps as available.

RPO 110

Flood Risk Management Plans

Development and Local Area Plans in the region should take account of and incorporate the recommendations of the Flood Risk Management Plans, including planned investment measures for managing and reducing flood risk. Natural Water Retention Measures (NWRMS) should be incorporated where appropriate in consultation with the Office of Public Works (OPW) and other relevant stakeholders.

RPO 111

Planning System and Flood Risk Management

Consideration must be given to future appropriate land-use policies in accordance with the requirements of the Guidelines "The Planning System and Flood Risk Management, 2009". Strategic and local flood risk assessments and plans should be prepared where appropriate, which should include consideration of potential impacts of flood risk arising from climate change. It is an objective to avoid inappropriate development in areas at risk of flooding and integrate sustainable water management solutions (such as SUDS, nonporous surfacing and green roofs) to create safe places in accordance with the Guidelines.

RPO 112

Flood Risk Management and Biodiversity

It is an objective to avail of opportunities to enhance biodiversity and amenity and to ensure the protection of environmentally sensitive sites and habitats, including where flood risk management measures are planned. Plans and projects that have the potential to negatively impact on Natura 2000 sites are subject to the requirements of the Habitats Directive.

RPO 114

Flood Risk and Climate Change

b. support investment in subsequent projects by capital spending agencies to deliver flood relief schemes under National Strategic Outcome: Transition to a Low Carbon and Climate Resilient Society. Such projects should be future proofed for adaptation to consider potential impacts of climate change.

RPO 115

River Basin Management Plan

a. It is an objective to ensure a cross-agency collaborative approach to implementing the River Basin Management Plan (RBMP). Planning Authorities shall ensure that land use plans and strategies are consistent with the RBMP.

b. It is an objective to ensure effective coordination between the requirements of the Floods Directive and the Water Framework Directive.

RPO 117

River Basin Management Plan and Spatial Planning

a. The RSES recognises that planning is critically important to the management of water resources. It is an objective to encourage the better integration of water issues into Planning Authority land-use plans and strategies.

b. It is an objective to encourage the integration of river corridors with green infrastructure in settlements. The guidance document "Planning for Watercourses in the Urban Environment" published by Inland Fisheries Ireland provides an integrated watercourse protection strategy.

The implications of climate change for the region are stark, consequences include greater risk and incidences of coastal, pluvial and fluvial flooding and all the attendant risks to infrastructure, homes, businesses and the economic health of Limerick City. Set out in the RSES are two principal approaches for mitigation and adaption works, as set out in the policies above, the works subject of this EIAR will reduce the existing vulnerabilities and deliver upgrades to the flood defences, consistent with the draft RSES.

Shannon Catchment Flood Risk Assessment and Management Study (CFRAM)

The Office of Public Works are working in partnership with their consultants, Local Authorities and other stakeholders to deliver the CFRAM Study for the Shannon River Basin District (RBD).

Work on the study started in January 2011. The Shannon RBD includes the entire catchment of the River Shannon and its estuary, covering some 17,800lm2 and 20% of the island of Ireland. The RBD covers parts of 17 counties: Limerick, Clare, Tipperary, Offlay, Westmeath, Longford, Roscommon, Kerry, Galway, Leitrim, Cavan, Sligo, Mayo, Cork, Laois, Meath, and Fermanagh.

The study focuses on areas known to have experienced flooding in the past and areas that may be subject to flooding in the future either due to development pressures or climate change. The final output from the study will be Catchment Flood Risk Management Plans, which will define the current and future flood risk in the Shannon RBD and set out how this risk can be managed.

The full extent of the Area of Further Assessment defined for Limerick City lies within three Units of Management and includes all of the developed land within the contiguous urban area of Limerick, and all lands zoned for development in or adjacent to Limerick City (including areas that may be outside of the Limerick City Council jurisdictional boundary). For the purpose of this Study, this AFA will be assessed as part of Unit of Management 25-26. Any flood risk management options proposed for this AFA will therefore be documented within the FRMP for Unit of Management 25-26.

In this respect, the proposed FRS is consistent with the findings of the study, to provide flood relief measures at critical locations, in which Limerick City is identified.

2.5.4 City Development Plan

The works proposed at King's Island, and subject of this EIAR, are within the development boundary of Limerick City and as such are under the Jurisdiction of Limerick and City County Council. For the purposes of this section the scope of the works will be discussed separately to distinguish and clarify specific planning considerations in relation to each sections of works and its locality.

Limerick City Council Development Plan (LCDP) 2010-2016 (as Extended)

The Limerick City Development Plan (LCDP), 2010-2016, Flood Risk Map highlights that King's Island is at risk of flooding indicating that it is within Flood Zone A (high probability of flooding). As a result, all proposed FRSs are required to follow 'The Planning System and Flood Risk Management' (2009). These guidelines are included as policy statements in the LCDP.

Policy WS8.

Flood Protection

"It is the policy of Limerick City Council to continue to work toward reducing flooding within the City and ensure that all new development proposals comply fully with the requirements of 'Planning Systems & Flood Risk Management Guidelines for Planning Authorities' 2009, and any other guidance during the lifetime of the Development Plan".

The proposed works, subject of this EIAR, seek to deliver such works and would be entirely consist with the aims of policy WS.8.

Policy WS.9 seeks to ensure that development should not case flood risk effectively:

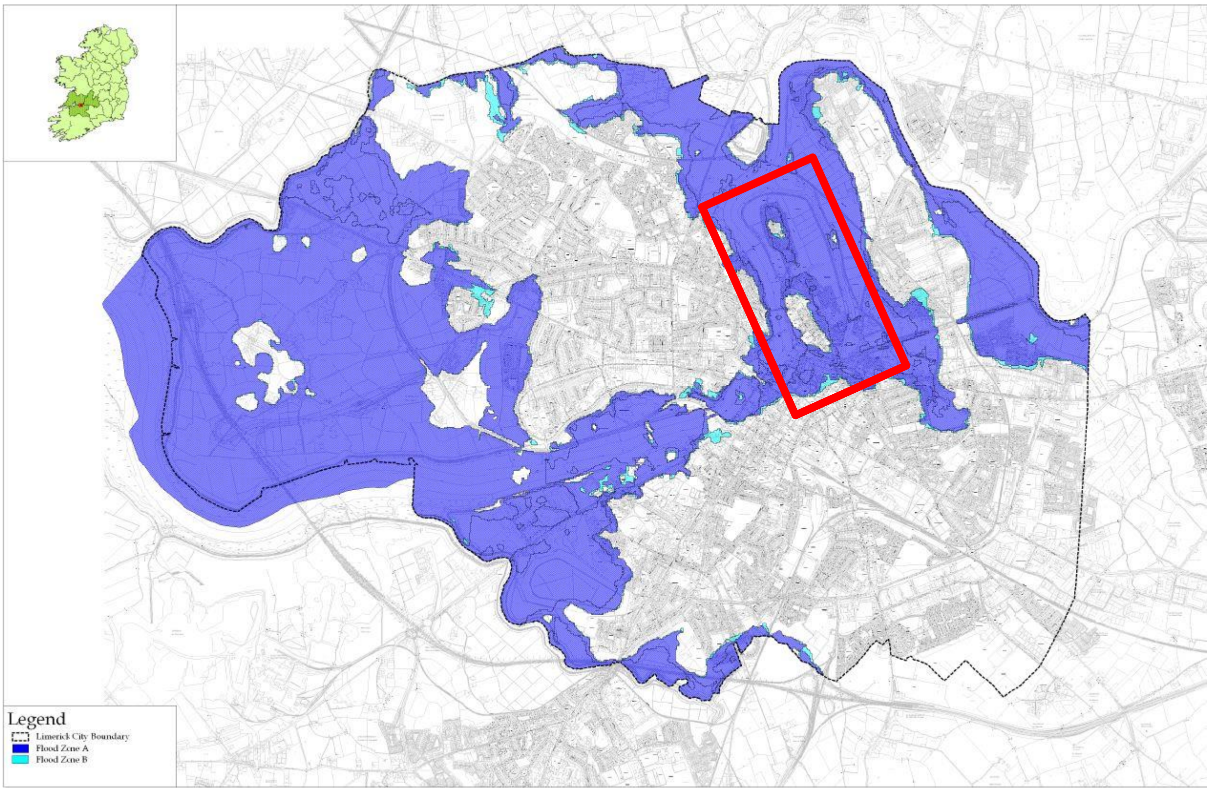

Figure 2-1. Flood Risk Areas, Limerick City Development Plan (area generally outlined in red).

Policy WS.9

Flood Risk

It is the policy of Limerick City Council to ensure that development should not itself be subject to an inappropriate risk of flooding nor should it cause or exacerbate such a risk at other locations.

As part of St. Mary's Park and Kings Island Framework Strategy in the LCDP, planning objective 6, states the need to prepare a flood risk assessment for King's Island and to determine the long-term flood remediation solution for Kings Island. The proposed FRS is the Council's response to objective 6 of the Plan.

The preferred option, discussed in detail in Chapter 5, comprises works in Flood Cell A, which encompasses the northern section of the island known as St. Mary's Park, and contains the following sub areas. The sub areas or cells are shown in Figure 2-2 Flood Cell Sub Areas.

Table 2-1. Project subareas (Area A)

	Area	Zoning
A1	Thomond Bridge to Verdant Place (as constructed)	2A Residential
A2	Verdant Place steps and crèche	2B Education, Community & Cultural
A3	North West Embankment	6A Public Open Space
A4	St. Mary's Park / SAC	6A Public Open Space
A5	Star Rovers to Athlunkard Boat Club	6A Public Open Space
A6	Athlunkard Boat Club	6A Public Open Space
A7	Sir Harry's Mall	1 (A,B,C) City Centre Area
A8	Absolute Hotel Boardwalk	1 (A,B,C) City Centre Area
A9	South of Absolute Hotel Boardwalk to Abbey Bridge	1 (A,B,C) City Centre Area
A10	Abbey Bridge to Baal's Bridge	1 (A,B,C) City Centre Area

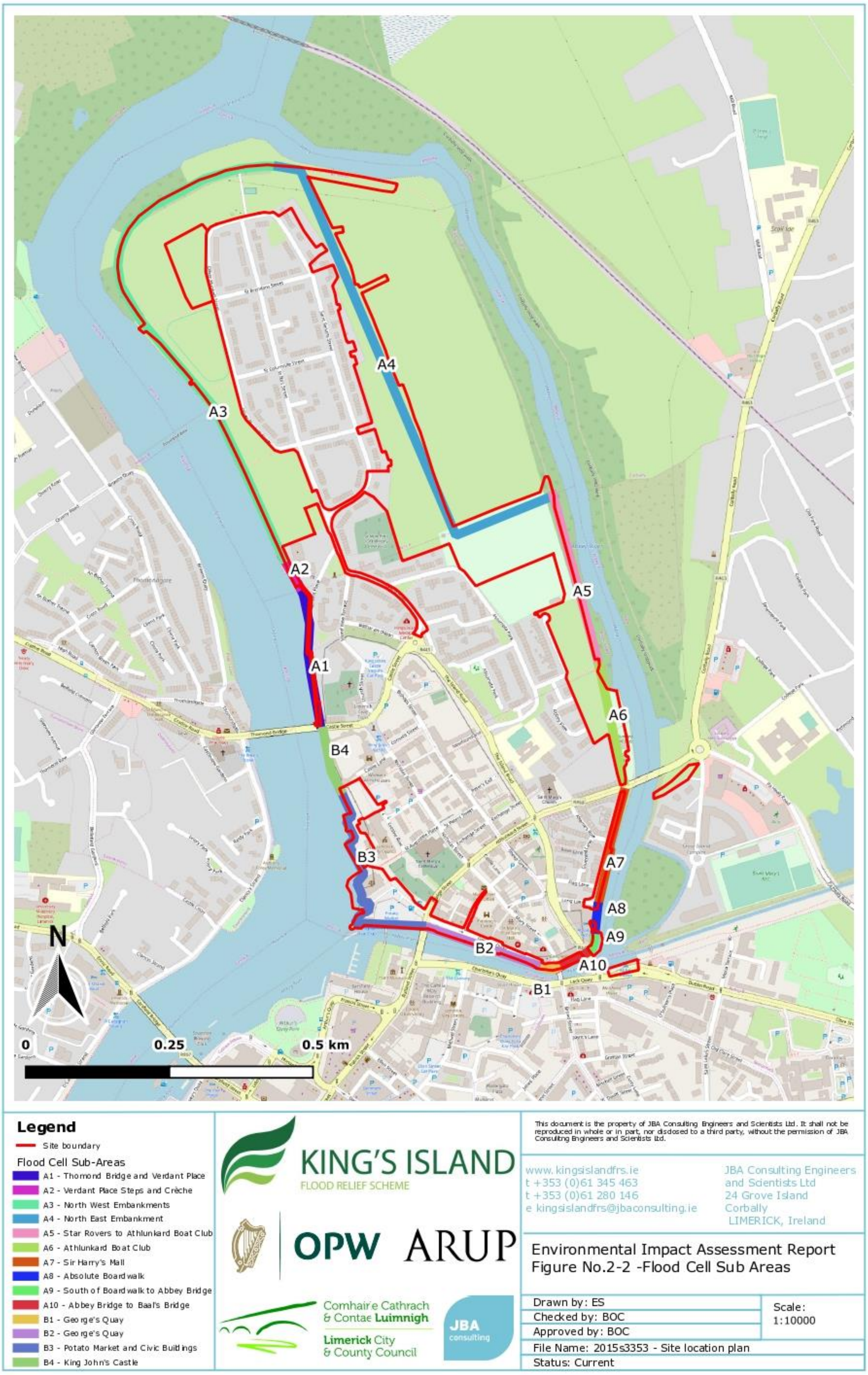

Figure 2-2. Flood Cell Sub Areas

In terms of zoning, the works proposed for Flood Cell A are largely located on lands zoned '6A Public Open Space', *to retain all land dedicated for public open space*. Flood Cell A also includes some lands zoned 2A residential at St. Mary's Park, which seeks *to protect and provide for residential uses and associated uses to support sustainable communities*, and lands zoned 2B Education, Community & Cultural. Under the zoning matrix for the lands, the provision of public infrastructure is supported, provided works do not detract from residential amenity, therefore the works proposed are consistent with the zoning objective.

Flood Cell B comprising the southern section of the island, known as Englishtown, which forms part of the city core.

Table 2-2. Project subareas (Area B)

	Area	Zoning
B1	George's Quay East	1 (A,B,C) City Centre Area
B2	George's Quay West	1 (A,B,C) City Centre Area
B3	Potato Market and Civic Buildings	1 (A,B,C) City Centre Area
B4	King John's Castle	1 (A,B,C) City Centre Area

Flood Cell B lands are primarily zoned '1 (A, B, C) City Centre Area', the zoning objective seeks

- to provide for the protection, upgrading and expansion of higher order retailing, in particular comparison retailing, and a range of other supporting uses in the City Centre retail area;
- support the retention and expansion of a wide range of commercial, cultural, leisure and residential uses in the commercial core area, (apart from comparison retail uses); and
- to reinforce the residential character of inner City residential neighbourhoods, while supporting the provision and retention of local services, and civic and institutional functions.

In terms of development the zoning matrix for the city centre area permits all manner of development, provided it does not detract from retail activity, therefore the proposed works are acceptable and rather would protect retail activity in the city core.

Flood protection is in place in the form of quay walls, however, no defence is in place around the Potato Market and civic buildings on Merchant's Quay. Works to upgrade the existing infrastructure is supported under the LCDP and zoning objective for the area, and will support the achievement of retail, commercial and residential objectives of the Plan.

There are no designated Architectural Conservation Areas within Kings Island.

The Limerick City Development Plan 2010-2016 (as extended): Volume 3 Record of Protected Structures lists 44 Structures within the study area. The National Inventory of Architectural Heritage (NIAH) Survey for Kings Island lists 31 sites within the subject area. Note there is a substantial degree of overlap with the Record of Protected Structures. King John's Castle is situated in Flood Cell B4, no flood measures are proposed for this area and would not impact the castle.

A portion of King's Island is designated as the Lower River Shannon Special Area of Conservation (SAC) and is situated upstream of the River Shannon and River Fergus Special Protection Area (SPA). These sites are protected under the EU Habitats Directive and are of international importance for their wetland, intertidal and estuarine habitats as well as wader and wildfowl populations. Chapter 11 Landscape, Biodiversity and Recreation in the LCDP outlines the special protections in place for designated SAC sites.

Policy LBR.8

It is the policy of Limerick City Council to apply the precautionary principle in relation to proposed FRS in environmentally sensitive areas to ensure all potential adverse impacts on any designated natural heritage area and any NATURA 2000 sites arising from any proposed FRS or land use activity are avoided, remedied or mitigated.

Policy LBR.9

It is the policy of Limerick City Council to ensure that proposals along the River Shannon and other waterways associated with the River Shannon catchment within Limerick City will achieve an *appropriate balance of uses commensurate with the sensitivity of the natural environment and avoiding adverse impacts on European conservation sites and sensitive natural receptors associated with the River Shannon.*

In this respect a Natura Impact Assessment (NIS) has been prepared and this conclusion that the proposed FRS is appropriately balanced and do not impact the sensitive nature of the SAC.

Limerick Regeneration Framework Implementation Plan (2015)

The Limerick Regeneration Plan was introduced in September 2013 and focuses in the revitalisation of communities within Limerick City over the next 10 years by raising standard of living, opportunity, health and wellbeing for all residents of the regeneration areas. It is envisaged to be one of the largest capital programmes and largest regeneration programme in the State. The Plan includes €253m investment on physical, €30m on social, and €10m on economic programmes.

"The aim is to recognise, diagnose, and treat the root causes, as well as, symptoms of social and economic exclusion in Limerick regeneration areas- Moyross and St.Mary's Park on the city's northshide and Southill and Ballinacurra Weston on the southside, so that future generations don't face the same challenges as current and former residents".

The proposed flood relief works seek to deliver much need protection to King's Island, an area of the city highly susceptible to flood damage, and thus support plans for future regeneration in the area.

2.6 Planning History

There are a number of historical planning applications associated with proposed flood works area and in the vicinity of works. The table below sets out the recent planning history associated with King's Island and the locations of works.

Table 2-3. Historical planning applications

Planning Ref. No.	Development Description	Applicant	Location	Flood Cell	Status
06/770117	Permission granted, on basis of outline permission, for a single storey childcare facility	St. Mary's Area Integrated Development Ltd.	North of King's Island, Youth & Community Centre, St Mary's Park	A3	Granted
08/770033	Development of office building with gallery and café for a site listed as a recorded monument	John Clogan	36-39 Nicholas Street, King's Island	B3	Granted
09/770271	Amended permission to raise the site level, consisting 1.3m over existing rear open space at permitted child care facility	King's Island Community Creche Ltd.	North of King's Island, Youth & Community Centre, St Mary's Park	A3	Granted
15/8004	Permission for the construction of two dwellings, including solar panels and associated site work at a protected structure, the Old Gaol (RPS053)	Limerick City Council (Part 8)	Gaol Lane	A10	Granted
16/8000	Provision of flood defences consisting of; new flood defence walls new footpath from Thomond Bridge to the existing embankment at the north of the community centre, realignment of the existing road following protected structures former Thomond Bridge Toll House (RPS No. 38), Verdant Place stretch of the City Wall (RPS No. 59) and Thomond Bridge (RPS No. 428)	Limerick City Council (Part 8)	Verdant Place, King's Island, Limerick	A1	As yet no decision has been made public

16/8007	For construction of 20 no. residential dwellings and public realm works on St. Columcille's Street	Limerick City Council (Part 8)	St. Mary's Park, King's Island	A3	As yet no decision has been made public
18/1093	The construction of a toilet block, a drying room and a covered outdoor area for existing crèche facility and all ancillary site works	Board of Management of King's Island Community Creche	Verdant Place, St. Mary's Park, King's Island	A3	Granted
18/8006	For the construction of a new district play area and outdoor gym facility including all necessary site works	Limerick City Council (Part 8)	Verdant Place, St. Mary's Park, King's Island	A3	Granted

2.7 Conclusion

Having regard to the provisions of:

- EU 'Floods' Directive 2007;
- The National Planning Framework;
- The Draft Regional Spatial and Economic Strategy for the Southern Region;
- The Planning System and Flood Risk Management 2009;
- Climate Change Sectoral Adaptation Plan for Flood Risk Management, 2015 ;
- Our Sustainable Future: Framework for Sustainable Development;
- National Climate Change Policy 2007-2012;
- Mid-West Area Strategic Plan (MWASP) 2012-2030;
- Shannon Catchment Flood Risk Assessment and Management Study (CFRAM); and
- Limerick City Council Development Plan (LCDP) 2010-2016 (as Extended).

It is concluded that the proposed FRS would be in compliance with national, regional and local planning policy provisions and would not seriously injure the amenities of the area or significantly impact the current land use objectives in King's Island and would, therefore, be in accordance with the proper planning and sustainable development of the area.

3 Constraints, Alternatives Considered, Options, and Scoping

The proposed FRS and this EIAR are informed and framed by initial environmental studies, which were prepared by JBA and Arup at the outset of the development. These phases included a Constraints Study of King's Island and surrounding lands and watercourses, and an Options Assessment which presented all alternatives and options for the proposed flood defences and recommended an emerging preferred option. When the emerging preferred option was agreed, and screened in as requiring an EIAR, an EIAR Scoping Report was prepared to outline the EIAR in sufficient detail to request public and statutory consultation prior to completion of the EIAR. These phases are described in further detail below.

3.1 Constraints Study

The Constraints Study was the first step in the determining the key environmental constraints and drivers which would inform the development of potential flood relief options and ultimately informed the preparation of this EIAR. The purpose of the Constraints Study was to determine constraints (physical, procedural, legal, environmental etc.) that exist, which could affect the design of the scheme, delay the progress of the scheme and could influence the cost of the scheme.

The scope of the Constraints Study followed the headings prescribed in the Environmental Protection Agency's Guidelines 'Advice Notes on the Current Practice in the Preparation of Environmental Impact Statements', 2003, which was the relevant guidelines at the time of the study. The prescribed headings were as follows:

- Human Beings
- Material assets
- Water
- Ecology
- Soils & Geology
- Landscape
- Archaeology & Cultural Heritage
- Traffic
- Air Quality
- Noise & Vibration

The key constraints identified for each of the headings above were carefully considered in the early phases of the project to ensure that the design was developed in line with the constraints. The Constraints Study was also the initial means of characterising the environment of King's Island which would later inform the Options Report, Scoping Report and the final EIAR.

The scope of the Constraints study was broad and looked at all environmental constraints in the context of the entire island, prior to the development of specific flood relief measures.

A summary of the constraints for each environmental heading are provided below:

3.1.1 Human Beings

- Land use zoning and planning in King's Island, as proposed by the Limerick City Development Plan (LCDP) and the Limerick Regeneration Framework Implementation Plan (LRFIP), could pose a constraint on the FRS because it could create limitations for construction of flood relief infrastructure;
- Most of the residential areas in King's Island are not-owner occupied or insured. Therefore, King's Island has a high rate of local authority owned properties, a high rate of derelict housing, and poor quality housing well below current and previous building standards. The recent floods in King's Island resulted in high financial implications for local authorities, while residents likely incurred little financial damages;
- The presence of various areas of historical, archaeological, and cultural importance in King's Island add a constraint to the FRS because any work around these areas has to be limited and must follow specific guidelines;
- The complex and unorganised road network in King's Island allows for isolation of the island and limits the access to areas of historical and cultural interest;
- The FRS must take into considerations ways to enhance public amenities including active and passive green spaces;

- The potential negative effects that the construction of flood relief mechanisms could pose on tourism of the Island during the construction and development stage of the scheme; and
- Residents' expectations and concerns may pose a restraint on the overall acceptance of a new flood relief scheme.

3.1.2 Material Assets

- The presence of the underground and underwater cables should be clearly identified before any excavations on land or in-river works are commenced;
- LCCC and the National Roads Authority will be consulted with in relation to the potential impact of a flood relief scheme on the existing or future road networks;
- Foul and storm water sewers:
    - Any flood relief scheme should examine the likelihood of flooding and the effect of the flooding in combined sewers;
    - The out-of-date sewer system in King's Island poses a constraint in the development of a FRS;
    - Following identification of drainage routes, the FRS team must ensure that these sewer systems will not interfere with the construction of any flood defence mechanisms (flood walls etc); and
    - Consideration should be given to connecting all of the existing storm water discharge points into a single adequately sized or a number of discrete discharge locations. The final design of the outfalls should ensure no ingress of seawater into the pipes.
- Electricity:
    - Any construction work that takes place in close proximity to underground electrical cables should be in line with the health and safety precautions that must be followed because underground electrical cables can cause fatal or severe injuries;
    - During the construction stage, special measure would have to be taken in order to ensure the construction does not interfere in any of the underground routes; and
    - These underground lines that are in close proximity of the rivers may be at risk of flooding in extreme weather conditions causing power outages in areas of King's Island.
- Gas network:
    - Similarly to the underground electricity lines, the gas network pipes could create a constraint for the FRS due to the need to plan and work sensibly around it;
    - Similar measure like the ones suggested by the HSE (ESB underground lines) apply to construction work around underground gas pipes; and
    - The pipes along Verdant Place and Sir Harry's Mall are the closest pipes to the surrounding rivers which is a major constraint for the FRS because there are flood walls proposed along Verdant Place (Verdant Place Flood Wall) and along Sir Harry's Mall (Sir Harry's Mall Flood Wall).

3.1.3 Water

- Given the current state of the Limerick Docks waterbody it is important not to worsen its WFD status. Therefore all possible risks of point source pollution or runoff during the construction of the FRS should be assessed and prevented;
- The construction phase of the development of flood relief infrastructure has the potential to pose a threat to the water quality in the River Shannon;
- The flood relief scheme should ensure that sewer overflows do not enter the waterbody;
- The current water and drainage infrastructure problem in King's Island is a constraint for the flood relief scheme because it increases the risk of point source pollution in a flooding event;
- Appropriate sewer infrastructure is crucial for the flood scheme to reduce discharge and avoid surface water infiltrating into the foul network;

- There is evidence of significant erosion on the existing embankment. On top of the damage caused by the 2014 flood, there is historical evidence of the existence of timber toe piles to address the erosion problem;
- The fissured bedrock poses constraints for the flood relief scheme due to the increased risk of slippage failure and seepage through the gravel layer underneath;
- The design and operation of the proposed scheme should be cognisant of the existing water quality and flora and fauna, particularly the SAC within the Study Area;
- The design and operation of any flood alleviation scheme must not compromise the requirements of the Habitats Directive or the Birds Directive and an Appropriate Assessment will need to be carried out; and
- The removal and disposal of any river/estuarine sediment should follow the guidelines for handling waste under the Waste Management Acts as amended. A strict chain of custody must accompany all excavated materials taken off site for disposal.

3.1.4 Ecology

- A portion of King's Island is designated as the Lower River Shannon SAC and is situated upstream of the River Shannon and River Fergus SPA. These sites are protected under the EU Habitats Directive and are of international importance for their intertidal and estuarine habitats and wader and wildfowl populations;
- The FRS works may result in significant effects on the Lower River SAC in the absence of mitigation. If this is the case, a Stage 2 Appropriate Assessment (AA) under Article 6(3)) of the Habitats Directive will be required to assess the impact of the works on the Natura 2000 sites and a Natura Impact Statement will be required to inform the AA;
- Otters are protected under the Wildlife Act 1976/2000, EU Directive 92/43 Annex II and IV and the Bern Convention Appendix III. The breeding and resting places of otters are also protected, even if there are no animals present. Under the above legislation it is an offence to kill or injury an otter and to damage or destroy a breeding or resting place. The surrounding habitat, with tall herb swamps, riparian woodland, treelines and the adjacent Shannon and Abbey Rivers, provide extensive potential habitat for breeding or resting locations;
- The Shannon is an important river for salmonid, lamprey and eel populations. In-channel works, or permanent modification of channel banks or bed, could have an adverse impact on aquatic populations and water quality;
- King's Island and its surrounding area is important for wintering and migrating waterfowl, in particular Whooper Swan. Mitigation will be required during the wintering bird season to minimise disturbance to these species;
- The riverine corridor and vegetated fringe of King's Island provides suitable habitat for nesting birds and also within the river walls and bridges that provide a number of cracks and crevices suitable for nesting birds. If possible, vegetation clearance associated with the works and any works to existing walls and bridges, should be conducted outside of the breeding bird season (March to September inclusive) to protect any nests that may be present;
- The scattered mature trees along the King's Island walkway, river walls and bridges provide potential roosting opportunities for bats, with the surrounding habitat providing good foraging and commuting routes. Options that require the removal of mature trees or works to riverine built structures with the potential to support roosting bats shall be assessed for bat potential; and
- Japanese Knotweed, Himalayan balsam and Giant Hogweed are listed as invasive plants under the EC (Birds and Natural Habitats) Regulations 2011 (S.I. 477/2011). These regulations prohibit the introduction and dispersal of these species. Therefore, the works associated with the flood relief scheme in areas where invasive species are present must use appropriate measures to ensure their containment. A task specific method statement must be compiled to implement these measures.

3.1.5 Soils, Geology, Hydrogeology & Hydromorphology

- Soils and geology

- The marine/estuarine soil deposits, which underlie the constraints study area are soft compressible soils and will require detailed site investigation to engineer a suitable flood defence for the Site;.
- The populated/urban areas of the site are underlain with made ground. Depending on the proposed flood defence, the made ground which is uncompacted and highly variable may require to be excavated and replaced with suitable founding material;
- The area around St. Mary's Park has a history of dumping and burning of waste. A site to the back of the estate on the east is a known illegal dumping site. Recently as part of the Regeneration Programme for King's Island, this site has been cleaned up, however it is still considered a high risk area for contaminated soil;
- The flood defence alignment and footprint will need to mitigate against causing minimal disruption to the SAC with regards to removal of vegetation, the horizontal and vertical extent of excavation of in-situ soils and minimising encroaching on the SAC;
- The Site is in an archaeologically sensitive area given its proximity to St. Johns Castle and historic city defence walls. The upper soil profile under the footprint of the proposed flood defence could be archaeologically significant and therefore minimising, where possible, the disruption to the in-situ soils on the site should be a design consideration; and
- Given local experience in this area and the lack of recorded karst features in the GSI data base, it is unlikely that karst features will be encountered on the site. However, it is prudent to consider that karst features such as caves, swallow holes, weathered rock and dolines can lead to ground surface and ground instability and are a constraint to be considered in the engineering design of the scheme.

- Hydrogeology
  - Groundwater flooding may occur in areas where there is shallow rock or very permeable soil deposits, as ground water may move under flood barriers. Groundwater and surface water level monitoring should also be undertaken simultaneously to allow correlation between groundwater level and river level changes;
  - The design of the flood defence should consider the water flow regime into and out of the site where the defences are being installed;
  - Groundwater dependent habitats may be impacted by the proposed flood defences through accidental contamination and alteration to base-flow to the SAC causing an area to dry out or flood out of season; and
  - Alteration to the surface water drainage and groundwater flow within the constraints area could lead to reactivation of the existing karst features and initiate ground surface and/or ground instability.
- Hydromorphology
  - The FRS will need to be cognisant of the marine/estuarine soft deposits that are found on the Island. The FRS should be designed to minimise the impacts of the hydromorphology in the rivers.

3.1.6 Landscape

- Views out
  - Protection of residential views out to the river, riverbank and open spaces within King's Island, as well as Limerick City landmarks beyond, from housing within St Mary's Park;
  - Protection of recreational views out to the river, riverbank and Limerick City landmarks beyond from riverside footpaths;
  - Protection of residential views out to the river and riverbank from housing along Verdant Place; and
  - Protection of residential and civic views out to the river and riverbank from housing and public spaces located around King John's Castle, City Hall and surrounding areas south of Thomond Bridge to Abbey Bridge to the south-east.
- Views in

- Protection of recreational views into the wetland north-east of King's Island, part of the Lower River Shannon SAC;
- Protection of recreational and residential views into King's Island and associated landmarks from open spaces and housing on the west bank of the River Shannon;
- Protection of civic views into King's Island and associated landmarks from locations such as Clancy's Strand on the west bank of the River Shannon across from King John's Castle, or Sarsfield Bridge and Honan's Quay south-west of the island;

3.1.7 Archaeology & Cultural Heritage

- Kings Island has a rich and varied archaeological, architectural and historical past with multi period monuments ranging from humble sites of local interest to large complexes (King John' Castle and St. Mary's Cathedral) of international significance. All of the features both above and below ground have varying degrees of statutory protection and the guiding principle should be their continued preservation in situ and to minimise any impacts on their character or setting.

3.1.8 Traffic

- The N7 Route through King's Island has existing traffic congestion. During construction of any flood scheme the traffic could pose problems for deliveries and access;
- The design of the flood relief scheme should look to avoid making traffic worse or remove already identified opportunities to improve traffic flows;
- The design of the flood relief scheme should consider where it could contribute to traffic improvements;
- Any Construction works as part of the King's Island Flood Relief scheme will have to be mindful of maintaining access for both pedestrians and cyclists as well as public transport via Island Road; and
- The traffic associated with the construction works for the King's Island Flood Relief scheme will need to be mindful of this Noise Action Plan.

3.1.9 Air and Noise

- The main impacts on air and noise will arise during the construction of the scheme. Traffic noise generated by trucks accessing the island will be one source of noise. However this source of noise will be for the duration of the construction only and in the longer term no noise will be generated during the operation of the scheme; and
- Similarly, air emissions will arise during the construction of the scheme both traffic induced air emission and air emission generated during the construction of the scheme. Dust will be the main component of these air emissions. Specific measures will be employed to reduce the dust emissions. Again, these emissions will only arise during the construction phase of the scheme.

3.2 Alternatives Considered

Alternative options were considered in the early phases of the development. This was completed as part of Stage I - Options Development, and the results are presented in the report "King's Island Flood Relief Scheme Options Assessment Report" completed by Arup and JBA in 2018. The options that were initially considered and screened in the earlier phases of the development are summarised below.

3.2.1 Directive 2014/52/EU

The EIA Directive 2014/52/EU requires that the main alternatives of a proposed FRS be considered and presented in the EIAR, and the reasons for selecting the emerging preferred option to be justified accordingly. This requirement is outlined in the following statement:

"A description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects".

Alternatives were considered for this development early on in the Options Development phase, and their viability assessed with regard to applicability to the areas, economic impacts/benefits, environmental impacts/benefits, social impacts and acceptability, and cultural benefits/impacts. The process employed at the early phase is described further below.

3.2.2 Initial alternatives considered and screening of viable measures

This section details all the flood risk management measures considered during the initial screening stage. Prior to the development of options/alternatives for the King's Island FRS, a Constraints Report was produced, which identified the environmental limitations of King's Island and its environs and highlighted any environmental constraints to be taken into account during the options development.

These measures, detailed in Table 3-1 below, were assessed with regard to their viability in terms of the following criteria:

- Applicability to the area;
- Economic (potential benefits, impacts, likely costs etc.);
- Environmental (potential impacts and benefits);
- Social (impacts on people, society and the likely acceptability of the measure); and
- Cultural (potential benefits and impacts upon heritage sites and resources).

Taking into account the environmental constraints, and the criteria above, the following options were considered and screened in the Options Report.

Non-structural measures

- Planning Control
- Building Regulations
- Flood Forecasting and Early Warning Systems
- Public Awareness
- Land Use Management

Structural measures

- Direct Flood Defences
- Barrier on up and downstream limits of the Abbey River
- Diversion Channels or Culverts
- Relocation of Property Occupiers
- Individual Property Protection (IPP)
- Pumping, Channel Widening
- Bridge/Weir Modifications.
- Upstream storage
- Tidal barrier

A screening exercise was carried out to assess the viability of each measure, presented in Table 3-1 below. Each criteria was assessed to be either viable (Y) or not viable (N) with respect to the appropriate option, or requiring further long term consideration (?).

Table 3-1: Initial Screening of Measures

Possible Flood Risk Management Measure	Applicability	Economic	Environmental	Social	Cultural	Initial Screening Result	Comment
Non-Structural Measures							
Planning Control	N	Y	Y	N	Y	Not viable as stand-alone option	Long time to implement and would not reduce the flood risk to an acceptable level as a standalone measure but should be considered as a partial option.
Building Regulations	N	Y	Y	N	?	Not viable as stand-alone	Long time to implement cultural change in building regulations and would not reduce the flood risk to

						option	an acceptable level as a standalone measure but should be considered as a partial option.
Flood Forecasting & Flood Early Warning System	N	Y	Y	N	N	Not viable as stand-alone option	Flood forecasting would allow advanced warning for possible flood events. Would help in erection of demountable barriers, however potential benefit would be limited as inundation in an event would be extensive. Limited warnings are received currently and will be sufficient to erect flood barriers and gates as part of an individual property protection solution.
Public Awareness	N	Y	Y	Y	Y	Not viable	Long time to implement and would not reduce the flood risk to an acceptable level.
Land Use Management	N	?	Y	?	N	Not viable	Long time to implement particularly from an economic and social perspective, and limited area over which it could be applied. Would not reduce the flood risk to an acceptable level in the historic areas of the island.
Structural Measures							
Upstream Storage	?	?	N	N	N	Not viable as stand-alone option	Primary source of flood risk is tidal. There is minimal fluvial contribution to flood risk. Would work alongside a tidal barrier to manage tidal flows. Applicability and economic measures are considered in the text but only viable in conjunction with a tidal barrier.
Tidal Barrier	?	N	N	Y	Y	Potentially viable as whole city, long term solution, but only in conjunction with upstream storage	Prohibitively high cost with environmental impacts but should be considered for climate change adaptation options and as a whole city approach. Would only work if fluvial flows could be managed through upstream storage.
Barrier on upstream and downstream limits of Abbey River	Y	N	N	Y	Y	Not viable as high cost and high environmental impact	Would allow removal of defences on Abbey River, and provide some protection to Corbally. Would not negate the need for defences on the Shannon.
Direct Flood Defences	Y	Y	Y	Y	Y	Viable	Undertake technical assessment.
Diversion Channels or Culverts	Y	N	N	Y	y	Not viable	Would not be effective in tidal flood risk scenario
Relocation of Property Occupiers	N	Y	Y	N	N	Not viable	Large no. of properties to be re-located in flood risk area, included historic areas of the city. Partial re-location could be considered, but regeneration programme in force.
Individual Property Protection	Y	Y	Y	Y	Y	Viable (in places)	IPP may be feasible for a select number of properties, however would not be technically viable for the majority of locations. Requires a warning system to erect defences.
Pumping	N	N	N	N	N	Not viable	Prohibitively high cost, environmental and social impacts due to scale of Shannon watercourse.
Channel	N	Y	N	?	?	Not viable	Primary flood risk is tidal. Channel

Widening							widening would not be effective and would have severe environmental implications. Societal and cultural implications cannot be quantified at this stage.
Bridge/Weir Modifications	N					Not viable	Structural constrictions do not add significantly to flood risk. Would not be effective. Economic, environmental, and cultural measures would not be relevant.

3.2.3 Technical assessment of potentially viable measures

Following the initial screening, the following flood risk management measures were identified as potentially viable measures for King's Island, and were taken forward for further technical assessment. The potentially viable measures were then considered on an area-by-area basis in the Options Assessment, taking into account the constraints faced on different parts of the island. The potentially viable measures consisted of:

- Do nothing;
- Do minimum; and
- Structural Measures:
  - -Direct defences including:
    - -Reinforced Concrete (RC) Walls;
    - -Enhanced and raised quay walls; and
    - -Engineered Earth Embankments.
  - -Individual Property Protection; and
  - -Tidal barrier with upstream fluvial storage.

Do Nothing

The 'Do Nothing' scenario is defined as the option involving no future expenditure on flood defences or maintenance of existing defences/channels. The implication is that the existing risk of flooding persists in the study area and possibly worsens over time due to worsening condition of the banks and effects from climate change.

This is not a sustainable option, so it was not considered further.

Do Minimum

The "Do Minimum" measure would involve ongoing maintenance works in order to maintain the existing standard of protection and would generally include measures such as repairing and reinforcing existing walls and embankments. This option does not address the potential for an allowance for climate change and increased flood levels on Kings Island.

This option was not considered further.

Structural Measures

Direct flood defences

The construction of direct defences along the banks of the existing river would contain flood volumes and flows within the river channel and may take the form of embankments, reinforced concrete walls or sheet-piling.

The final choice of method, i.e. embankments or reinforced concrete / sheet piled walls, was selected to undergo further detailed site investigation during Phase I. It was not appropriate to use the full Multi-criteria Analysis (MCA) processes to choose between construction techniques within the various areas, as it was important to not only consider options that are feasible in terms of cost. In these situations, the lower environmental impact measure may be more expensive. Therefore, in order to provide an informed debate, a simplified MCA was undertaken on the two main construction techniques.

In general, it was considered that embankments would be more suited to the northern part of the island, where space allows. Embankments are already part of the landscape character and require a more natural finish to blend in with the existing landscape. In the southern, urban part of the island, space is limited and lengths of both formal and informal flood defence walls already exist. This was determined as a viable option. Within each area-based discussion, the most appropriate form of direct defence was proposed as the direct defence measure, and the reason for this choice explained in the Options Report.

Individual property protection (IPP)

This measure involved protection of properties on an individual basis. This would typically consist of demountable barriers, which are effective to approximately 0.6m flood depth. Above this depth, the water pressure on the walls of typical domestic properties would likely cause structural damage. IPP would also include measures to seal or otherwise secure windows and vents and may involve tanking buildings above and below ground to resist ingress of water.

IPP measures were not considered feasible as a standalone measure, due to the large number of properties at risk and the large predicted flood depths. However, there are some flood cells where smaller numbers of properties are at risk and IPP could be used in conjunction with existing or new structural measures.

Demountable barriers have the disadvantage of requiring a timely flood warning to ensure they are erected prior to the flood occurring. There is a warning system in use in Limerick City, which allows for deployment of barriers along Clancy's Strand and O'Callaghan Strand. Risks associated with their use include failure to respond quickly enough or inconvenience caused by deployment without a flood occurring. However, they have the advantage of being relatively cheaper than lengths of flood wall and can be used to target specific 'at risk' buildings. They also provide a more discrete finish in areas of high visual or historical amenity value, or where views are to be protected.

It is important that a continuous and passive response to flood management is provided where possible. Because of the risks associated with the timely erection of the barrier, any measure involving IPP which places a significant number of people or properties behind demountable defences was screened out as being non-technically viable. In localised situations, and where alternatives are either non-viable or non-cost beneficial, the use of IPP was considered.

Tidal barrier and upstream storage

The option to install a tidal barrier would involve providing it downstream of Limerick City. It was found that the optimum location for the tidal barrier would be close to Coonagh West, just downstream of the Limerick tunnel. This location would have the added benefit of providing protection from tidal flooding to the whole of Limerick City, when installed in conjunction with fluvial storage upstream.

In this location, the barrier would have an approximate length of 435m, from bank-top to bank-top. In summary it was found that even with the tidal barrier in place, and defending against the peak 0.5% AEP tide level, the maximum water level upstream in Limerick City would remain very similar for every configuration that was tested. This is due to insufficient capacity upstream of the tidal barrier and significant fluvial flows during the period of barrier closure. The maximum reduction realised in a given configuration was approximately 100mm. Significant defences would still be required at King’s Island and the scale of works required as part of a tidal barrier could not be justified for such a small reduction in flood defence level. In addition, the works that would be required to span the estuary and provide the required upstream storage would be significant and would pose numerous environmental challenges.

There is already considerable upstream storage provided through the ESB's Ardnacrusha Power Station and Parteen Weir, which allow extensive tracts of floodplain submergence during extreme floods.

Provision of sufficient additional storage that does not impact on existing development is not possible.

3.3 Options Assessment

The Options Assessment Report presented the various structural and non-structural defences in the wider context through screening all available alternatives considered (as described above in Section 3.2), and from the screening process developed options specific to each flood cell, of which there are 14 on King's Island.

Flood cells are defined on the basis of the extent of the 0.5% AEP flood extent across King's Island. There are two flooded cells, Flood Cells A and B as shown in Figure 4-1 in Volume 3.

Flood Cell A- This is the predominantly residential part of the island and currently has a level of flood protection primarily provided by embankments and additional sandbags, although walls also contribute to the perimeter protection. One of the key constraints of this area is the Lower River Shannon Special Area of Conservation (SAC) and the proximity of its boundary relative to the proposed flood relief options. It includes the following sub-areas:

Table 3-2. Flood Cell A sub areas

Flood Cell	Area of Scheme	Approx Start Chainage	Approx End Chainage
A1	Thomond Bridge to Verdant Place (as constructed)	0+000	0+260
A2	Verdant Place steps and crèche	0+260	0+365
A3	North West Embankment	0+365	1+250
A4	St. Mary's Park / SAC	1+250	1+920
A5	Star Rovers to Athlunkard Boat Club	1+920	2+500
A6	Athlunkard Boat Club	2+500	2+655
	Athlunkard Street/Bridge - no works in this section	2+655	2+670
A7	Sir Harry's Mall	2+670	2+880
A8	Absolute Hotel Boardwalk	2+880	2+910
A9	South of Absolute Hotel Boardwalk to Abbey Bridge	2+910	2+960
	Island Road - no works in this section	2+960	2+965
A10	Abbey Bridge to Baal's Bridge	2+965	3+020
	Mary Street - no works in this section	3+020	3+035

Flood Cell B- This is the predominantly commercial part of the study area. Where there is flood protection, it is in the form of quay walls. However, there is no defence provision around the Potato Market and civic buildings on Merchant's Quay. Relating new flood management measures to the existing built environment is the key constraint in the south of the island. It includes four sub-area B1-B4.

Flood Cell	Area of Scheme	Approx Start Chainage	Approx End Chainage
B1	George's Quay East	3+035	3+070
B2	George's Quay West	3+070	3+265
	Bridge Street – no works in this section	3+265	3+275
B3	Potato Market and Civic Buildings	3+275	3+705
B4	King John's Castle to Thomond Bridge - no works in this section	3+705	

3.3.1 Potentially Viable Measures

A number of potentially viable flood defence measures were identified for each flood sub-cell. The potential measures were screened and used to inform the development of two Potential Options for the proposed FRS.

Table 3-3. Summary of Potential Measures

Area	Potential Measures

A1 - Thomond Bridge to Verdant Place	Advanced works completed
A2 - Verdant Place Steps and Crèche	Direct defences
A3 - North West Embankment	Direct defences
A4 - St Mary's Park / SAC	Direct defences - Inner alignment Direct defences - Outer alignment
A5 - Star Rovers to Athlunkard Boat Club	Direct defences
A6 - Athlunkard Boat Club	Direct defences and IPP
A7 - Sir Harry's Mall	Direct defences - boardwalk and glass panel
A8 - Absolute Hotel Boardwalk	Regrade ramps
A9 - South of Absolute Hotel Boardwalk	Direct defences
A10 - Abbey Bridge to Baals Bridge	Direct defences
B1 - George's Quay East	Direct defences - raise existing wall
B2 - George's Quay West	Direct defences
B3 - Potato Market and Civic Buildings	Direct defences Road raising and IPP
B4 - King John's Castle	Do nothing

3.3.2 Development of Options

This section further develops the potentially viable measures identified above into options. At this point, Multi Criteria Assessment (MCA) for each flood cell was carried out to aid in the selection of the preferred option. Table 3-4 provides a summary of potential measures for each area. From these measures, two potential options have been developed.

Table 3-4: Summary of potential measures

Area	Potential Measures
A1 - Thomond Bridge to Verdant Place	Advanced works completed
A2 - Verdant Place Steps and Crèche	Direct defences
A3 - North West Embankment	Direct defences
A4 - St Mary's Park / SAC	Direct defences - Inner alignment or Direct defences - Outer alignment
A5 - Star Rovers to Athlunkard Boat Club	Direct defences
A6 - Athlunkard Boat Club	Direct defences and IPP
A7 - Sir Harry's Mall	Direct defences - raise existing wall
A8 - Absolute Hotel Boardwalk	Regrade ramps
A9 - South of Absolute Hotel Boardwalk	Direct defences
A10 - Abbey Bridge to Baals Bridge	Direct defences
B1 - George's Quay East	Direct defences - raise existing wall
B2 - George's Quay West	Direct defences
B3 - Potato Market and Civic Buildings	Direct defences or Road raising and IPP
B4 - King John's Castle	Do nothing

The potential viable measures were combined to create potential options which would manage flood risk and achieve the objectives set at the outset of the study. As the proposed FRS is predicated on providing a consistent standard across the whole island, a direct defence scheme is the preferred strategic solution.

These potential options show variation in only one area, with the remaining parts of the flood cell having only one potential measure.

Table 3-5. Potential options for Flood Cells A and B

Flood Cell	Option	Description
A	1	Inner alignment at A4
	2	Outer alignment at A4
B	1	Direct defences at B3
	2	Road raising and IPP at B3

3.3.3 Assessment of Potential Options

Analysis was carried out for the two identified flood cells, on the basis that the choice of option in one flood cell would not impact on the choice in the other flood cell. Drawing on the potentially viable measures, two alternative options were identified for each flood cell, as summarised in Table 4-3.

The design standard for this study by which the highest water levels are predicted is the 0.5% AEP event for tidal flood risk. The option selected must achieve this design standard but must also have provision for adaptability to future scenarios and rising water levels due to the effects of climate change.

The merits of the alternative options were summarised on the basis of:

- Cost
- Multi-Criteria Analysis (MCA) score
- Environmental and ecological impact
- Process and programme
- Climate change adaptability.

Also taken into account in the selection of the preferred option was the combined professional judgement of the steering group members and consideration of the core messages which arose during the stakeholder consultation process.

Cost

A full build-up of costs was provided in the Options Report. These costs were as presented at the December 2017 Public Information Day and were changed following the refinement of the preferred option.

MCA Outcomes

The effectiveness of each of the viable options can be measured in terms of how it achieves a set of flood risk management objectives. This section summarises the detailed multi-criteria analysis (MCA) of the shortlisted options which was carried out to evaluate the performance of each option in terms of predefined objectives. It follows the OPW Guidance Note adopted for the Flood Risk Management Plans, which was applied the detailed scheme appraisal.

As part of this process, each objective was given a global and local weighting. Each option was then scored relative to the present-day situation (baseline), based on how well they met the objectives. The output from this stage was a total weighted score for each option. The option with the highest score was deemed to be most desirable.

Following the completion of the multi criteria analysis the following outcomes were given:

Criteria Scores: The MCA produced a weighted score for each objective and the sum of these within each of the criteria classifications is the Criteria Score, Table 3-6.

- **MCA Benefit Score:** The sum of the scores for the economic, social and environmental criteria. It excludes the technical criteria score. This score represents the net benefits of the option; and
- **Option Selection MCA Score:** The sum of the scores for all four of the criteria. This score compliments the MCA Benefit Score with the Technical Criteria Score, and hence includes

all of the aspects that should be taken into account in considering the preferred option for a given location.

Table 3-6: Criteria Scores

Criteria	Option A1	Option A2	Option B1	Option B2
Technical	1100	1100	900	500
Economic	299	299	128	73
Social	927	929	554	532
Environmental	-382	-530	-270	-218
MCA Benefit Score	844	698	412	385
Options Selection Score	1944	1798	1312	885

When the MCA Benefit Score and Options Selection Score are considered, the highest scoring option for Flood Cell A is the inner alignment, and in Flood Cell B is direct defences with road raising. The results of the assessment are discussed further below.

Assessment of Flood Cell A

The two options for consideration in flood cell A were the inner and outer alignment. The assessment considered that:

- The MCA scores for technical, economic and social criteria did not provide enough of a difference to allow a decision to be made as to which option was preferred;
- Construction techniques for each are reasonably similar, with the result that there is relatively little to distinguish them;
- The measured cost for the outer alignment is approximately 15% more expensive than the inner as a result of the substantial removal of the existing embankment, required sheet piling of the embankment on the wet-side and a highly restricted construction method;
- In addition to the measured costs, further specialist hydrogeological and ecological surveys would be required to demonstrate that the sheet piling would not impact on the integrity and functioning of the wetland;
- There is a significant difference between the environmental and ecological impacts of the two options, reflected in the MCA scores of -382 and -530 for the inner and outer alignments respectively. Because the existing embankment and footpath fall within the SAC and are bordered by alluvial woodland and wetland on the wet and dry sides respectively, proposals for construction in this area can only be progressed subject to Appropriate Assessment;
- The ecological impacts of raising the flood defences on the outer alignment, and encroaching further into the SAC, would give rise to additional Appropriate Assessment Screening and may not be permitted; and
- Both options are equally adaptable for climate change on a technical basis, although the visual impacts of the inner alignment will be greater, given the proximity of the route to the residential part of the island.

On the basis of the above, Option A1 (inner alignment) was progressed as the emerging preferred option and presented to the public as part of the Public Information Day.

Assessment of Flood Cell B

The two alternative options considered in flood cell B are B1, direct defences coupled with road raising, and B2, road raising with IPP. The key differentiating factors between these two options are cost, technical viability (in terms of the forecasting and manual erection of demountables needed in B2) and loss of access to the public realm and buildings while demountables are in place. The assessment concluded that:

- The measured construction costs for Option B1 is 450% more expensive than Option B2;

- There is little to choose between the overall MCA scores, although direct defences score more highly in the technical criteria because the walls will form a passive system, where IPP relies on receipt of flood warning and a manual intervention;
- The walls score lower on the environmental criteria, primarily because there will be some in-channel works required to construct the cantilevered walkway and defences around the courthouse. Further north, the walls can be constructed from the landside;
- Operationally, the difference between the two options is linked to the public realm. If Option B2 is progressed, there will be periods when access to the Courthouse will be blocked, and the rear of the civic buildings and public walkway alongside the river will be flooded. It is noted that the civic buildings and city hall are used as the head-quarters for emergency planning, so a key element of working with Option B2 will be the development of a revised Major Emergency Plan, including designation of an alternative operation base, to be used in the event of flood warnings being issued;
- Option B2 does not provide a passive flood defence for any of the buildings; protection is reliant on receipt of a flood warning and deployment of flood barriers. This may result in precautionary erection of flood barriers when no flood occurs, and, in the worst-case situation, non-erection of barriers and a flood event happening;
- Provision of direct defences will allow permanent access to the buildings and public spaces, even in times of flood, and does not rely on the receipt of flood warnings. However, there will be an impact on architecture and heritage, including the protected structures, and some loss of visual amenity both for those in the Court house looking out and those viewing the south side of the courthouse from across the river; and
- The direct defences will be designed to be adaptable under climate change scenarios, although the nature of the glass panels means only one incremental increase in height is considered feasible. Road raising and IPP are not adaptable, so Option B2 is limited in time. Adapting Option B1 to climate change will require more innovative approaches, coupled with the raising of the glass walls, and may include alternative land use and building design.

When considering the cost benefit of the options, B2 would emerge as the option to carry forward. However, this option fails to meet the criteria and operational constraints detailed by Limerick City and County Council, which are full addressed by Option B1.

3.3.4 Emerging preferred option

Having assessed the various measures and options in each flood cell, conclusions were drawn to inform the emerging preferred option.

The emerging preferred option is A1-B1, Inner alignment in Area A4 and Direct Defences for Area B3. Such an option represents the combination which meets the council's brief for passive flood defences and will ensure the most sustainable, long-term use of the area around Merchant's Quay. It also provides advantages through MCA, including significant benefits in avoiding works within the SAC boundary at the north of the island.

A detailed description of the proposed FRS is provided in Chapter 4 - Description of Proposed FRS.

3.4 Scoping Stage

This Scoping Report was the first stage in the preparation of the EIAR. The Scoping Report introduced the proposed FRS, defined the location and extent of works, identified the key environmental issues and receptors in the vicinity, the potential impacts of the proposal, and identifies the likely environmental studies that are required to inform the full EIAR.

The information in this report was based on:

- Information gathered during earlier stages of the project including the Constraints and Options stages;
- Existing environmental data bases, reports and mapping; and
- Consultation with stakeholders and the public.

Table 3-7 summarises the findings of the initial scoping exercise. It was decided that there could be potential impact (negative or positive) with respect to all aspects of the environment and the EIAR will assess all aspects of the environment at relevant phases. As has been described, it was decided that the following disciplines would be further assessed in the EIAR.

Table 3-7. Summary of the scoping assessment findings

Environmental Topic	Construction Phase	Operational Phase
Population and Human Health	x	x
Material Assets	x	No significant impact predicted
Road and Traffic	x	No significant impact predicted
Water	x	x
Cultural Heritage	x	x
Biodiversity	x	x
Landscape and Visual	x	x
Geology and Soil	x	x
Air and Noise	x	No significant impact predicted
Climate Change	x	x
Interaction between environmental aspects	x	x
Cumulative impacts	x	x

The Scoping Report is intended to outline key issues to be addressed in the preparation of the EIAR and NIS for the FRS. Consultation with the public, statutory organisations, and non-statutory organisations was undertaken to ensure input from all interested parties from the earliest stages of the EIAR and NIS preparation.

The Scoping Report was issued to statutory consultees as part of the consultation phase of the EIAR. The results of the statutory consultation and public consultation are described in Chapter 5.

4 Description of Proposed FRS

4.1 Introduction

This section of the EIAR outlines the development of the proposed FRS for King's Island as shown in Figure 5-1 Site Location Map, Volume 3. The proposed FRS has been previously described in the project Options Assessment Report[11] as the Emerging Preferred Option. Generally described, it is a series of flood defences positioned around King's Island comprising both new and upgraded flood walls (incorporating transparent panels in the urban areas) and earth embankments plus associated public realm improvements. It is discussed in detail below.

4.2 Preliminary Engineering and Landscape Design Elements

A description of the engineering and landscape design elements of the projects is included below.

4.2.1 Flood Embankment Design

The proposed embankment for areas A3 to A5/A6 (Ch 0+330 to 0+1250) is set back on the inside of the existing embankment along the west and northwest of the island and then is positioned south between St. Mary's Park and the wetland before turning east and continuing along the inside of the existing embankment along the east of the island along the football pitches to Athlunkard Boat Club. Approximately 2,200 linear metres of embankment will be formed. The material will comprise 93,900m^3 of inert engineering fill, 43,000m^3 of landscape fill (class 4) and 6,700m^3 of topsoil, totalling 143,600m^3. The top of the embankments will be 0.2m above the flood defence level, which is 5.3mOD Malin on the River Shannon and 5.1mOD Malin on the Abbey River. The typical embankment height is 3 to 3.5m above ground level.

The embankment will be constructed of impermeable clay, with a top width of 5m, typically, with local widening points. The clay will typically slope down at a 1(V):3(H) slope on both sides. Topsoil excavation will be required along an approximately 3m wide strip beneath the embankment in order to key the embankment into the existing ground and block seepage along the base of the embankment.

Additional landscape fill and topsoil will be placed at a shallower gradient (typically 1(V):1.75(H)) along the slopes of the proposed embankments in order to blend into the surrounding landscape of St. Mary's Park. Overall, with the total width will range from 16 to 70m but will vary at different locations and is designed to blend into St. Mary's Park and mitigate impacts to the landscape character. The surface would be seeded with meadow grassland. A new bitmac footpath (3m wide) is proposed along the top of the embankment, with breakout areas to allow street furniture in the future.

Refer to Arup engineering drawings KIRFS-C-103, KIRFS-C-104, KIRFS-C-105.

4.2.2 Flood Wall Design

The proposed wall in Area A1 will be a continuation of the existing flood defence wall constructed at Verdant Pace, with steps to allow access to the river. The wall will be founded on piles.

In Area A2, a flood defence reinforced concrete wall, with stone facing on both sides, founded on piles is proposed. The existing footpath will be raised to maintain a pedestrian view and guarding height of 1.1m. Excavations will be required to a depth of 1.5m for the wall foundation and pile cap. The excavation will be approximately 3m wide.

In Area A6, a flood defence reinforced concrete wall founded on piles will tie in to the proposed embankment at the northern end of Athlunkard boat club. There will also be an additional piled retaining wall to support a raised ground height for the new vehicle access at this location. Excavations will be required to a depth of 1 – 3m for the wall foundation and pile cap. There is also a manhole (4m depth x 2m diameter), and intertidal storage tank (2m depth x 10m width x 10m length), as outlined in the works description for this area.

11 JBA Consulting and Arup, on behalf of LCCC (v5, 2018) *Options Assessment Report for Flood Relief Scheme at King's Island, Limerick*, unpublished

The proposed wall design for Area A7 will be raised from its existing level to the flood defence level and strengthened, requiring excavation to construct the wall foundations. Excavations will be required to a depth of approximately 1.5m to construct the wall foundations. The excavation will be approximately 2 – 3m deep and 2m wide.

In Area A9 the existing parapet wall is to be replaced with a new reinforced concrete wall, to a height of 1.4m above ground level, which will be faced to match the existing stone finish. The wall will be founded on piles to be constructed from a jack-up barge or pontoon in the Abbey River. The existing footpath will be excavated in order to construct the new wall and foundations, which will be approximately 1.5m in depth. Demolition of the existing wall parapet will also be required.

In Area A10 the entire length of the wall will be replaced with a new reinforced concrete wall with stone cladding to a maximum height of 1.4m, to match the existing stone finish. The existing footpath will be excavated in order to construct the new wall and foundations. Excavations of approximately 4 – 5m depth and 3m wide at ground level will be required to install a mass concrete backing wall. Demolition of the existing wall parapet will also be required. Ground anchors through the existing quay wall may also be required to strengthen to existing quay wall.

In areas B1/B2, the proposed new parapet wall will be a gravity wall with ground anchors through the existing quay wall, interspersed with stretched of glass flood defence panels founded on a mass concrete backing. Existing large trees will be protected, managed (crown raised and removal of basal sucker) and retained during the construction of the new concrete walls and glass panels. Excavation will be required for installation of the mass concrete backing and flood wall of 4 – 5m depth and 3m wide at ground level in the location of the glass panels. Excavation will be required for the proposed gravity foul sewer to a depth of 2 to 3m and 1.5m wide at ground level.

The proposed flood defence walls in Area B3 consist mainly of glass panels founded on a mass concrete backing wall. Excavation of 4 – 5m depth and 3m wide at ground level will be required for the mass concrete backing wall. Around the Courthouse, it is proposed to remove the existing boardwalk and construct a new flood defence wall with glass panels, founded on piles. Additional concrete L-walls will be required in the area around the entrance to Curragower Boat Club and the Sylvester O'Halloran Bridge. A pedestrian access ramp will also be provided at the Sylvester O'Halloran bridge entrance, while a flood gate will maintain access to the boat club. Excavations up to 1.5m depth will be required for the wall foundations at these locations. Two inter-tidal storage tanks will be built at Merchant's Quay, the first of which will have a depth of excavation of 3.2m and width of approximately 9m. Sheet piles will be used to form the excavation. The second intertidal tank at LCCC offices will have a depth of excavation of 2.5m, with varying width but will extend as far as the proposed defence wall.

Refer to Arup engineering drawings KIRFS-C-102, KIRFS-C-106, KIRFS-C-107, KIRFS-C-109, KIRFS-C-110, KIRFS-C-111, KIRFS-C-113, KIRFS-C-114, KIRFS-C-116.

4.2.3 Lighting Design

The lighting design along the pedestrian and cycling pathway at the proposed King's Island Flood Relief Scheme development will be as per the following relevant guidelines and standards:

- BS 5489 Code of practice for the design of road lighting;
- IS EN 13201 Road Lighting requirements;
- Bats & Lighting Guidance Notes for Planners, engineers, architects and developers (Bat conservation Ireland, December 2010);
- CIBSE Lighting Guide 6 Illuminating the Outdoor Environment; and
- CIBSE Lighting the Environment - A guide to good urban lighting.

The light fittings on the proposed embankment around St. Mary's Park will be mounted at 6m above ground level and at approximately 30m centres. The columns will be of aluminium construction and their colour and finish is as shown in the Landscape Strategy Document accompanying the planning application.

All light fittings will be LED, have asymmetrical projection i.e. directional, and with colour temperature of 2700K (warm spectrum preferred by bats). The radiation will be above 500nm to avoid blue or UV light, most disturbing to bats. The lights will be positioned facing away from the River Shannon and the SAC to minimize impact on bats along this route; i.e. in Area A3, the lights will be facing east, while in Area 4, the lights will face west as the footpath alignment on the embankment turns to run parallel with St Munchin’s Street.

The lights will be on during hours of darkness to provide a minimum light level for security to the footpath on the proposed embankment. The lights will be dimmable with individual photocells fitted to each light fitting, which will allow the lights to switch on automatically at dusk at a low output and slowly dim up to their full output as the natural light decreases. This will minimize light spill for mammals at dusk which is their peak time for feeding when they exit roosts/setts/holts for foraging. The lighting will also be controlled by occupancy/motion sensors so that it will remain at a low output if there was no pedestrian traffic or mammal activity nearby. This will also mitigate light overspill into the rear of residential properties on St Munchin’s Street although tree planting in this area will filter the lighting from the embankment into the rear of the properties.

Refer to drawings KIFRS-E-101 to 110.

4.2.4 Landscape Design and Public Realm

The Landscape Design comprises landscape and visual mitigation plus public realm proposals across the scheme. The landscape design proposals are presented in the Landscape Design and Public Realm Strategy which forms part of this planning application.

Landscape design works include:

- Visual mitigation to the existing riverside wall to blend the finishes and coping into the proposed wall in areas A1/A2;
- Softening of the gradients of the engineering flood embankment to enhance the adjacent public open space in area A3; and
- Tree planting to filter visibility from embankment to the rear of properties in St Munchin's Street in area A4.

Additional public realm aspects will include:

- Pitch reorientation and environmental enhancement around the Star Rovers sport pitches in area A5;
- Provision of a 3m wide combined footpath and cyclepath around the north of the island around St. Mary's Park and the SAC (in areas A3-A5), which will include improved lighting, spaces for permanent outdoor furniture, and improved connections to the residential streets in St. Mary's Park;
- Upgrading of footpaths, and tree planting within the urban areas A6-A10 and B1-3; and
- Suitable wall finishes to blend in with the historic flood walls, and the addition of transparent glass panels to improve views out to the Abbey River and the River Shannon in areas A6-A10 and B1-3.

Refer to drawings KIFRS-A-001 to KIFRS-A-013.

Refer to Arup/ Nicholas de Jong Landscape Design and Public Realm Strategy Report (2019).

4.3 Proposed Option

On the basis of the information provided above and detailed in the Options Assessment Report, the emerging preferred option comprises direct defences along the inner alignment for area A4, and along the outer alignment for areas A1-A3 and A5-B3. This is the combination which meets the Limerick City and County Council/OPW brief for passive flood defence, and one area of demountable flood barriers around Merchant's Quay. It also provides advantages identified through multi-criteria analysis (MCA), including significant benefits arising from avoiding works within the SAC boundary at the north of the island. This EIAR describes the impacts from the preferred option, which are detailed below.

A detailed description of the proposed FRS and associated drawings, photomontages, and design strategies, accompany the planning application.

4.3.1 Area A1 - Thomond Bridge and Verdant Place (Ch 0+00 to 0+260)

A1 Existing Condition

Area A1 extends north from Thomond Bridge along Verdant Place to where the footpath on the western side of the island meets the public road. Flood defence works were carried out along this length of Verdant Place in 2017. The existing wall was raised by circa 0.6m to form the external (river side) face of a new reinforced concrete flood defence wall constructed immediately on the inside of the existing masonry wall. The inside of the wall (road side) of Verdant Place was clad with stone to resemble the outside of the wall (river side). It was then capped with a concrete coping. Details were agreed in consultation with LCCC's relevant heritage and architectural professionals.

The smaller section of the wall to the south, is lower than the northern section relative to footpath level, and was not altered as the ground level is already above the flood defence level as it rises up towards Thomond Bridge.

A1 Design Proposal

Subsequent to the previous work, the much lighter colour of the concrete coping relative to the rest of the wall, is considered to be too stark, especially when viewed from the river side. To resolve this, it is now proposed to paint the coping in a darker shade of grey to blend in more with the existing wall, as can be seen in Photomontage 2, Volume 4.

A new grey concrete coping and associated railing atop is proposed along the southern section of wall to meet the required guarding height. This will replace the existing safety railing which currently sits inboard of the masonry wall.

Verdant Place drainage has been addressed as part of the initial Advanced Contract as undertaken by Wills Bros Ltd. in 2016. No further construction works are proposed.

4.3.2 Area A2 - Verdant Place Steps and Crèche (Ch 0+260 to 0+365)

A2 Existing Condition

To the west of the creche, an old embankment exists along the SAC boundary, but is in poor repair. Between the creche fence and the embankment, there is a circa 1.5m wide footpath. The Verdant Place River Access Steps are located to the south west of the creche and lead down to the edge of the River Shannon. The flood defence works carried out in 2017 included the addition of a temporary concrete barrier where the Verdant Place steps are located, and the addition of an access staircase over the defence wall which leads down onto the steps. This was installed as a temporary measure to provide some protection to the crèche, as the top steps are much lower than the required flood defence level.

A2 Design Proposal

South of the crèche, there is not enough space to accommodate a new flood defence embankment between the walkway without encroaching into the SAC. It is therefore proposed instead to replace the old embankment and temporary concrete barriers with a new stone clad reinforced concrete flood defence wall, approximately 70m in length and 1.2m in height. This stretch of wall will require piled foundations due to the poor ground conditions in the area. The section of new wall around the Verdant Place Steps will be designed to match the existing section of wall in this area and will be painted grey in the same way as outlined for Area A1 above. The access staircase will not be painted to provide contrast and will be left in place to provide access over the flood defences and down to the Verdant Place steps, as it is used by locals for recreation and to access the River Shannon. The new section of proposed wall will extend northward from the crèche until the point where the proposed embankment (described in the following section) and walkway achieves a ground elevation at flood defence level of 5.3mOD. It will finish with a pier at this location. This new section of defence wall will be stone faced on both sides. The existing footpath alongside the new wall will be raised to a minimum level of 4.1mOD and slope to maintain a relative wall height of 1.2m. The footpath will be a bitmac surface and will tie into the existing walkway and the new walkway along the proposed flood defence embankments. The raising of the existing walkway will maintain views of the River Shannon along the pathway. Street lighting will be provided along this stretch with lighting columns which are 6m in height, and will be consistent with the lighting proposed along the flood defence embankments around the north of the island.

There is an existing storm outfall immediately west of St Mary's Crèche and Community Centre. The existing non return valve is damaged and will be replaced as part of the proposed Scheme. An overflow will be provided to the filter drain and swales to the north for storage during pluvial events while the outfall is surcharged. Refer to Drainage drawing KIFRS-C-200.

4.3.3 Area A3 - North West Embankment (Ch 0+365 to 1+250)

A3 Existing Condition

There is currently an existing embankment encircling the north of the island with an associated footpath running along its crest. Approximately 520m of the existing embankment's length is located within the SAC. Large sandbags were previously installed as temporary flood defence measures along the embankment crest, during a previous high flood event. However, many of these sandbags are damaged and no longer provide adequate protection. There is an open drain on the landward (eastern) side of the existing embankment which currently contains a protected species, pondweed (*Groenlandia densa*).

A3 Design Proposal

A new flood defence embankment is proposed along 920 metres of the northwest perimeter of the island. It will be constructed on the inside of the existing embankment. The crest of the new embankment will be at the flood defence level of 5.3mOD. It will have a crest width of 5m and be constructed of a low permeability clay core. Local widening will occur at discrete points to allow for the future provision of street furniture and outdoor exercise equipment by LCCC. The embankment core will typically have a maximum side slope of 1 in 3 on both sides. In many cases, the final side slopes will be much shallower to form a sinuous landscaped embankment. The shallower sides slopes, outside of the clay core, will be constructed of general fill, making use of suitable excavated material to minimise the need for offsite disposal. A hollow between the new and old embankments will be avoided by infilling the area with suitable fill, thus avoiding any potential for standing water in this location. The embankment surface will consist of meadow grassland. The total width of the embankment will range from 16 to 70m but will vary at different locations and is designed to blend into the open landscape around St. Mary's Park. A new bitmac footpath (3m wide) will be constructed along the embankment crest tying into cross connecting paths to the St. Mary's Park residential estate to the east and south. Street lighting (6m high columns) is proposed along the outside of the walkway. Luminaires will be directed inward, away from the SAC.

The proposed embankment will envelop the existing drainage ditch which currently contains the protected pondweed. Along the northwest corner of the island, a replacement open ditch is proposed on the inside of the proposed embankment. This open ditch provides replacement conditions for the pondweed (*Groenlandia densa*) to be translocated under licence from the existing ditch. Filter drains are proposed on the inside of the proposed embankments to the north and south of the proposed open ditch, to a depth of approximately 1m. Refer to Drainage drawing nr KIFRS-C-202.

There is an existing outfall to the River Shannon towards the north-west corner of the island, taking discharge from an existing open drain on the inside of the existing embankment. As part of the Scheme, this outfall will be decommissioned, with a new outfall being constructed taking discharge from the southern end of the new open ditch. A new replacement outfall is outlined on drawing nr KIFRS-C-201.

It is proposed to provide an access ramp adjacent to the embankment to allow fishermen access the existing mooring points in the area between Ch. 0+850 and 0+950.

4.3.4 Area A4 - North East Embankment (Ch 1+250 to 1+920)

A4 Existing Condition

Similar to the north west of the island, there is an existing embankment in poor repair wrapping around the perimeter of the island (within the SAC), It also includes large sandbags which are badly damaged. A section of this embankment was breached in the past and has since been temporarily repaired with sheet piling that protrudes out of the ground by more than 2 meters in some places. There is a historic remediated landfill to the rear of the houses along St. Munchin's Street and further south a bund has been created where Japanese Knotweed removed from elsewhere was placed.

A4 Design Proposal

The proposed flood defence embankment is approximately 850m in length and is to run along the rear of the houses on St. Munchin's Street. Where the embankment passes by the existing Japanese Knotweed bund, a small part at the northern end of the bund will need to be excavated locally to provide sufficient space for the embankment corridor. The excavated material will be replaced on top of the existing bund (not within the SAC) which will be reprofiled. This work will be undertaken in accordance with current best practice with regard to invasive species. The bund will subsequently be treated on site as part of a multi-year eradication programme.

The dimensions of the embankment will be similar to the north west embankment, (5m crest width), composed of a low permeability clay, subsoil and seeded with meadow grassland. As the embankment will be constrained for space (by the rear of the back gardens of the houses on St. Munchin's Street to the west, and the SAC to the east), its side slopes will not be graded to the same extent as in St. Mary's Park. A number of connecting paths will be provided to connect St. Munchin's Street to the embankment walkway. Street lighting will be installed on the outside of the walkway, similar to the north west embankment. Semi mature trees will be planted between the houses and the embankment to screen overlooking of the properties from the raised ground level.

At present, overland flows from the rear of houses fronting onto St Munchin's Street discharge to the SAC and ultimately to the Abbey River via the ‘Green Lady’ outfall which is located towards the north-east of the Island.

Drainage from the inside of the new flood embankment will be conveyed to extended open drains within the SAC. It is proposed that the outfall and head walls will be constructed outside of the SAC prior to extending the existing open drains to connect with same. The northernmost outfall through the eastern embankment will discharge at ground level outside of the SAC boundary. Non-return valves will be provided to all outfalls.

Filter drains will be installed on the inside of the embankments and will discharge through the embankment and into existing open drains within the SAC. In some locations, the existing open drains will need to be extended westwards to meet the outfalls through the new embankments. These outfalls will be fitted with non-return valves. The filter drain running along the inside of the embankment at the southern end of area A4 will discharge to the existing open drain to the north of Star Rovers.

The footpath along the existing embankments on the eastern side of the island adjacent to the River Abbey will remain in place. The short length of path adjacent to and inside the sheet piling will be repaired with the sheet piles cut down, removing the current break in the existing walkway.

Refer to Drainage drawings nr KIFRS-C-203 and 204

4.3.5 Area A5 - Star Rovers to Athlunkard Boat Club (Ch 1+920 to 2+500)

A5 Existing Condition

The existing embankment and sandbags are in a state of disrepair and continue along the perimeter of the island until the boundary of the Athlunkard Boat Club. An existing open drain runs along the perimeter of the Star Rovers pitches.

A5 Design Proposal

The proposed flood defence embankment will extend approximately 400m around the northern and eastern sides of the sports fields until it reaches the northern boundary of Athlunkard Boat Club. The SAC is very closely aligned to the northern and eastern sides of the Star Rovers FC pitches. The embankment side slopes will therefore be reduced to minimise encroachment onto the area of the pitches whilst avoiding the need for any alterations to the east-west open drain defining the boundary of the SAC. The existing north-south open drain will be infilled.

In order to provide sufficient space for the proposed embankment along the northern side of the Star Rovers pitches, the AstroTurf pitch will be partially relocated further south by approximately 17m. This will result in temporary disruption to the playing area during construction and the loss of 6 parking spaces and storage area on the western side, accessed from Assumpta Park. A row of semi mature trees will be planted along the western edge of the sports area to screen the training pitches from residents in Assumpta Park.

A 2m high paladin boundary security fence will be erected, offset 3m from the base of the embankment. as it wraps around the grass pitches. High ball-stop netting will also be erected behind the goals of both the Star Rover FC and Athlunkard FC pitches. The proposals in this area are illustrated in Photomontages 4 and 5, in Volume 4.

Drainage from the inside of the proposed new embankment both to the north and east of the Star Rovers pitch will discharge to the existing open drain at the south-east corner of the SAC. This drainage will also pick up any existing drainage from the playing pitches. A non-return valve will be provided to the proposed outfall. Refer to Drainage drawing nr KIFRS-C-205.

4.3.6 Area A6 - Athlunkard Boat Club (Ch 2+500 to 2+655)

A6 Existing Condition

The existing western boundary of the boat club is made up of concrete walls, stone walls, security railings and a security gate. Immediately to the west of the boundary wall, is a circa one metre wide strip of grass, briars, elder and ivy. West of this is an existing walkway which is also used for vehicles by the boat club users.

Foul drainage from the boat club currently discharges directly into the Abbey River.

A6 Design Proposal

A new access road/path is proposed to access the boat club at its north-western corner. The proposed embankment will be graded down from an elevation of 5.30mOD to existing ground level of 4.20mOD on the northern side of the boat club. The existing wall along the western side of the boat club will be replaced with a flood defence wall, 2.75m in height to provide a secure boundary. North of the Club House, the defence wall will be stone faced on the public footpath side, with a plaster finish on the river side. South of the Club House, the defence wall will be stone faced on both sides. The wall elevation will be simplified in design to remove a number of steps in its plan alignment. Informal shrub and climber planting will be located along the dry side of the new wall. The proposal in this area is illustrated in Photomontage 6, in Volume 4.

The footpath will be graded down to the existing public footpath on the western side of the boat club wall and will be widened to 3m for continuity with the new footpath around the island. Vehicular access will be extended as far as the existing boat club entrance to maintain the existing access route from the back of Athlunkard Street.

There are two outfalls to the Abbey River in this area. One drains Abbey View estate and some local roads via a 600mm diameter pipe. Its outfall is already fitted with a non-return valve. Inter-tidal storage will be provided via an underground concrete tank (approximately 2m depth x 10m width x 10m length) to temporarily store storm water during extreme river levels in the Abbey River, at high tide.

The adjacent outfall is understood to be an overflow from a soakaway to the underside of the green open space fronting Lee Estate. This outfall will be fitted with a non-return valve to prevent inundation from the tide.

Existing toilets and showers from Athlunkard Boat Club currently discharge to the Abbey River. A new foul sewer system will be constructed, redirecting foul drainage from the boat club to the main Limerick sewer system. This will require construction of a new manhole at a depth of approximately 4m. The existing foul sewer will be abandoned.

To accommodate the softened side slopes on the inside of the proposed flood embankment, a number of existing foul manholes will be raised by c.1.5m..Refer to Drainage drawing nr KIFRS-C-207.

4.3.7 Area A7 - Sir Harry's Mall (Ch 2+670 to 2+880)

A7 Existing Condition

An existing flood defence wall runs along the length of Sir Harry's Mall (approx. 216m). It was constructed about 15 years ago but does not reach the currently required flood defence level. A footpath runs alongside the wall over the southern portion of Harry’s Mall, with a public road immediately adjoining the wall for the northern portion.

A7 Design Proposal

The existing wall will be raised to the required flood defence level and strengthened. This requires excavation to construct extensions to the wall foundations. The wall extension will be clad to match the existing stone cladding. The extended wall will give rise to a relative wall height in excess of the maximum desirable height of 1.2m along the northern portion of the Mall. At the southern end, a new raised viewing platform will be constructed to maintain river views, with accessibility ramps at either end and steps down to the footpath and road level to improve pedestrian permeability in the area. At some breakout areas, a railing will be provided to protect pedestrians from fall. In order to maintain delivery access to the Absolute Hotel, the footpath opposite the ramp will be realigned and reduced to the recommended minimum width of 1.8m. The road will be narrowed in some locations and some parking spaces will be lost. However, one lane of traffic and one lane of parking spaces will be available to maintain the current one-way street. The proposal in this area is illustrated in Photomontage 7, Volume 4.

Storm water drainage along Sir Harry's Mall is currently drained to the Limerick Main Drainage sewer via existing road gullies. Some road gullies will be relocated as part of the scheme to accommodate the raised and stepped access on the inside of the existing flood wall. This is illustrated on drainage drawing nr KIFRS-C-208.

4.3.8 Area A8 - Absolute Hotel Boardwalk (Ch 2+880 to 2+910)

A8 Existing Condition

The existing boardwalk is at a level of 5.1m AOD and so already provides the required flood defence level.

A8 Design Proposal

The access landings at either end of the boardwalk have an existing level of slightly less than 5.1mOD. As a result, it is proposed that they will be raised by up to 100mm to 5.1mOD to meet the required flood defence level.

Drainage will remain as-is with existing gullies connected to the Limerick Main Drainage sewer.

4.3.9 Area A9 - Absolute Hotel Boardwalk to Abbey Bridge (Ch 2+910 to 2+960)

A9 Existing Condition

This 40m stretch currently consists of a more modern stone parapet wall and railing, on top of a historic quay wall, with a walkway running between the wall and the Absolute Hotel.

A9 Design Proposal

The more modern portion of the parapet wall and railing is to be replaced with a stone clad reinforced concrete wall, to a maximum height of 1.4m, but more typically 1.2m. The historic quay wall is to be retained, cleaned, pointed and grouted. The new RC wall will be supported on minipiles cored towards the rear of the existing quay wall, to a depth of approximately 1.5m. It will be clad with rough-hewn stone in a snecked pattern, laid to courses with a double chamfered rectangular stone coping.

The existing drainage system will remain as it is, with existing gullies connected to the Limerick Main Drainage sewer.

4.3.10 Area A10 - Abbey Bridge to Baal's Bridge (Ch 2+965 to 3+020)

A10 Existing Condition

An historic masonry quay wall runs along this 60m stretch of the Abbey River. There are three distinct sections of the wall which comprise different finishes and are of varying ages. The western portion of the wall is already sufficiently high to achieve the flood defence requirement, whereas the eastern half does not.

A10 Design Proposal

The entire length of the existing will be replaced with a new stone clad concrete parapet wall to a maximum height of 1.4m, but more typically 1.2m. The existing quay wall will be cleaned, repaired, grouted and repointed. It will be strengthened by the addition of a mass concrete backing wall. The eastern section of the wall will be faced with rough-hewn stone in a snecked pattern, laid to courses with a double chamfered rectangular stone. The western section of the wall will be faced with stone and coping to match existing. A new pier is proposed to define the change in visual appearance between the two sections of the wall. The proposal in this area is illustrated in Photomontage 8, Volume 4.

The existing drainage system will remain as it is with existing gullies connected to the Limerick Main Drainage sewer. The existing 150mm diameter outfall will be replaced with a 225mm diameter outfall and associated non-return valve. Refer to Drainage drawing nr KIFRS-C-209.

4.3.11 Areas B1&B2 - George's Quay (Ch 3+035 to 3+265)

B1/B2 Existing Condition

The majority of the wall in this stretch (approximately 240m) comprises of a modern RC parapet wall (mimicking cut limestone coursing), sitting atop of a more historic limestone quay wall. The parapet is broken at the location of the access point to the pontoon opposite Barrington's Hospital. It is also broken in 3 locations with railed viewing areas, concentrated at the western end. A 24m length of the existing wall is above the required flood defence height at the easternmost section but does not always provide the required guarding height of 1.1m. Railings have previously been retrofitted on the inside of these sections to provide safe guarding. The remainder of the parapet wall is below the required flood defence level. Twelve trees of medium and high amenity value are located along this stretch, species include Common Lime, Norway Maple and Oriental Plane. Three new trees ae also to be planted.

B1/B2 Design Proposal

Due to the high amenity value of the trees, the design philosophy has been to protect, manage (crown raised and removal of basal sucker) and retain them.

To meet the flood defence requirement, the existing concrete parapet wall is to be replaced by a new stone clad gravity concrete wall over most of its length and will also achieve the pedestrian guarding height of 1.1m. The wall is to be built atop of the historic quay wall which will be strengthened by pointing and grouting, coupled with the installation of ground anchors. The ground anchors will be approx. 10m in length, to be cored through the rear of the existing quay wall to bedrock. The use of ground anchors avoids the need for a new concrete backing wall, which allows the existing trees to be retained.

The stone clad concrete gravity parapet wall will be interspersed with stretches of glass flood defence panels. Glass panels will be located in the following locations:

- Around the eastern former access steps to the river:
- Around the western former access steps to the river; and
- The three western viewing areas including the spaces between them.

Where glass flood defence panels are proposed, the existing quay wall will be cleaned, repaired, grouted and repointed, and will be further strengthened by the addition of a mass concrete backing wall.

The existing pontoon has open access to George's Quay, and does not provide the required flood defence height. The pontoon will remain in place. A new wall will run along the land side of the pontoon incorporating new access steps over the wall. Flood gates were considered for this section to provide ramped access to the pontoon, but following discussions with Waterways Ireland and LCCC in relation to the use of this pontoon, it was agreed that full disabled access was not required and that stepped access would be sufficient, thus allowing for a more robust passive solution, which avoids the need for demountable barriers.

The existing steps down to the river will also be cleaned and repaired. The proposal in this area is illustrated in Photomontage 9, Volume 4.

Road raising at Bridge Street junction will also be carried out as a back-up flood defence to isolate the George's Quay flood cell from the Merchant's Quay flood cell as the latter relies on a demountable flood gate. The road raising to flood defence level, ensures that the George's Quay cell is passively protected.

In area B1, the existing 150mm diameter surface water sewer will be upgraded to 225mm diameter. The existing outfalls will be abandoned, with the proposed sewer instead discharging to the Abbey River via a new outfall to the west. A non-return valve will be provided on the outlet.

In area B2, the existing 150mm diameter sewers will be replaced with larger pipes. Gullies at the proposed ramp location on Bridge Street will convey flows from Bridge Street towards the proposed network at Georges Quay and discharge to the Abbey River via the existing outfall. Gullies and rainwater downpipes from the buildings along Creagh Street will be disconnected from the existing LMD combined sewer and diverted to a new SW sewer along the street. An overflow to the LMD sewer will be provided within the final manhole at a level of 3.75m, which is located at the lowest point along the street. This will allow the sewer network to surcharge prior to overflowing in the event of an extreme pluvial event coinciding with a tide level of 3.75m or higher in the Abbey River.

Refer to Drainage drawing nr KIFRS-C-209.

4.3.12 Area B3 - Potato Market to King John's Castle (Ch 3+275 to3+705)

B3 Existing Condition

Both the existing cantilevered viewing platform in the Potato Market and the Sylvester O'Halloran bridge access are below the required flood protection level. The Curragower Boat Club entrance and the Court House boardwalk/wall are also below the design flood defence level.

A railing runs along the quay edge, atop of the historic quay wall, alternating with sections of historic stone parapet, terminating in the corner adjacent to the outer wall of King John's Castle.

B3 Design Proposal

The cantilevered viewing opening in the Potato Market will be replaced with a glazed flood defence panel, supported by the existing quay wall strengthened locally by the construction of a mass concrete backing wall.

A stone clad ramped access structure will provide the flood defence to the existing access opening to the pedestrian bridge. The proposed flood defence ramp will be offset from the existing buildings allowing access to the existing doorway and windows. The walls along the Potato Market will be repaired where necessary, by pointing and grouting, to achieve the required flood levels. A new approximately 2.5m high independent flood defence wall will be constructed on the Potato Market side of the existing Curragower Boat Club boundary wall. Once it meets the Potato Market railing it will reduce in height to the 5.3mOD. The wall will be faced with rough-hewn stone in a snecked pattern laid to courses with a stone coping. The wall will extend through the Potato Market railings after approx. 4m length to form a pier on the other side.

An automatic flood gate will be constructed at the entrance to Curragower Boat Club. Its deployment will be triggered by an ultrasonic level gauge sited at the adjoining quay side. This will be a hinged automatic flood gate with a manual override option. For further redundancy, a secondary manual barrier will also be installed parallel to the automatic barrier, but on its dry side. An RC flood wall clad with masonry is proposed to extend northwards from the flood barrier to the next change in direction of the quay wall. It will be founded on the existing quay wall which will be pointed and grouted, and further strengthened through the construction of a mass concrete backing wall. A raised table top will be located in the area framed by this wall, the automatic barrier and the Potato Market railings, with ground levels of 4.15m AOD providing passive protection for events up to the 1 in 5 year event.

Glass flood defence panels will extend westwards at the viewing platform atop of an RC stub wall clad in masonry. This will be founded on the historic quay wall which will be pointed and grouted and further strengthened by the construction of a mass concrete backing wall. The ground level at this location will be raised by approximately 300mm to reduce the relative difference between dry side ground level and flood defence height to 1.2m thus ensuring clear views of the river are not restricted along the public walkway.

Along the cantilevered boardwalk by the Court House, glass flood defence panelling is also proposed. This will sit atop of a new shorter RC cantilever element which will replace the existing cantilevered walkway. Even though the overall width is reduced, the existing railing will be set back to provide a 2.4m wide public walkway whilst still retaining a separate security pathway around the courthouse for maintenance purposes. This glass flood defence panelling will extend to the northern boundary of the Court House. The new RC cantilever will sit atop of the historic quay wall which will be pointed and grouted. New mini-piles at circa 4m centres will be required to support the new RC cantilever slab. These mini-piles will be installed alternating with the existing ground anchors which are also at circa 4m centres.

Beyond the Court House, further glazed flood defence panelling is proposed as far as the location of the existing fountain to the west of the Civil Offices. These panels will sit atop of the historic quay wall which will be pointed and grouted and further strengthened, by the construction of a mass concrete backing wall. The proposals in this area is illustrated in Photomontages 10 and 11 in Volume 4.

To the northwest of the Civil offices, an historic Bridge links the old city wall (which is a National monument) to an historic Mill structure, the remains of which can just be seen protruding from the historic quay wall. An historic tunnel structure is also located in this area. A comprehensive desk study assessment has been undertaken to define in so far as is possible the location of all of these below ground features. However, recognising that the actual position of features may deviate slightly, a flexible flood defence and associated foundation design has been adopted which can respond to any slight deviation in alignment without compromising the structural stability of the solution or altering the above ground aesthetics. The risk will be further mitigated by undertaking additional archaeological test trenching under ministerial consent, which is due to take place in Q1, 2020. With the exception of some very short sections of glazed flood defence panels, the flood defences in this area will consist of stone clad RC parapets, founded on a grillage of bored concrete piles. The layout of the piles has been developed to avoid any damage to the archaeological features. This approach will ensure that the features are preserved in situ and recorded. It is also proposed to incorporate some interpretation boards at this location to tell the story of these historic features. At this location, six early mature Lime trees will be removed to ensure no further root damage is caused to any archaeological features in the area.

The final section of flood defences in this area, located to the north of any archaeological features will consist of further glazed flood defence panelling. These panels will sit atop of the historic quay wall which will be pointed and grouted and further strengthened, by the construction of a mass concrete backing wall. This solution will tie into high ground just south of St. John's Castle but without any direct connection to the Castle structure itself, thus avoiding any direct impact on the National Monument.

There are a number of existing outfalls which discharge to the River Shannon from the Potato Market, Courthouse and the rear of City Hall.

2 No. outfalls from the Potato Market carpark are to be made redundant as part of the scheme works. A new storm outfall will be provided to accommodate storm drainage from the Potato Market carpark and the access road in/out of Merchants Quay. A by-pass petrol interceptor will be constructed to enhance the water quality prior to discharge. An inter-tidal storage tank will be constructed to prevent flooding on the surface during extreme tide conditions in the Shannon. This inter-tidal storage tank will be located between the court house and the potato market, replacing the existing tank within the potato market car park.

The existing outfall to the south-west of the civic building will be increased in size with a non-return valve installed. An overflow within the final manhole will convey flows to the proposed inter-tidal storage tank to the north while the outfall is surcharged.

The existing outfall to the rear of the City Hall will be increased in size with a non-return valve installed. Inter-tidal storage for existing paved areas behind the new glass panel and the wider contributing area will be provided adjacent to the outfall such that flooding on the surface does not occur during high tide conditions in the Shannon. 6no. early mature Lime trees are to be removed to facilitate construction of the storage tank.

The existing outfall to the south-west corner of King Johns Castle will be increased in size with a non-return valve installed. As this outfall drains existing car-parking predominantly to the west of

City Hall, a by-pass petrol interceptor will be constructed to enhance the water quality prior to discharge. Refer to drawings nr KIFRS-C-209 to C-216.

4.4 Construction Overview

An Outline Method Statement is provided in Appendix A Outline Construction Method Statement which gives an overview of the steps required during the construction phase for each area of flood defences. This is summarised in the section below, and includes information relevant to the impact assessment provided in the remainder of the EIAR. The Outline Method Statement should be read in conjunction with the section below to give a full understanding of the works as proposed.

It is expected that the construction phase will take place over 18 months.

4.4.1 Construction compound

Site establishment by the Contractor will include the following:

- Offices;
- Site facilities (canteen, toilets, drying rooms, etc.);
- Office for construction management team;
- Secure compound for the storage of all on-site machinery and materials;
- Temporary car parking facilities;
- Temporary fencing;
- Site Security to restrict unauthorized entry;
- Bunded storage of fuels and refuelling area. Bunds shall be 110% capacity of the largest vessel contained within the bunded area;
- A separate container will be located in the Contractors compound to store absorbents used to contain spillages of hazardous materials. The container will be clearly labelled, and the contents of the container will be disposed of by a licenced waste contractor at a licenced site. Records will be maintained of material taken off site for disposal;
- A maintenance programme for the bunded areas will be managed by the site environmental manager. The removal of rainwater from the bunded areas will be their responsibility. Records will be maintained of materials taken off site for disposal;
- The site environmental manger will be responsible for maintaining all training records;
- The contents of any tank will be clearly marked on the tank, and a notice displayed requiring that valves and trigger guns be locked when not in use;
- Drainage collection system for washing area to prevent run-off into surface water system; and
- All refuelling of vehicles will be carried out at the fuel stores within the main site compound and only ADR trained personnel will be permitted to operate fuel bowsers.

4.4.2 Construction traffic route

HGV's will travel to and from the site via the R445 and Island Road. Further construction traffic details and the associated impacts are described in Chapter 7 of this EIAR. The proposed construction route is shown in Figure 7-2 in Volume 3.

4.4.3 Excavation and Infilling

Excavation and import of soil will be required for construction of the embankments. The material will comprise 93,900m^3 of inert engineering fill, 43,000m^3 of landscape fill (class 4) and 6,700m^3 of topsoil, totalling 143,600m^3 for the construction of approximately 2,200 linear metres of embankment at different locations around the island.

4.4.4 Surface Water Run-off and Groundwater Pumping

Groundwater pumping will be required where the water table is encountered during excavations, most likely around the quay walls (George's Quay and Sir Harry's Mall). Mitigation has been recommended in Chapter 9 of this EIAR to ensure that groundwater discharged via pumping is not contaminated with suspended solids.

4.4.5 Instream Works and Works Near Water

Works at Merchant's Quay and the Absolute Hotel are constrained by the available space for machinery to operate from the banks, and so will require the use of jack up rigs on the bed of the River Shannon and Abbey River to be used as work platforms. There will be two areas of instream works on the Shannon and Abbey Rivers:

(1) At the south east corner of the Absolute Hotel, instream work on the Abbey River is proposed. This is necessary for construction of a section of reinforced concrete wall to replace the existing parapet wall which is below the design flood defence level. Instream works will comprise the construction of a temporary, enclosed working platform on stilts (jack up rig) adjacent to the wall to allow part of the construction works to occur from the river side.

(2) At the south west of the Courthouse, instream work on the Shannon River is proposed. This is necessary for construction of a section of board walk around the Courthouse and would include sealing of existing joints, tanking of walls, removal of vents on walls adjacent to the river prior to the construction of the boardwalk and glass panels. Instream works will comprise the construction of a jack up rig to allow part of the construction works to occur from the river side.

These working platforms will be moved respective of the needs during each phase of construction including demolition of existing walls, excavation, and installation of new walls. Installation of the rigs will involve dropping legs onto the bed of the river and bolting into the side of the quay walls.

4.4.6 Risk of Flooding During Construction

There is a possibility that a flood will occur on King's Island during the construction phase, as the duration of construction is approximately 18 months. To ensure that King's Island does not become more vulnerable to flooding during construction, the old flood embankments around the north of the island will be left in situ until the new embankments are finished.

The old flood defences which must be demolished on the south side of the island will become vulnerable to flooding during the period of construction. In particular, the areas A9 south of the Absolute Hotel, Area 10 Abbey Bridge to Baal's Bridge, and area Area B2 at the pontoon access, will be vulnerable. It is noted that these areas are currently vulnerable to flooding, and the construction phase will not increase this vulnerability in a significant way.

4.5 Sub-Area Construction Requirements

4.5.1 A1 Construction Method

Both the wet and dry sides of the coping will be painted across the full length of Verdant Place. Between Thomond Bridge and the new flood defence wall, install a concrete coping and safety railing to the appropriate guarding height. No excavation or in-river works will be required.

4.5.2 A2 Construction Requirements

To install the flood defence wall, the existing embankment will need to be excavated and the footpath and sandbags will be removed. Excavation will be required to a depth of approximately 1.5m to install the RC wall. Bored piles will be installed to bedrock level (approximately 11m depth in this area).

4.5.3 A3 Construction Requirements

A construction compound is proposed in the open space in the northwest corner of St. Mary's Park. A buffer zone of approximately 10m will separate the proposed and/or open ditch from the construction compound. The construction compound will also be bunded to avoid any potential discharge to the proposed open ditch.

The proposed open ditch to host the protected pondweed will be constructed before the proposed embankment is formed. This is to ensure that the pond weed can be translocated directly and avoid being stored off site. The construction sequence for the proposed open ditch is as follows:

- Excavate the proposed open ditch.
- Ensure that the base of the open ditch is hydraulically disconnected from the river by means of:

a) maintaining a minimum thickness of approx. 1m clay at the base of the open ditch (most likely) or

b) additional excavation to insert a suitable clay lining at the base of the open ditch.

- Allow the open ditch to fill (from surface water and ground water flow).
- Relocate the pondweed.
- Establish an exclusion zone around the open ditch for the remaining duration of the works
- Fill in the existing ditch.

The existing sandbags, footpath, and concrete plinth along the edge of the River Shannon will be excavated and removed. The rest of the existing embankment will remain in place and be tied into the sloped surface of the new embankment. The alluvial woodland (a protected habitat and part of the SAC) on the river side of the existing embankment will remain untouched.

Topsoil excavation will be required underneath the entire footprint of the clay embankment. This will be completed under licence with full archaeological monitoring. The topsoil will be stockpiled and stored on site for later reuse on the proposed embankment.

4.5.4 A4 Construction Requirements

Topsoil excavation will be required underneath the entire footprint of the clay embankment. This will be completed under licence with full archaeological monitoring. The topsoil will be stockpiled and stored on site for later reuse on the proposed embankment.

Some minor local excavation will be required in the SAC to connect the existing open drains to the new embankments. This work will be overseen by a site ecologist.

The existing sheet piles will be cut down to 200mm below ground level with the void backfilled with existing soil. Construction work will be carried out from the river side and not from within the adjacent SAC. The bitmac footpath path adjacent to the sheet piling will be approximately 120metres in length and 2.5m wide. The existing ground will be excavated to an approximate depth of 350mm for construction of the footpath.

4.5.5 A5 Construction Requirements

Topsoil excavation will be required underneath the entire footprint of the clay embankment. This will be completed under licence with full archaeological monitoring. The topsoil will be stockpiled and stored on site for later reuse on the proposed embankment.

Removal of vegetation (cutting down but not removal of roots) will be required along the length of the proposed embankment and adjacent to the open drain. The destruction of a badger sett located in the bankside of the open drain is required to accommodate the construction of the embankment. Correspondence with NPWS regarding the destruction of the sett has confirmed that a license is not required. The Department of Culture, Heritage and the Gaeltacht have issued a letter stating that neither the Department nor NPWS oppose the works, provided the report mitigation and TII's guidelines, and any variant of the above as specified by regional staff, are followed.

To facilitate construction, six mature trees are to be removed along the alignment of the proposed embankment parallel to the Abbey River. An arborist survey was carried out which identified that these trees were not in good condition.

4.5.6 A6 Construction Requirements

Excavations will be required to construct the flood defence wall (1-3m), the manhole (4m depth x 2m diameter), and intertidal storage tank (2m depth x 10m width x 10m length). The proposed flood defence wall will be supported on bored concrete piles. Grading and excavation works will be required adjacent to the banks of the Abbey River to construct the access track behind the boat club.

Three small trees (including a White beam, a Cherry and Norway Maple) are recommended[12] for removal south of the boat club to facilitate construction of the new wall, replacement trees will be implemented as part of the landscape design for the project.

[12] Arborcare (2019). Tree Survey Report: King's Island Flood Relief Scheme, Draft Report.

4.5.7 A7 Construction Requirements

Excavations will be required to a depth of approximately 1.5m to construct the extensions to the wall foundations. Construction of the new footpath, steps, and ramps will require temporary closure of the road during the construction phase.

4.5.8 A8 Construction Requirements

No significant works are proposed.

4.5.9 A9 Construction Requirements

To install the mini-piles, drilling will be required towards the rear of the historic quay wall. Construction of the RC parapet will require excavation up to 1.2m. Due to restricted land access at this location and limited space on the walkway, an in-channel barge/jack-up rig will be required in the Abbey channel, to provide additional space for piling machinery to operate.

4.5.10 A10 Construction Requirements

The existing footpath will be excavated in order to construct the new parapet and backing wall. Excavations of approximately 4 to 5m depth will be required. Two existing small trees on the walkway, surveyed by an arborist, are to be removed for construction and they will be replaced with like for like species on completion of the construction works. The footpath and roadway will also be reinstated to match existing.

4.5.11 B1 Construction Requirements

Excavation will be required for installation of the mass concrete backing and flood wall. This work will be complete from the Quay and will require closing the footpath and road for the duration of the works.

Trees will be pruned as per arborist recommendations to allow sufficient head room for construction.

At the section of wall to be retained, the masonry parapet coping will be removed and stored for later reinstatement.

4.5.12 B2 Construction Requirements

Excavation will be required for installation of the mass concrete backing and flood wall. This work will be complete from the Quay and will require closing the footpath and road for the duration of the works. Glass panelling will be installed where indicated in the design.

Trees will be pruned as per arborist recommendation, to allow head space for construction. Drilling will take place through the existing wall to a depth of approximately 5m to install the steel stitching bars.

In the Pontoon Access area, 1no. tree will be removed to facilitate the works. The existing parapet wall will be removed. The wall will be excavated and the new flood wall cast.

4.5.13 B3 Construction Requirements

Excavation will be required for installation of the mass concrete backing and flood wall.

Potato Market

This work will be complete from the island side and will require closing the footpaths and Potato Market parking area for the duration of the works.

The Potato Market viewing platform and railing will be removed. The Sarsfield pedestrian bridge will be closed for the duration of the works.

The Potato Market walls will be demolished, excavated, replaced in some places, and retained/repaired in others.

Curragower Boat Club

At the Curragower Boat Club, excavation will be required along the length of the proposed wall and flood gate. The existing road will be re-levelled. The depth of excavation under the flood gate will be approximately 1m.

Courthouse

Excavation will be required for installation of the mass concrete backing and flood wall. This work will be complete from the river and will require closing of the footpath for the duration of the works. Due to limited space on the walkway, a barge/jack-up rig will be installed on the bed of the Shannon River to give additional space for machinery to operate, and to catch any debris falling onto the river side of the wall during excavation. It is expected that 3 set-ups will be required to carry out the proposed works.

The boardwalk will be demolished. Bored concrete piles will be installed as part of the concrete foundation for the glass panelling. Glass panelling will be installed where indicated in the design.

Between the Courthouse and King John's Castle

Past the courthouse, 6no. early mature Lime trees between the Council offices and the glass panelling will be removed for construction and replaced with appropriate species on completion of the construction works.

Excavation will be required to support the concrete backing of the existing wall. The footpath will be removed and reinstated following installation of the wall foundation.

5 Consultation

5.1 Introduction

Consultation is an on-going part of the EIAR process and is implemented from the Screening Stage onward. There are two required elements of consultation prior to the submission of an EIAR. The first avenue for consultation is to seek opinions and input from statutory bodies that have an interest or who may be affected by parts of the development, including government bodies and regulatory bodies. Non-governmental organisations and other relevant organisations were also contacted as part of this consultation process. These consultees were identified in the Scoping stage of the EIAR and were contacted as specified. The second avenue is to consult with local residents, business owners, and locals who may be impacted by the development or any member of the public who has an interest in the proposed FRS.

5.2 Statutory Consultation

In accordance with the EIA Directive (85/337/EEC) as amended in 2011 Directive (2011/92/EU) and 2014 Directive (2014/52/EU) under Article 6 and the Aarhus Convention, statutory and non-statutory bodies, local authorities, and relevant stakeholders must be consulted on the specific characteristics of the project and its likely impacts on the environment.

The EIAR requirements for consultation are defined in the EIA Directive (85/337/EEC) as amended in 2011 Directive 2011/92/EU and 2014 Directive 2014/52/EU under Article 6.

Article 6 (1)

Member States shall take the measures necessary to ensure that the authorities likely to be concerned by the project by reason of their specific environmental responsibilities are given an opportunity to express their opinion on the information supplied by the developer and on the request for development consent.

Statutory Authorities referred to in Article 6 (1) were consulted on the specific characteristics and scope of information to be considered in the EIAR for the proposed FRS at the scoping stage.

5.3 Consultation on Scoping Stage

5.3.1 Statutory consultees

Statutory consultees were issued a letter and a copy of the Scoping Report by email on 21st December 2018 requesting that any comments, observations or submissions in relation to the scope and level of information to be included in the EIAR be made prior to submission. Consultees were asked to respond by the 8th of February 2019, giving sufficient time to ensure clarity and consistency of the consultation and ensure that relevant statutory consultees had the opportunity to participate. All submissions (responses, comments, and recommendations) are appended and have informed the final scope of this EIAR.

The list of statutory consultees who were consulted on the Scoping Report are:

- An Bord Pleanála (ABP);
- An Taisce-The National trust for Ireland;
- Bord Gais;
- Bord Na Mona;
- Coillte;
- Dept. of Agriculture, Fisheries, and Marine;
- Dept. of Communications, Climate Action, and Environment;
- Dept. of Housing, Planning, and Local Government;
- Dept. of Transport, Tourism, and Sport (DTTAS);
- Dept. of Culture, Heritage and the Gaeltacht;
- Dept. of Culture, Heritage and the Gaeltacht (National Parks and Wildlife Services);
- Dept. of Culture, Heritage and the Gaeltacht (National Monuments Section);
- DTTAS Emergency Planning Unit;

- Environmental Protection Agency (EPA);
- Electricity Supply Board (ESB);
- Failte Ireland;
- Health and Safety Authority (HSA);
- Health Service Executive (HSE);
- Inland Fisheries Ireland (IFI);
- Irish Water;
- Office of Public Works (OPW);
- Teagasc;
- The Heritage Council;
- Transport Infrastructure Ireland; and
- Waterways Ireland (Scariff Office).

Non-statutory consultees were also sent the Scoping Report and were asked to submit a consultation response. These included:

- Barringtons Hospital;
- Bat Conservation Ireland;
- Birdwatch Ireland;
- Environmental Health Service;
- Environmental Sciences Association of Ireland;
- Geographical Society of Ireland;
- Geological Survey Ireland;
- Institute of Geologists of Ireland;
- Irish Creamery Milk Suppliers Association;
- Irish Farmers Association;
- Irish Heritage Trust;
- Irish Peatland Conservation Council;
- Irish Planning Institute;
- Irish Wildlife Trust;
- LCCC (Archaeology);
- LCCC (Conservation);
- LCCC (Engineering);
- LCCC (Heritage Officer);
- LCCC (Physical Development);
- LCCC (Planning);
- LCCC (Roads);
- Limerick and District Anglers;
- Limerick Tourism;
- Local Chambers of Commerce;
- Mid-West Regional Authority;
- National Association of Regional Game Councils;
- National Building Agency;
- National Federation of Group Water Schemes.

5.3.2 Consultation Responses

Of the 53 consultees contacted, the following responses were submitted as summarized in Table 5-1. The statutory bodies who had comments are summarized in the following sections, and are provided in Appendix B.

Table 5-1. Summary of statutory consultation responses

Consultee	Response	Response Date
Coillte	Email - no objection	10/01/2019
Department of Agriculture, Fisheries, and Marine	Email - no objection	11/01/2019
Department of Culture, Heritage and the Gaeltacht (DAU) including National Parks and Wildlife Services (NPWS)	Email ref. G Pre00001/ 2019 requesting that the archaeological assessment be completed under certain guidelines as outlined Letter dated 22 March 2019 included points regarding ecological impacts for works proposed in Areas A3, A7 and A9. Letter dated 12 June 2019 included recommendations for the treatment of underwater archaeology and the proposed translocation of opposite-leaved pondweed and juvenile lamprey.	06/02/2019 22/03/2019 12/06/2019
DTTAS Emergency Planning Unit	Email - no objection	07/01/2019
ESB	Email with attached map of existing utilities on and surrounding King's Island	09/01/2019
Faillte Ireland	Email with attached Guidelines on the treatment of tourism in an Environmental Impact Statement	09/01/2019
Geological Survey Ireland	Email ref. 18/171 with suggestions regarding the use of GSI databases, and groundwater vulnerability	14/01/2019
Inland Fisheries Ireland (IFI)	Letter with observations and recommendations regarding the design proposal, which were considered at the design stage of the project	05/01/2018
Institute of Geologists of Ireland	Email - no objection	07/01/2019
LCCC (Archaeology)	Email with a suggestion for consideration regarding archaeology	01/02/2019
LCCC (Planning and Environmental Services)	Email with suggestions for consideration regarding the NIS report, climate change, and surface and groundwater sections of the EIAR	04/01/2019
National Federation of Group Water Schemes	Email - no objection	07/01/2019
Transport Infrastructure Ireland	Email with General guidance for the preparation of an EIAR, where National Roads Network may be affected	23/01/2019

Responses are further summarized and addressed in the following table according to their relevance to the appropriate section of the EIAR.

Table 5-2. Summary of Issues Raised through Statutory Consultation

Consultee	Summary of Additional Issues Raised	How the issue is addressed in this EIAR
4. Description of Scheme		
IFI	IFI requested the following regarding the Options Development in 2017 re: Alignments West Embankment Option 2 - The design of the embankments should consider local fisherman and other water users who may need to exit the water quickly in the event of a rapid rise in water level. - Embankments should accommodate access to the bathing area along the west side of King's Island. - An access ramp should be considered and ensuring	The design of the embankment, the provision of lighting and the surface water drainage scheme are outlined in Chapter 4- Description of Scheme. The following works have been scoped out of the proposed FRS: - Works at Thomond Weir - Embankments in close proximity to the river

Consultee	Summary of Additional Issues Raised	How the issue is addressed in this EIAR
	that existing stairways to the river are maintained and are accessible. - If the embankment is in close proximity to the river, the toe of the embankment should be armoured with large heavy limestone or sandstone for anti-scour and erosion protection. - If embankments are constructed away from the water's edge (except for tidal or high flood flows) it is likely that there will be little or no impact on the aquatic habitats except where they have been specifically identified. - If the riverbed is encroached, attention must be given to juvenile lamprey ammocoetes which may be present in the sediments along the water's edge. - Mitigation measures for silt run-off from embankment construction works should be developed and agreed with the relevant authorities including IFI. - As sections of embankment are completed, any exposed raw earth should be seeded with an appropriate grass seed as soon as possible. - Contractors should liaise with: the Local Authority, IFI and NPWS in respect of all methodologies. - The importance and condition of SAC wetlands and drainage channels needs to be assessed. - A surface water plan should be developed detailing discharge points into the River Shannon, and information in respect of the surface water drainage from the bridge and the roadway. Silt and hydrocarbon removal facilities should be incorporated into the design of the crossing. - Flora survey of watercourses and wetlands must be undertaken as part of the Environmental Impact Assessment (liaise with NPWS). - IFI should be consulted in relation to any instream proposals for road construction works at Thomond weir. - New lighting should be "cowled" or designed to ensure that the pool of light falls only on the footpath and carriageways and not on the water on either side of the bridge. - It may be necessary to remove some trees and to have a maintenance plan to ensure that no significant large trees are permitted to grow on the embankment which may cause future bank instability. - IFI Biosecurity protocols should be applied in respect of all works undertaken in this area.	The impact of the scheme on the aquatic habitats is addressed in Chapter 8 - Biodiversity The impact of the scheme on surface and ground water and recommended mitigation is addressed in Chapter 9 - Surface and Groundwater.
IFI	IFI would have no objection to the use of a retaining wall on the landward side to limit the extent of the embankment if this is deemed necessary and feasible To culvert or remove the watercourse will cause deterioration in the status of this watercourse and the ECJ has already indicated that at this may not be allowed It may be necessary to design a section of the bank to facilitate the preservation of the watercourse and the running track	These options have been scoped out of the design due to environmental constraints. This is addressed in the Options Report which can be viewed on the scheme website. http://www.kingsislandfrs.ie/downloads/
	Good liaison should be developed with the appropriate methodologies to minimise any negative impact on the fisheries and aquatic habitats It is important that when the road is being constructed using the pillars of the old weir that any refurbishment works are carried out in the open season for instream works or in accordance with an appropriate derogation under the Local Authority Works Act 1949 To improve the amenity of the river and facilitate passage of boats, including kayaks angling cots, sculling boats et cetera it may be desirable to remove one or two of the piers and developing a clear span structure in this space	These options have been scoped out of the design due to environmental constraints.

Consultee	Summary of Additional Issues Raised	How the issue is addressed in this EIAR
DTTAS	All urban street development should go through the Design Manual for Urban Roads and Streets (DMURS) process or perhaps be run by the NTA to ensure that no opportunity to supply a more sustainable built environment is lost (including any opportunity to build a cycle lane where space allows).	The proposed streetscape is addressed in the Landscape Design Strategy Document which accompanies the Planning Submission.
DAU (NPWS)	The overhang design on Sir Harry's Mall (cantilevered boardwalk is proposed to extend for 2.0m), is particularly favourable, as it allows maximum tide debris to still accumulate under the walkway rather than further downslope in the vegetated habitat area if a wall was constructed.	The proposed cantilevered walkway at Sir Harry's Mall has been removed from the project. As such it is not necessary to address this issue in Chapter 8 - Biodiversity.
	The habitat present is alluvial tree-line in an estuary environment with characteristic species such as white willow (Salix alba), crack willow (Salix fragilis) and summer snowflake (Leucojum aestivum). It forms part of the Estuary habitat type, as well as being important for the connectivity of alluvial woodland habitat on the opposite bank to the south-east. However, the upper 1.5m near the existing wall is not of particular conservation value compared to the area downslope from this. From Photo 1 in the Technical Note, it can be seen (second tree) that crack willow will readily grow horizontally outwards. It is recommended that the 3-5 trees removed or coppiced, are replaced by planting, or by facilitating regeneration, outside the boardwalk, so that the tree-line / estuary ecotone is maintained.	The proposed cantilevered walkway at Sir Harry's Mall has been removed from the project. As such it is not necessary to address this issue in Chapter 8 - Biodiversity.
	It would be the Department's preference that the existing drain, where opposite-leaved pondweed is found, is retained. The reason for this preference is the low success of translocation projects for this species in the past.	A response was submitted to NPWS at the design stage, which was followed by a meeting which took place between NPWS, LCCC, Arup, and JBA, on the 2nd of July to discuss these matters. This is summarized below in Section 5.3.3.
	Three pieces of information are required for the Department to advise fully on the question of marshland at the cSAC boundary: 1. It needs to be calculated how much marsh habitat within the cSAC will be lost to the embankment. 2. The type of marsh vegetation proposed to be lost within the cSAC needs to be described. 3. The extent to which the marsh vegetation is dependent on poor drainage (perched water), as opposed to water due to groundwater backup due to river flooding, needs to be established.	
6. Population and Human heath		
Failte Ireland	An email was sent with an attachment of the following document: Fáilte Ireland's Guidelines for the treatment of tourism in an EIS. Failte Ireland have recommended that these guidelines should be taken into account during the preparation of an EIAR.	These guidelines have been used to inform Chapter 6 - Population and Human Health. This chapter will address the impact of the scheme on tourism. Additionally, the impact of the scheme on historical artefacts related to tourism in Limerick city will be addressed in Chapter 15- Cultural Heritage.
LCCC	An assessment of the effects of proposed lighting on both residents and ecology should be provided.	The impacts of proposed lighting are addressed in Chapter 8 -Biodiversity and Chapter 13 - Landscape and Visual Assessment.
7. Material Assets		
ESB	Information regarding utilities in the surrounding area of King's Island were requested. In response, ESB sent maps indicating the approximate location of ESB underground (UG) cables and overhead (OH) lines. Guidelines on Safe construction with electricity were also provided.	This information was used to inform Chapter 7 - Material Assets, which gives an assessment of the disruption to utilities from the proposed FRS.

Consultee	Summary of Additional Issues Raised	How the issue is addressed in this EIAR
TII	Transport Infrastructure Ireland (TII) have recommended that as set out in the DoECLG Spatial Planning and National Roads Guidelines (2012), it is in the public interest that, in so far as is reasonably practicable, the national road network continues to serve its intended strategic purpose. The EIAR should identify the methods/techniques proposed for any works traversing/in proximity to the national road network in order to demonstrate that the development can proceed complementary to safeguarding the capacity, safety and operational efficiency of that network.	Chapter 7 -Material Assets incl Traffic addresses the construction related traffic and the routes affected.
	Consultations should be had with the relevant Local Authority/National Roads Design Office with regard to locations of existing and future national road schemes.	The Roads section of LCCC was sent a copy of the Scoping Report and consultation was requested as part of this statutory consultation process. LCCC Roads section did not respond to the enquiry, however Chapter 7 - Material Assets incl Traffic will address the construction related traffic and the routes affected.
	Clearly identify haul routes proposed and fully assess the network to be traversed. Separate structure approvals/permits, and other licences may be required in connection with the proposed haul route and all structures on the haul route should be checked by the applicant/developer to confirm their capacity to accommodate any abnormal load proposed.	The network to be traversed for construction machinery including haul routes will be addressed in chapter Chapter 7 -Material Assets incl Traffic.
	Where appropriate, subject to meeting the appropriate thresholds and criteria and having regard to best practice, a Traffic and Transport Assessment be carried out in accordance with relevant guidelines, noting traffic volumes attending the site and traffic routes to/from the site with reference to impacts on the national road network and junctions of lower category roads with national roads. TII's Traffic and Transport Assessment Guidelines (2014) should be referred to in relation to proposed FRS with potential impacts on the national road network. The scheme promoter is also advised to have regard to Section 2.2 of the TII TTA Guidelines which addresses requirements for sub-threshold TTA.	Chapter 7 -Material Assets incl Traffic will address the construction related traffic and the routes affected. TII's Traffic and Transport Assessment Guidelines (2014) have been referenced where appropriate. Section 2.2 of the guidelines have been considered regarding sub-threshold TTA, and analysis and opinion has been provided regarding the criteria outlined therein.
	TII Standards should be consulted to determine the requirement for Road Safety Audit (RSA) and Road Safety Impact Assessment (RSIA)	Chapter 7 -Material Assets incl Traffic addresses the construction related traffic and the routes affected. This comment has been forwarded for inclusion in the site specific Construction Management Plan (CMP).
	Assessments and design and construction and maintenance standards and guidance are available at TII Publications that replaced the NRA Design Manual for Roads and Bridges (DMRB) and the NRA Manual of Contract Documents for Road Works (MCDRW)	Assessments and design and construction and maintenance standards and guidance will be incorporated within the scheme design.
	The developer, in conducting Environmental Impact Assessment, should have regard to TII Environment Guidelines that deal with assessment and mitigation measures for varied environmental factors and occurrences. In particular, evidenced assessment of the protection of the strategic function of the national road in relation to the following matters is required; a. TII's Environmental Assessment and Construction Guidelines, including the Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes (National Roads Authority, 2006), b. The EIAR should consider the Environmental Noise Regulations 2006 (SI 140 of 2006) and, in particular, how the development will affect future action plans by the relevant competent authority. The developer may	The recommended guidelines have been referenced in chapters 11- Noise and 12- Air/Climate.

Consultee	Summary of Additional Issues Raised	How the issue is addressed in this EIAR
	need to consider the incorporation of noise barriers to reduce noise impacts (see Guidelines for the Treatment of Noise and Vibration in National Road Schemes (1st Rev., National Roads Authority, 2004)).	
8. Biodiversity		
IFI	IFI have requested the following re: Instream Works The proposed "instream working platforms" may give rise to considerable environmental disruption, pollution and adversely affect lamprey and fish habitat Consider that coffer dams using sheet piles might provide a better alternative for instream works For any instream works a fisheries assessment will be required and there is a strong possibility that a fish removal operation will be required If the work is taking place in the close season then derogation will be required under The Local Authority Works Act 1949 Early contact should be made with the contractors for this development so as to ensure that method statements can be agreed	Instream works were scoped out during the design development phase of the project due to environmental concerns. Alternative construction techniques have been proposed and are described in Chapter 4 - Description of Proposed FRS. It is proposed to use jack-up barges in areas A10 and B3 to access the quay walls during the construction phase. Appropriate follow-up consultation has been made with NPWS and IFI, and mitigation measures have been put in place and agreed with the Department as described in Chapter 8 - Biodiversity.
LCCC	Thomas O'Neill (Heritage Officer) requested that the EIAR should cross reference, where necessary, with the NIS. This could include topics such as treatment of Annex Habitats, treatment of the Triangular Club Rush and Opposite Leaved Pond Weed and associated mitigation measures such as relocation	Chapter 8 -Biodiversity addresses the impact of the scheme on protected species and habitats and cross-references the contents of the NIS and associated mitigation measures.
	Thomas O'Neill (Heritage Officer) has welcomed the following: A comprehensive Invasive Species Management Plan (Scoping Report Section 5.7.1.4) Assessment Methodology in Scoping Report Section 5.7.3.1 (re: Ecological Surveys). Bird surveys commissioned for the SIFP could provide valuable background information The proposed assessment of the effects of lighting on both residents and ecology	These aspects will be addressed in: -Invasive Species Management Plan -The impacts of proposed lighting are addressed in Chapter 8 -Biodiversity and Chapter 6 - Population and Human Health
DAU (NPWS)	Area A3 (Northwest Embankment): A Section 21 (Wildlife Act) licence will be necessary for the translocation of the opposite-leaved pondweed, and should be applied for to the Licensing Unit, National Parks & Wildlife Service (NPWS).	This point is discussed further below in Section 5.3.3.
	Area A9 (Hotel to Abbey Bridge) & Courthouse: A survey for juvenile lamprey in the working area of the jack-up rig is recommended, and impacts on juvenile lamprey habitat assessed.	This point is discussed further below in Section 5.3.3.
	For all areas involving riparian works, a pre-application and pre-construction otter survey following NRA guidance is recommended (see https://www.tii.ie/tiilibrary/environment/construction-guidelines/Guidelines-for-the-Treatment-of-Ottersprior-to-the-Construction-of-National-Road-Schemes.pdf)	This aspect will be addressed in Chapter 8 -Biodiversity.
	The following information should be included in the Natura Impact Statement: - A statement of the efficiency of the removal of the juvenile lamprey (i.e. how many are likely to be left behind); - A statement of where the juvenile lamprey will be translocated to, and their likelihood of survival; - A clear description of how the jack-up barge will be operated and supported, and whether rock infill will be	This point is discussed further below in Section 5.3.3.

Consultee	Summary of Additional Issues Raised	How the issue is addressed in this EIAR
	required, and if so, how this will be removed post-construction; - A prediction of how quickly un-compacted silt habitat will naturally regenerate, and how soon the area will be fully recolonized to baseline condition.	
9. Surface and Ground water		
GSI	Parts of King's Island have High Groundwater Vulnerability. This should be taken into account during planning	There are two groundwater bodies within the study area that are relevant to this assessment: Limerick City North (IE_SH_G_139) and Limerick City East (IE_SH_G_138). Groundwater vulnerability has been discussed further in Chapter 9 - Surface and Groundwater.
10. Soil, Geology and Hydrogeology		
LCCC	Thomas O'Neill (Heritage Officer) requested to consider in Hydrogeology section the possibility of contaminated flow into nearby water courses or though ground water. This is most likely during the construction phase as the Scoping document points out. Water dependant ecology (p.35) could be a common topic in both EIAR and the NIS.	Impacts on surface water and groundwater have been studied extensively through all stages of the project, from the "Do Nothing" scenario, to construction, and through operation of the scheme. This information has been included in chapter 9 Surface and Groundwater and chapter 10-Soils and geology. Potential impacts to aquatic ecology have been addressed in chapter 8 - Biodiversity.
GSI	The use of GSI resources is encouraged including information on Geology, Groundwater, Quaternary, Landslides, and Geological Heritage, Physiographic Units which are available through the GSI Map Viewer website	These resources have been used to inform Chapter 9- Surface and Groundwater.
	There are no County Geological Sites in the vicinity of King's Island	No response required.
11. Noise		
LCCC	The referenced Noise Action Plan is out of date. Update reference to the Noise Action Plan to reflect the new publication for 2018 -2023.	This information has been noted and the new Noise Action Plan 2018-2023 has been referenced in chapter 11 Noise.
12. Air and Climate		
LCCC	Thomas O'Neill (Heritage Officer) requested that climate change should be tied in with the necessity of flood defences to prevent future flood events and associated potential for accidents, as per new EIAR guidance.	The scheme design takes into account the possible impacts of climate change, and in particular sea level rise. An assessment of the adaptability of the alternative measures has been carried out. Where new walls and embankments are being constructed, they are being built to allow the defence to be raised in the future. This is addressed in chapter 12- Air and Climate.
13. Landscape and Visual		
	No comments were made regarding Landscape and Visual amenity.	The landscape and visual assessment is provided in Chapter 13 of the EIAR.
14. Cultural Heritage		
DAU	All proposed FRS and strategies should be in compliance with the National Monuments Acts 1930 to 2004 and with the national policy on protection of archaeological heritage – 'Framework and Principles for the Protection of the Archaeological Heritage'	Archaeology has been of great concern during development of the FSR, as there are two National Monuments in State Care within the subject area - King John's Castle and

Consultee	Summary of Additional Issues Raised	How the issue is addressed in this EIAR
	published in 1999 by the Department of Arts, Heritage, Gaeltacht and the Islands	Fanning's Castle. There is one site within King's Island that is subject to a Preservation Order. A full archaeological assessment was completed by Moore Group (Moore Archaeological and Environmental Services Ltd.) as part of this EIAR and is provided in Chapter 14 - Cultural heritage. This assessment gives a full description of the existing environment, and the mitigation measures that are recommended to preserve the archaeological, built heritage and underwater heritage of King's Island.
	All areas of archaeological heritage should be addressed, including; - Immovable cultural heritage e.g., monuments and ancient field boundaries. - Underwater cultural heritage. - Movable cultural heritage e.g., loose carved stones, sculptures, architectural fragments etc.	This aspect will be addressed in Chapter 14 - Cultural heritage
	All impacts which may impinge on the archaeological heritage should be assessed by a suitably qualified archaeologist.	Chapter 14 - Cultural heritage will be prepared by a licenced archaeologist.
	Where appropriate, specialists in the field of archaeological heritage should be consulted throughout the process, from design through to implementation	Chapter 14 - Cultural heritage will be prepared by a licenced archaeologist
	All surveys pertaining to archaeological heritage must be of a high standard in order to allow informed decisions to be taken.	Chapter 14 - Cultural heritage will be prepared by a licenced archaeologist
	All impacts must be assessed, to include ground disturbance, impacts on the setting of the monuments and visual impacts. These should include direct, indirect, temporary and cumulative impacts.	Impacts during the construction phase on the archaeological resource will be address in chapter 14 - Cultural Heritage.
	Mitigation of impacts, identified through consultation, should be taken into account within the development at the earliest possible stages. Various approaches should be considered, such as avoidance, design modification and relocation where appropriate	Mitigation of impacts including avoidance are addressed in chapter 14 - Cultural Heritage
	Where there are no archaeological monuments present, but the development is large in scale, e.g., over 0.5 hectares in area and over 1 kilometre in length, it is recommended that an archaeological assessment should be undertaken, unless there are substantial grounds to show that it is not necessary. Refer to Framework and Principles for the Protection of the Archaeological Heritage 1999, in particular section 3.6.6 in regard to EIA.	The archaeological assessment is contained within chapter 14 - Cultural Heritage
	The EIAR Cultural Heritage section should assess the potential for previously unrecorded cultural heritage items found underwater, which should include archaeologically assessing any in-stream or riverbank/intra-riverine impacts. This section should also address the potential for identification of water-logged material and make provision for a defined finds retrieval strategy and post-excavation strategy to be included in all proposed works from the beginning.	A response was submitted to NPWS at the design stage, which was followed by a meeting which took place between NPWS, LCCC, Arup, and JBA, on the 2nd of July 2019 to discuss these matters. This is summarized below in Section 5.3.3.
LCCC	Archaeologist Sarah McCutcheon has requested that robust mitigation measures should be applied with regards to archaeology, as King's Island is a sensitive archaeological site.	Mitigation of impacts including avoidance are addressed in chapter 14 - Cultural Heritage
	Heritage Officer Thomas O'Neill has encouraged the emphasis on the importance of monuments around the "water's edge"	The archaeological assessment addresses moments around the water's edge and is contained within chapter 14 - Cultural Heritage

5.3.3 Additional Consultation with NPWS

A letter dated 12 June 2019 (ref G Pre00001/2019, Appendix B) was sent to JBA regarding the pre-planning consultation, following the application for a derogation license to translocate the protected plant *Groenlandia densa*. A response was submitted by JBA, which was followed by a meeting on 2nd July between LCCC, NPWS, JBA, and Arup, to discuss and resolve the above. A summary of this correspondence is provided below.

Re: Translocation of opposite-leaved pondweed

It would be the Department's preference that the existing drain, where opposite-leaved pondweed is found, is retained. The reason for this preference is the low success of translocation projects for this species in the past

JBA Response: Retaining the open drain will create engineering, public health and associated risks which together with Project Supervisor Design Process (PSDP) review we are required to design out such risk where possible, namely:

- 1. Relocating the new embankment on the inside of the existing open drain will cut off the flow path for overland flows, which currently recharge the open drain
- 2. A new embankment on the inside of the existing open drain will create a dumping ground within the existing open drain, as it will be hidden between the existing and new embankments
- 3. Should any person(s) get into trouble within the open drain, they will not be visible from St Marys, therefore, an increased risk of drowning
- Locating the proposed embankment inside of the existing open drain will be such that the said drain will be exposed to the tidal element of the River Shannon more regularly and will eventually be lost as the existing embankment is eroded and/or fails in due course.

Resolution:

Re: Construction methodology of embankment regarding translocation of Opposite-leaved pondweed *Groenlandia densa*

- Methodology will include sequencing of construction allowing the excavation of new ditch and drainage connection to the Shannon River prior to that of the embankment.
- Pondweed must stay in original ditch as long as possible but may go into suitable storage for a period prior to translocation. It must not be moved to new ditch before suitable hydrological and water chemistry conditions are in place.
- The Section 21 licence for the translocation of the pondweed will be contingent on final method statement approved by NPWS.

Re: Enhancement plan for Opposite-leaved pondweed in environs of Limerick.

- The enhancement of other sites where pondweed occurs in Limerick was a preferred option by NPWS.
- Further liaising with NPWS is required to proceed with this type of project.

Re: SAC Boundary

Three pieces of information are required for the Department to advise fully on the question of marshland at the SAC boundary:

1. It needs to be calculated how much marsh habitat within the AC will be lost to the embankment.
2. The type of marsh vegetation proposed to be lost within the SAC needs to be described.
3. The extent to which the marsh vegetation is dependent on poor drainage (perched water), as opposed to water due to groundwater backup due to river flooding, needs to be established.

JBA Response:

ARUP

1. The design of the embankment is now calculated to cause the loss of 2,826 m² or 2.4% of marsh habitat in two areas of the flood plain (north west, south west). This was clarified at the meeting on 2nd July 2019 as a mapping error. The actual loss is 7,082m² or 5.85% of total marsh habitat, as resolved below.

2. A description of the marsh habitat to be lost within the SAC is provided in Chapter 8- Biodiversity.

3. Marsh vegetation on the King's Island flood plain is largely dependent on poor surface water drainage (perched water). There is no evidence of saline intrusion of estuarine/river water onto the floodplain during the tidal cycle.

Resolution:

- The legal SAC boundary through the marsh habitat was confirmed by NPWS.
- The importance of the marsh habitat as part of the ecological unit of the Annex 1 Estuaries [1130] habitat was emphasised.
- Marsh habitat must be considered, but loss of part of it is not significant i.e. no adverse affect, if it is above regular flood waters.
- Loss of marsh habitat is 7,082m² or 5.85% of total marsh habitat outside of the SAC boundary. Embankment design will ensure no loss of habitat within SAC boundary (see Chapter 8- Biodiversity).

Re: Translocation of juvenile lamprey

The following information should be included in the Natura Impact Statement:

- A statement of the efficiency of the removal of the juvenile lamprey (i.e. how many are likely to be left behind);
- A statement of where the juvenile lamprey will be translocated to, and their likelihood of survival;
- A clear description of how the jack-up barge will be operated and supported, and whether rock infill will be required, and if so, how this will be removed post-construction;
- A prediction of how quickly un-compacted silt habitat will naturally regenerate, and how soon the area will be fully recolonized to baseline condition.

JBA Response: The requested information has been provided in detail, and is included in the NIS Report.

Resolution:

- Lamprey are a qualifying interest of the Lower Shannon SAC and juvenile lamprey may occur in soft sediment beneath jack-up rig locations in Area A9 Abbey River and Area B3 Shannon River. Electro-fishing of juvenile lamprey will take place in these locations prior to positioning of jack-up rigs.
- It was recommended by NPWS to liaise with William O'Connor of Old Shannon River Trust (OSRT) for comment on FRS methodology prior to submission of planning.

Re: Badger License

Resolution

- A potential outlier Badger sett was recorded in the embankment/ditch to the south of the flood plain on the east side of King's Island. Due to potential impact of construction of new embankment on underground passageways, permanent closure of sett is recommended.
- JBA will apply for a derogation licence under Section 23 (7)(iv) of the Wildlife Act (1976 as amended) for closure of the sett. This also will involve camera trap survey to assess activity of Badger at the sett. Alternative sett locations in the vicinity of King's island will be investigated.

Re: Underwater Archaeology

The EIAR Cultural Heritage section should assess the potential for previously unrecorded cultural heritage items found underwater, which should include archaeologically assessing any in-stream or riverbank/intra-riverine impacts.

This section should also address the potential for identification of water-logged material and make provision for a defined finds retrieval strategy and post-excavation strategy to be included in all proposed works from the beginning.

> *JBA Response:* There will be no in water excavations associated with the proposed works. The only in-water impact will be the proposed use of a jack-up barge to facilitate works on the parapet walls.

Letter from NPWS dated 13 August 2019: The Department reiterates our previous requirements that the EIAR Cultural Heritage section should assess the potential impacts of all works, including cumulative impacts on submerged archaeology either by barge operations, excavation for flood defence walls in areas that may be reclaimed, etc. as well as archaeologically assessing any in-stream or river bank impacts. The services of suitably qualified archaeological personnel with underwater archaeological experience should be engaged to undertake the UAIA. The EIAR should also put forward recommendations to archaeologically mitigate in advance any in-water works, to ensure there are no delays to works going forward should substantial underwater cultural heritage be encountered.

The EIAR Cultural Heritage Section should also address the potential for identification of water-logged material and make provision for a defined finds retrieval strategy and post-excavation strategy to be included in all proposed works from the beginning.

> *JBA Response:* There will be limited occasions when in-river works might be required eg. at the Absolute Hotel (Area 9) and works around the Courthouse (Area B3). At these locations the contractor may decide to undertake the work from the land side or may decide that in-river works would be easier and safer. If the contractor's Method Statement requires the work in-river, it is anticipated that a jack-up rig will be used to access the area under construction. The rig would be assembled on land and lowered into the water. The feet of the rig is the only piece of plant that will come in contact with the river bed. It is anticipated that the jack-up rig, if used, would be re-positioned three times while working around the Absolute Hotel and possibly four or five times around the Courthouse. If the contractor decides to use a jack-up rig, JBA/Arup will organise a licenced and approved underwater archaeological specialist to undertake an underwater archaeological investigation. The scope of the investigation will be agreed with the Department in advance. The findings of the assessment and the proposed mitigation measures will be provided to the Department in advance of any work taking place in these areas.

5.3.4 Public Consultation

There have been four public information days on the King's Island FRS. They are detailed below.

Initial Public Information Day - October 2015

The first public information day was held on Wednesday 7th October 2015 in Limerick City and County Hall, Merchant's Quay. It was promoted through various means such as publicity though the Stakeholder Advisory Group, meetings with local groups, social media, traditional media, leaflets drops, posters, and word of mouth. Although widely advertised, the attendance was lower than expected with 40 people signing the attendance register. However, the feedback received was useful and clearly identified the major concerns of local residents with regards to the FRS. There was genuine interest in the works, and particularly in the timeline for construction. However, the feeling from most attendees was that a solution was needed, and whilst a particular option may not be the most appealing, for example in terms of visual impact, it is more important that flood protection is provided, and completed in a timely manner. Specific issues raised were as follows:

- Proposed flood wall - the majority was in favour of this concept but that the height of the flood defence and general visual impact were concerns and that the proposed wall should if possible include 'cut through walkways' to give the option of cutting a walk short;
- Access to river edge - consideration of access point to river edge for fishing, recreational activities and visibility of the water course and landscape beyond;
- St. Mary's Park embankments - the proposed walkway should include cameras and lighting to assist personal safety. Consideration should also be given to incorporate social aspects in the embankment design, especially for children and seniors e.g. seats, flowers/planting, and a garden;
- Public right of way - retention of public right of way along the west side of Merchant's Quay;
- Cultural heritage - The archaeological sensitive area along St Marys Wall, Georges Quay, Merchants Quay and Verdant Place should be taken into consideration;
- Visual appearance of flood walls - where possible, existing masonry quay walls should be incorporated into proposed flood defences using limestone where possible to minimise the visual impact. Flood defences should be incorporated into the recreational promenade encircling King's Island;
- Communication - regular community engagement was requested including updates on any new developments regarding the scheme. Residents of nearby Corbally also requested to be included the project communication due to concerns of insurance cover for their residential properties; and
- Climate Change Impact and Nature Conservation-concerns were expressed regarding the effects of climate change and nature conservation;

Verdant Place Public Consultation Day - March 2016

A second public information day took place on Tuesday 1st March 2016. This was for the Verdant Place Advanced Works which were progressed through the Part 8 planning process ahead of the main scheme. This event was held in the King's Island Community Centre which is adjacent to Verdant Place. The consultation was promoted through social media, traditional media, leaflets drops, posters, pavement stands and word of mouth. Thirty-six (36) people attended the event. All those who attended and provided addresses were residents of King's Island. All comments received on the scheme were positive with several attendees expressing their approval of the one-way system, others expressed their support at the action being taken against flooding. Less common comments were one attendee who said they hoped the wall would not spoil the view out on to the river and another attendee requested that the works be completed before Christmas 2016.

Emerging Preferred Option Public Information Day - December 2017

A third Public Information Day (PID) took place on Wednesday 20th December 2017 to present the emerging preferred option for the scheme and to seek the views and opinions of attendees before the next stage of the project, which is preparation of the planning application. Given the feedback from the previous events, this PID was staged as a two-venue event, with displays in the City and County Hall during the day and continuing in the Community Centre in the evening. Information about the scheme including a detailed photomontage and a short film showing a 3D fly-over were made available for review and comment, and members of the Team were present to discuss the proposals and receive feedback. 89 people attended between the two venues, and included residents of King's Island, Corbally and the city centre. The key issues raised were specific to each flood cell sub area and are listed below:

- A1 Verdant Place (completed element of the scheme) - consideration to be given to raising height of footpath to give a view of Shannon, and provision of an access ladder at Pump Kiosk. Comments were made regarding the finish of the wall;
- A3 North West Embankment - concern by residents of the pinch point at chainage c.550 where the embankment is getting very close to existing houses on Oliver Plunket Street and the impact this may have in exacerbating anti-social behaviour, and loss of open space;
- A4 St Marys Park / SAC - the route of the proposed embankment (referred to as 'Inner alignment') was generally accepted, provided the outer walkway was also maintained. A minority of residents (those living to the east of Munchin's Street) wanted reconsideration of the outer alignment which follows the riverbank on north eastern part of Kings Island and is within the SAC;

- A5 Star Rovers - Objection to plans for loss of training pitches at Star Rovers. Some residents raised concerns about moving the car park and reopening the closed lane way near to the car park, while others welcomed this move as it is currently used for dumping.
- A6 - Athlunkard Boat Club - ensure that the public right of way to the backs of houses on Athlunkard Street is maintained;
- A7 Sir Harry's Mall - request for continuation of walkway from the Absolute Hotel to O'Dwyer Bridge, potentially on the outside of the existing wall;
- A8-A10 - No comments;
- B1 Georges Quay East - concern at loss of mature trees required for construction of new wall in this location; and
- B2 Georges Quay West - concern that proposed stone finish on wet side matched existing.
- B4 King John's Castle - consideration of a continuous walkway on the west side of the castle.

Final Public Information Day on the Preferred Option - August 2019

The fourth Public Information Day (PID) took place on Thursday 29th August 2019 to explain the preferred scheme and to display the photomontage prepared to assist the Landscape and Visual Impact assessment for the project prior to submission of the planning application. This PID was staged in the City and County Hall in the evening from 4:00pm until 8:00pm. Information about the scheme including a detailed photomontage, engineering drawings, and landscape drawings, were made available for review, and members of the Team were present to give information about the design. General comments raised by attendees but not formally recorded in the comment sheets were as follows:

- When will it happen?
- Objection to the presence of the walkway on a new embankment at back of St.Munchin's street;
- Objection to the location of the new embankment (proximity to houses on both east and west);
- Resident of St. Munchin park asked if they would be a public meeting to explain the planning proposals before going to planning;
- Residents in St Mary's park said that facilities for horse riding & motor bike riding should be provided by LCCC for young people to avoid messing up the new landscape areas with bike and horses;
- Concern about dust control and air quality monitoring during the construction period;
- Question regarding Star Fort in wetlands area related to St John's Castle (identified in St.Mary's park by another participant);
- Concern about modern glass panels close to the historic castle and quay walls; and
- Suggestion that seating be placed on the embankment at Star Rovers for the matches to remove spectators from a current inconvenient location.

6 Population and Human Health

6.1 Introduction

This chapter describes the likely impacts of the proposed FRS on the human environment including the potential effects on human health and disruptions to the population. This chapter addresses primarily the effects of the proposed scheme on human health, demographics, potential receptors such as schools and existing community facilities, and recreation and tourism. Other sections of the EIAR are closely linked to effects on population and human health. All of these sections should be read to gain a full understanding of the impacts on human health. These sub-topics include assessment of the effects of the proposed FRS on:

- Material assets including utilities, waste, and traffic (addressed in Chapter 7);
- Noise and vibration (addressed in Chapter 11);
- Air Quality (addressed in Chapter 12);
- Landscape and Visual impacts (addressed in Chapter 13).

6.2 Methodology

This chapter has been prepared having regard to the EIA Directive 2014/52/EU and the associated Draft Guidelines on the information to be contained in Environmental Impact Assessment Reports (EPA, 2017), as well as the Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment, August, 2018.

It is noted that Article 3 of the 2014 Directive effectively defines the EIA process as identifying, describing and assessing in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on a series of specified environmental factors. The first of these is “population and human health” which replaces “human beings” in the 2011 Directive. The term “human health” is not defined in the 2014 Directive.

Consideration of human health effects resulting from the construction and operation of a project should focus on health issues arising in the context of the other environmental factors listed in Article 3 of the Directive/ Section 171A of the Act, including:

- Population;
- Biodiversity, with particular attention to protected species and habitats;
- Land, soil, water, air and climate;
- Material assets, cultural heritage and the landscape; and
- Interaction between the above factors.

European Commission guidance relating to the implementation of the 2014 Directive, in reference to “human health” states “*Human health is a very broad factor that would be highly Project dependent. The notion of human health should be considered in the context of other factors in Article 3(1) of the EIA Directive and thus environmentally related health issues (such as health effects caused by the release of toxic substances to the environment, health risks arising from major hazards associated with the Project, effects caused by changes in disease vectors caused by the Project, changes in living conditions, effects on vulnerable groups, exposure to traffic noise or air pollutants) are obvious aspects to study. In addition, these would concern the commissioning, operation, and decommissioning of a Project in relation to workers on the Project and surrounding population”*.

The appraisal of likely significant effects on population and human beings was conducted by reviewing the current socio-economic environment in the areas close to the proposed FRS.

Baseline information with respect to the demographic and employment characteristics of the resident population within the catchment area was sourced from the 2011 and 2016 Censuses[13]. The data included information on population, structure, age profile, and household size, number of persons at work and unemployment profile. Information was also sourced from the following:

- Limerick City Development Plan 2010-2016 (as Extended);
- Limerick Regeneration Framework Implementation Plan 2013;

[13] CSO. (2011 & 2016). Central Statistics Office. [Accessed July 2019]. http://www.cso.ie/en/index.html

- Limerick Regeneration Framework Implementation Plan Environmental Report (for the purposes of Strategic Environmental Assessment) (2013);
- Limerick Tourism Development Strategy Action Plan 2019-2023; and
- Limerick Metropolitan Cycle Network Study (2019)

During the preparation of this EIAR, consultations with a number of parties were made in order to ensure that environmental issues, including socio-economic, recreational and amenity issues relating to the project were addressed. The parties consulted are listed in Chapter 5 of this EIAR.

The following guidelines were also consulted during the preparation of this Chapter:

- Fáilte Ireland's Guidelines for the treatment of tourism in an EIS; and
- EPA Guidelines on Information to be Contained in an EIAR (2017)

6.3 Existing Environment

6.3.1 Site Description

The proposed scheme is along the perimeter of King's Island, totalling approximately 3.6 linear kilometres of flood defences. The site is generally divided into two main areas based on geographic location and land use: St. Mary's Park to the north of the island, which is primarily residential, and Englishtown to the south of the island which the historic centre of Limerick City and is generally more commercial.

The outer edges of St. Mary's Park is presently public open space with existing embankments topped with a footpath and sandbags along the outer edges as an emergency flood defence. The existing embankments are used by the public as a walking path. Verdant Place, a road which gives access from Thomond Bridge to St. Mary's Park, is also located in the northern section of the island and was refurbished in 2017 to upgrade the flood defences along the quay.

The southern edges of the island are generally a mix of quay walls topped with public footpaths, buildings, and road infrastructure. These include Sir Harry's Mall, the Absolute Hotel, George's Quay, the Potato Market, Curraghgour Boat Club, Merchant's Quay, the Limerick Court Office, Limerick City and County Council buildings, and King John's Castle. There are several notable and widely used places along George's Quay, including The Locke Bar, Azur Restaurant, Limerick Institute of Technology (LIT), and Barrington's Hospital.

6.3.2 King's Island

King's Island is located in the centre of Limerick City, surrounded by the Shannon and Abbey River. The Island is made up of two distinct areas: Englishtown and St. Mary's Park. Englishtown is a historical region of Limerick city, located in the south of the Island, while St. Mary's Park is a housing estate located at the north end of the Island. Nicolas Street, St. Mary Street, Athlunkard Street, and Island Road are in the centre of Limerick City and connect the Island with the rest of the city centre. The streets have tourist and commercial potential, yet the presence of various empty and underused sites and buildings along it, degrade the area aesthetically. Despite that, King's Island still retains some significant architectural and archaeological heritage such as the remains of the Limerick City Walls, King John's Castle, Thomond Bridge and St. Mary's Cathedral.

King's Island is divided into three Electoral Divisions as shown in Figure 6-1, Volume 3:

- John's A (St. Mary's Park, Oliver Plunkett Street, St. Brendan's Street, St. Bridget's Avenue, St. Ita's Street, St. Munchin's Street, St. Patrick's Avenue, St. Senan's Street);
- John's B (Island View Terrace, Assumpta Park, Verdant Crescent, Lee Estate, Old Dominic Street, Church Street, Castle Street, the Parade, Abbey View, Island Road, Convent Street, Castle Lane, Newgate Lane, St. Peter Street, Crosbie Row, Exchange Street, Merchant Quay); and
- John's C (Key Row, Sir Harry's Mall, Long Lane, Sheep Street, Mary Street, Bridge Street).

Due to continuous isolations economically and socially between the north and south portion of the Island, the levels of deprivation have increased significantly. According to the HSE, St. Mary's Park Estate has received a deprivation score of 10 (scale 1-10), 10 being considered of very high deprivation. Although the most disadvantaged area is St. Mary's Park at the north of the Island, the south end of the Island still faces economic and social constraints. St. Mary's Park has one road that connects it to the rest of Limerick City, and this has resulted in its physical, social, and economic isolation. There are multiple vacant and derelict houses in the estate, most which do not have appropriate insulation and majority which would not meet current building standards. The physical condition and state of the residences in St. Mary's Park are a direct correlation of living conditions in this area. St. Mary's Park has been specifically identified in the Limerick Regeneration Framework Implementation Plan 2013[14] as a deprived area in need of regeneration.

At the east of Munchin's Street, some local residents turned a strip of land into a landfill site of illegal domestic waste that became a severe environmental blackspot. This illegal landfill site has now been removed by Limerick City Council.

The difficulties in King's Island have been reflected in the census. The population King's Island has slowly been declining, and the population of Limerick City has been increasing but at a much slower rate than the national average. The Limerick Regeneration Framework Implementation program aims at reversing the pattern. Flooding is one of the Key Challenges identified in the Regeneration Plan (2013) for St. Mary's Park as described:

A key challenge in St Mary's Park is the designation of the majority of the area under Flood Zone A. Residential use is classed as a highly vulnerable use within this area and new build residential development is not permitted except in exceptional circumstances.

Additional key challenges include the lack of access/movement in and out of the area, lack of open play spaces, lack of historic character reflecting the archaeological significance of the area, and lack of physical character. These challenges are being addressed as part of the Regeneration Plan.

6.3.3 Shannon and Abbey Rivers

King's Island is surrounded on the north and west sides by the River Shannon, and the east and south sides by the Abbey River. The River Shannon, as the largest river in Ireland, has a catchment area of 17,000 km^2 which discharges to King's Island and Limerick City. The Abbey River has been modified to provide locks for navigation. Both the Abbey and the Shannon provide valuable recreation and landscape amenities.

Popular activities on the rivers include kayaking, angling, boating, and swimming. There are walks centred around both rivers for people to enjoy views from and toward King's Island.

There are two active boat clubs on the island, the Curraghgour Boat Club, and the Athlunkard Boat Club, which provide access to the river for boat users. Rapids located on the riverbed by King John's Castle provide a spot for anglers at low tide and provide an important landscape feature. Scenic river walks include the Three Bridges Walking Route, which is a popular 3.6km walk beginning at Arthur's Quay Park, crossing to King's Island and passing St. Mary's Cathedral and King John's Castle, crossing Thomond and Sarsfield Bridges, to give a stunning view of the River Shannon and some of Limerick's most iconic landmarks.

Tourism amenities such as King John's Castle, the Treaty Stone, and the three bridges through Limerick are all located on the banks of the Shannon, and scenic views across the river toward these amenities are of important cultural significance to Limerick City. Businesses such as the Locke Bar, J.J. Bowles, and the Curraghower Pub benefit from the scenic views of the River Shannon toward King's Island and the quays by providing outdoor spaces for patrons to enjoy scenic views of the river.

6.3.4 Limerick City

King’s Island is within the heart of Limerick City. Limerick is the third most populous urban area in the state, behind Dublin and Cork. The city dates from the year 812 and has a rich ancient and medieval history. Limerick is at the heart of Ireland's Midwest and is an important focal point for the surrounding counties. Limerick's prominence is driven in part by the University of Limerick, Limerick Institute of Technology, Shannon Airport in Co. Clare and Shannon Development. Notable cultural focal points within the city include the Milk Market, O’Connell Street, William Street, People’s Park, King’s Island, Arthur’s Quay, Bishop’s Quay, and Clancy’s Strand. Three bridges cross the River Shannon: Shannonbridge, Sarsfield Bridge, and Thomond Bridge.

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[14] Limerick City & County Council. (2013). *Limerick Regeneration. Framework Implementation Plan*. Available: http://www.limerick.ie/council/limerick-regeneration-framework-implementation-plan

The past census reported a large population decline in central city areas following the collapse of the local and national economy from 2008 onwards. The economic recession in Ireland had a profound effect on Limerick, notably due to the announcement in 2009 that Dell was to close its manufacturing facility in Limerick, which high level employment for a significant number of people in the area. In recent years, Limerick has experienced a slow recovery in line with the changing economic landscape in Ireland. Many multinational companies are based in Limerick, and today the city is a growing recipient of foreign direct investment.

Following the merger of Limerick County Council and Limerick City Council in 2014, a new Metropolitan District of Limerick City was set up that included the city urban area and also settlements close to the city such as Patrickswell and Castleconnell. The Limerick City Metropolitan District is divided into 3 wards or electoral areas which are; Limerick City East, Limerick City North and Limerick City South which elect eight, six and seven Councillors respectively.

There are a number of transport facilities in Limerick City. Limerick Colbert station is the railway hub for the city and the Midwest Region with a number of intercity and commuter rail services serviced by Iarnród Éireann. There is an intercity bus service, as well as services connecting the city to rural towns and villages in counties Limerick, Clare, Tipperary, and Kerry. Several bus services run daily to other city centres including Galway, Dublin and Cork. Shannon Airport is 20 km west of the city in County Clare. It is one of Ireland's main airports and is easily accessible from Limerick. Limerick's position at the top of the Shannon Estuary has made the city a major commercial port, which was expanded through the development of canals giving access to the River Shannon. Historically, Limerick port was located near the confluence of the Abbey and Shannon rivers at King's Island. Today the port is located further downstream on the Shannon alongside the Dock Road and is operated by the Shannon Foynes Port Company who operate all marine activities in the Shannon estuary.

Limerick is an important centre for higher education in Ireland, being home to the University of Limerick, Limerick Institute of Technology, Mary Immaculate College, and Griffith College Limerick, which together contribute a student population of over 20,000.

The city has a loyal sporting fanbase, primarily in rugby, Gaelic football, hurling, and association football. There are two major sporting stadiums including the LIT Gaelic Grounds and Thomond Park, which regularly host nation-wide sporting events. Limerick Racecourse and the Limerick Greyhound stadium are located outside the city at Greenmount.

Tourist attractions of architectural and historical note in the city centre include Limerick City Museum, King John's Castle, St Mary's Cathedral, the Hunt Museum, the University of Limerick, and the Treaty Stone, all located on or in proximity to King's Island.

6.4 Demographics

The smallest geographical units distinguished by the Central Statistics Office (CSO) are Electoral Districts (EDs) and Small Areas (SAPS). Limerick City was considered a Legal town (LT) in the 2011 Census and is a Formal Legal Town (FLT) in the 2016 Census due to changes in the Council boundaries. The boundaries of the Legal Town of Limerick City are shown in Figure 6-2, Volume 3.

Table 6-1 outlines the population change between 2011 and 2016 in the State, in Limerick City LT/FLT and King's Island. This Table demonstrates the population increases are slightly lower in Limerick City Legal Town Area compared to the National rates, and King's Island saw the opposite trend of population decrease of 1.8% from 2011 to 2016.

Table 6-1. Population Trends within the intercensal period 2011-2016

District	2011	2016	Change from 2011-2016 (%)
State	4,588,252	4,761,865	+3.8
Limerick County	191,809	194,899	+1.6
Limerick City (LT/FLT)	57,106	58,259	+2.0
King's Island	2207	2167	-1.8

King's Island contains three Electoral Districts: John's A, John's B, and John's C, as shown in Figure 6-1. The proposed FRS site borders all three of these Eds. Table 6-2 shows that the population has decreased notably in John's A (St. Mary's Park area) from 2011 to 2016, decreased slightly in John's

B (the medieval quarter), and increased substantially in John's C (southern, commercial area of King's Island). It is noted that several houses were demolished in St. Mary's Park as part of the Limerick Regeneration Plan by LCCC, with the intention to build infill housing.

Table 6-2. Population Trends of Electoral Districts within King's Island

Electoral District	2011	2016	Change from 2011-2016 (%)
Johns A	863	759	-12.0
Johns B	976	952	-2.4
Johns C	368	456	+23.9
Total	2207	2167	-1.8

6.4.1 Households

Table 6-3 below outlines the average household size in each of the geographical areas assessed. The statistics illustrate an increase in household size from 2011 to 2016 in King's Island, a slight decrease, showing the opposite trend to the State and no change in Limerick City, as follows:

Table 6-3. Average Household Size (persons per household)

District	2011	2016
State	2.73	2.75
Limerick City	2.47	2.47
King's Island	2.45	2.37

There were 866 households in King's Island (3 EDs) in 2016 (886 in 2011) and a decrease in population.

6.4.2 Employment

Recent trends in employment were evaluated using CSO information generated from the 2011 and 2016 Census statistics. The information was compiled on the basis that:

- The labour force is defined as the sum of people aged 15 years and over who are at work or who are employed; and
- The participation rate is the proportion of persons in the labour force aged 15 years and over expressed as a percentage of all persons in that age group.

Statistics shown in Table 6-4 below outlines the employment figures for the State, Limerick City (Legal Town boundaries), and for King's Island.

Table 6-4. Employment Figures for the State and Limerick City

Area	Total Persons		At Work		Unemployed (ex 1st time job seekers)		% Rates of Participation in Labour Force	
	2011	2016	2011	2016	2011	2016	2011	2016
State	4,588,252	4,757,976	1,807,360	2,006,641	390,677	265,962	48.7	61.4
Limerick City	57,106	58,259	18,419	20,778	6788	5022	39.3	43.4
King's Island	2207	2167	528	602	414	270	29.4	2.9

Table 6-5. Employment Figures for King's Island (Persons 15 Years and Over)

ED	Total Persons		Unemployed (ex. first time job seekers)		At Work	
	2011	2016	2011	2016	2011	2016
John's A	651	600	201	109	156	118
John's B	814	824	165	117	232	275
Jon's C	328	405	48	44	140	209
Total	1793	1829	414	270	528	602

This indicates that the number at work in King's Island increased during the intercensal period, though at significantly lower rates than the national trend. The number of unemployed declined in King's Island, consistent with State and Limerick City trends.

Table 6-6. Distribution of employment by broad industrial group in Limerick City and King's Island area (Number of persons aged 15 and over) 2016

Industry	Limerick City	King's Island
Agriculture, forestry and fishing	47	0
Building and construction	673	16
Manufacturing industries	2523	67
Commerce and trade	4876	139
Transport and communications	1794	56
Public administration	868	22
Professional services	4991	164
Other	5006	138
Total	20778	602

The majority of employment in the King's Island in 2016 is in the commerce and trade, and professional services grouping.

6.4.3 General Health

The population was surveyed in the 2016 Census and asked if they would considered their health to be bad or very bad.

Table 6-7. Percentage of population who stated their health was bad or very bad, 2016

Electoral Division	Percentage of population who stated their health was bad or very bad, 2016
John's A	6.9
John's B	5.4
John's C	1.5
National Average	1.6

People living in John's A (St. Mary's Park) and John's B (below St. Mary's Park to Athlunkard Street) tend to be in bad health compared to the national average. People living in John's C tend to be within the national average for health.

6.5 Principal Potential Receptors

An assessment of the principal potential receptors within the environs of the proposed FRS including homes, schools, tourism, recreational, agriculture, commercial and industrial premises was conducted in detail below.

6.5.1 Homes

According to the most recent 2016 census, John's A ED contains approx. 286 dwellings, John's B contains 430 dwellings, and a further 170 units in John's C. This gives a total of 886 dwellings on King's Island. Two major estates on King's Island include the following:

- Lee Estate, located east of Island Road and south of the Star Rovers pitches (bordering area A5); and
- St. Mary's Park, located at the northern section of the Island (surrounded by Areas A3 and A4).

6.5.2 Schools and Colleges

There are five schools within King's Island, which include one middle school, two national schools, and a joint campus initiative of the Shannon Consortium Partners University of Limerick (UL), Limerick Institute of Technology (LIT), Mary Immaculate College (MIC), and The Institute of Technology Tralee (ITT).

Table 6-8. Educational Facilities on King's Island

School Type	Name	Address
Middle School	Gaelcholáiste Luimnigh	Sir Harry's Mall, Limerick
National School	St Marys Girls National School	Island Road, Limerick City
National School	St Marys Boys National School	Island Road, Limerick City
College	LIT George's Quay	George's Quay, Limerick

Both Gaelcholáiste Luimnigh and LIT George's Quay are located on quays where works are proposed.

6.5.3 Childcare Facilities

There are two childcare centres located within the catchment area of the proposed FRS site, as listed on the Limerick Childcare Committee Register.

- Northside FRC King’s Island Community Crèche, which is located on St. Ita's Street, on the edge of St. Mary's Park, is along the border of King's Island where works at flood cell Area A2 are proposed. This creche offers Full-Day, Part-Time, and Sessional Pre-School.
- St. Mary’s Preschool & Homework Club is located in St. Mary's Girls' School, on Bishop Street, offers Sessional Preschool services.

6.5.4 Health, Social and Community Facilities

There are several health, social, and community facilities on King's Island. In addition, Limerick City and County Council is located at the Civic Buildings along Merchant's Quay, which are adjacent to the proposed FRS.

Table 6-9. Health, Social, and Community Facilities on King's Island

Name	Address
Medical Facilities	
Bon Secours Hospital Limerick	Barringtons, George’s Quay, Limerick
Ultimate Health Clinic	George's Quay, Limerick
Elaine McGowan Dietetic Clinics	6-9 George's Quay, Limerick
Bishop Street Health Centre	Bishop Street, Limerick
Abbeygrove Surgery	Sir Harry's Mall, Limerick
Kings Island Medical Centre	Island Road, King's Island, Limerick
Social Facilities	
St. Mary's Aid Community Centre	Nicholas Street, Limerick

Limerick City Community Development Project, St. Mary's Office	5 Verdant Crescent, Kings Island, Limerick
Churches	
St. Mary's Cathedral	Bridge Street, Limerick
St. Mary's Church	6 St Mary's Pl, Island Rd, Limerick
St. Saviours Dominican Friary	30-38 Island Rd, Limerick
Recreational Facilities	
Star Rovers FC	St. Marys Park, Limerick

6.5.5 Commercial

There are various businesses based in King's Island, these are summarised in Table 6-10 below. These businesses are located on major roads such as Nicholas Street, Island Road, Verdant Crescent, Athlunkard Street, and Church Street, in the southern end of the Island (Englishtown).

Table 6-10. Summary of King's Island Local Business. This list does not include all businesses

Local Business Name	Address
Abbey River Coffee	The Potato Market, Merchant's Quay,
Absolute Hotel Limerick	Sir Harry's Mall, Limerick
Aegis Archaeology	32 Nicholas St, King's Island, Limerick
Amber Restaurant	4 George's Quay, Limerick
AZUR	8 George's Quay, Limerick
Bakehouse 22	22 Nicholas St, Limerick
Bambury Bookmakers	43 Nicholas St, Limerick
Castle Antiques	2 Castle St, King's Island, Limerick
Escape Limerick	15 Nicholas St, Limerick
F&G Motor Factors Limited	1 Athlunkard St, Limerick
Island Theatre Company	Church St, King's Island, Limerick
Katy Daly's Heritage Pub And Kitchen	12 Castle Street, Limerick
Lilac Rose	George's Quay, Limerick
Limerick City Museum	Castle Lane, off Nicholas Street, King's Island, Limerick
Limerick Civic Trust, Builders	Bishops Palace, Church Street, King's Island, Limerick
Limerick Landscaping	6 Verdant Cres, King's Island, Limerick
Nelly's Corner	46 Nicolas Street, Limerick
O'Donoghue's Shop	King's Island, Island view terrace
Paddy McMahon & Son Butchers	9 Athlunkard Street Limerick
Post office	Mary Street Limerick
Skip Hire	King's Island, Limerick
St Marys Parish Credit Union	47 Athlunkard St, Limerick
Stix Arcade & Snooker Hall	Nicholas St, Limerick
Sunflower Take-Away	34 Nicholas St, Limerick
The Cauldron Bar	33 Nicholas Street, Limerick
The Locke Bar	3 George's Quay, Limerick
The Potato Market Car Park	The Potato Market, Merchant's Quay,
Treaty City Brewery	24 & 25 Nicholas St, Limerick
Yummy Yummy Asian Street Food	51 Athlunkard St, Limerick

6.5.6 Tourism

Limerick Tourism Development Strategy Action Plan 2019-2023[15] aims to revitalise the tourism sector in Limerick. This strategy presents four main drivers of tourism that are considered central to driving tourism in Limerick: Waterways, Activities, Heritage, and Arts and Culture. King's Island will play a significant role in this tourism strategy particularly around Heritage as it is the historic core of Limerick City. King's Island is an area with a lot of potential for tourism with significant architectural and cultural heritage. There are still remains of the Limerick City Walls and various buildings from the 12th and 13th century including King John's Castle, Thomond Bridge and St. Mary's Cathedral. The area in the south of King's Island has been recognized as the historic core of Limerick or the Medieval Quarter. There is also an Old Military Cemetery at the southern edge of St. Mary's Park that is likely to date back to the mid-Nineteenth Century. King's John Castle is the main attraction in King's Island welcoming over 40,000 visitors annually from Ireland and overseas.

In addition to the cultural heritage, King's Island offers a pathway along the riverside, which goes around the whole Island surrounded by treelines and wetlands. There are SACs within the Island which may attract nature enthusiasts (bird watchers), as well as, runners and cyclists.

The Limerick City and County Council has put a number of policies in place to encourage tourism and amenities, particular in King's Island:

- *Policy ACT.31 (King John's Castle): LCCC want "to facilitate the redevelopment of King's John Castle and Nicholas Street as a tourist destination".*
- *Policy ACT.36 (Cultural Quarters): LCCC aim "to promote and develop cultural quarters in the city and in particular, John's Square, the Georgian Quarter, the Commercial Core, the Medieval Quarter and the docklands".*

6.5.7 Recreation

Water Recreation/Rowing

The island has two rowing clubs namely the Curraghower Boat Club, adjacent to the Court House on Merchant's Quay, and Athlunkard Boat Club, adjacent to O'Dwyer's Bridge. The banks of the River Shannon and the Abbey River at the north side of King's Island are used frequently by boat users for access and egress into the river.

King's Island Walking/Cycling Pathway

There is an existing shared pedestrian/cycle pathway along the perimeter of King's Island. While recent damage has severed the continuity of the walkway, the facility will be upgraded and re-opened as part of the proposed FRS to include a 3m-wide cycle path and walkway.

Sports pitches

The sports fields and pitches east of Assumpta Park are leased to Star Rovers FC (northern pitches, including an AstroTurf pitch, car park and changing rooms) and Athlunkard Villa FC (southern pitch).

Due to space constraints at Star Rovers FC, and to avoid works inside the SAC (including construction access), the required alignment of an embankment will require reconfiguration of the pitches and carparking area of the football club (as shown the project Landscape design Strategy). There would also be some impact on the pitch and club facilities, including the southern playing pitch, changing rooms and boundary fence and netting. Following liaison with the associated clubs, and direction from LCCC, a number of possible reconfigurations have been developed and assessed for this location. The main benefit of this option would be to provide continuity of defence line with an embankment around the full perimeter of the SAC.

It is proposed to continue the line of direct defences from Area A4 to provide flood defences to this section of the island through an embankment running alongside the eastern boundary of Star Rovers and Athlunkard Villa FC. The footprint of the embankment will encroach along the eastern perimeter of the Star Rovers FC sports grounds, including the training pitches. As this land is leased by Star Rovers FC and Athlunkard Villa FC from LCCC, discussions between the Landowner and Tenant are required. The following should be noted:

15 Limerick City and County Council. (2019). *Limerick Tourism Development Strategy Action Plan 2019-2023.*

- The container changing facilities may need to be relocated in consultation with Star Rovers FC during the construction phase;
- The existing boundary fencing and netting at the eastern side of the playing fields will also need to be relocated;
- The line of the defence encroaches onto the river side of the SAC between Chainage 2+100 and 2+400 and slightly encroaches into the Star Rovers football grounds. The key environmental issues and their significance at this location are discussed below; and
- Construction of the embankment may cause a temporary disruption to the users of the football pitch.

Strategic Walking and Cycling Route 1

The Limerick Metropolitan Cycle Network Study was published in 2019, having regard to International, National, Regional and Local plans and policies in which the vision for the future cycling network has been identified and the policies regarding proper planning and development. This study arose from LCCC and UL's bid to become a smarter travel city and the winning of an award to achieve this.

The study sets out an envisaged network of cycle routes for Limerick City and its Environs. The strategy was formulated with a key focus on linking workplaces and educational centres with residential areas. Prior to the development of the Study, Limerick City Council had developed a number of cycle lanes as part of new road developments in the City, at three locations – the Childers Road/Carew Park access road, the Corbally Link Road (Phase 1), and the N7 realignment from Groody Bridge to Plassey Park Roundabout. These were incorporated into the Cycle Network Strategy.

The Limerick Smarter Travel Plan identified four areas which could benefit from greater connectivity: Limerick City Center, Corbally, Southill, and Castletroy/UL/National Technology Park. As a result, five routes were proposed which would comprise a network of cycle lanes and pedestrian links to better connect Limerick City.

One of the routes, Route 1, connects Corbally to Limerick City via King's Island. It runs along Corbally Link Road and Athlunkard Street/Bridge Street. Details of the schematic proposals are presented in Figure 7-3 below.

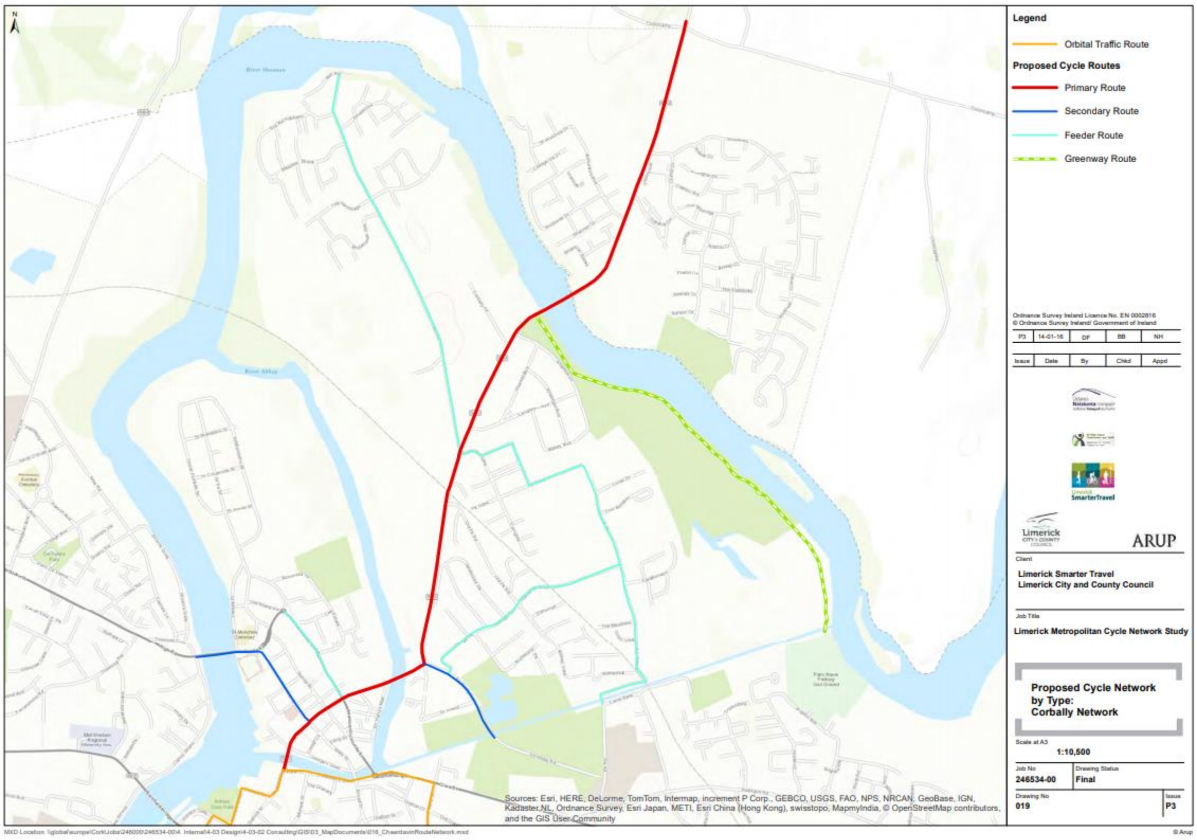

Figure 6-3. Corbally to Limerick City Centre Proposed Cycle Route (Limerick Metropolitan Cycle Network Study, 2019)

Bike Share Scheme

Limerick City contains a public bike share scheme, "Coke Zero Bikes", which currently has 22 docking stations located around the city centre, 2 of which are located on King's Island: Merchant's Quay opposite the Potato Market, and Island Road opposite St. Mary's Church.

6.6 Predicted Impacts

The impacts of the proposed FRS on population and human health in relation to health and safety, residential and recreational amenity and economic activities are evaluated in the following sections.

6.6.1 Do Nothing Scenario

Under the Do Nothing Scenario, it is extremely likely that flooding will continue to occur in King's Island. Flooding has the potential to affect up to 886 homes, as well as the identified businesses, health, social and community facilities, as well as recreational facilities. Tourism potential for the wider Limerick City and County has the potential to be affected by flooding.

Flooding is likely to compromise human health directly through destruction of property. Considering that human health is reported to be very low in John's A and John's B EDs, additional threats to human health could be detrimental to the existing population.

Overall, the predicted impact is the potential for a significant disruption to normal life and wellbeing for the people of King's Island.

6.6.2 Construction Phase

The potential construction phase impacts on local residences and businesses associated with the proposed FRS will relate mainly to traffic, noise, air emissions and visual impacts, all of which are outlined in Chapters 7, 11, 12, and 13 of this EIAR, respectively.

Impacts on Development Context and Land Use Zoning

No economic activity will be displaced through the construction phase of the proposed FRS. It is possible that disruptions to pedestrian walkways will reduce foot traffic and disrupt access to certain businesses, particularly those located on George's Quay. There will be no severance, rights of way loss or conflicts with other sites during the construction phase.

Impacts on Population

During the construction phase of the proposed facility, employment will be created, creating a positive impact on the local population in terms of potential job opportunities. The potential use, both personal and business-related, of local services, including available accommodation, will benefit the local population.

Impacts on Economic Activity

During the construction phase of the proposed facility, employment will be created bringing more people to King's Island, whose use of local retail, leisure and accommodation services will potentially stimulate economic activity for local businesses. In addition to direct construction employment it is anticipated that the proposed project will lead to indirect employment via related services during the construction phase.

Impacts on Human Health and Safety

There is a potential for emissions to impact on human health due to the presence of HGVs and construction machinery operating on site. Mitigation measures have been recommended to lessen these impacts. In addition, access to open space will be reduced during the construction phase in areas where new embankments are to be built and where the existing pathway will be out of use. These impacts will be temporary.

As with any construction site there will be potential risks to the health and safety of construction personnel on-site due to the use of large, mobile machinery and heavy equipment and materials However, health and safety procedures will be put in place as part of the construction management plan with the appointed contractor. It is considered that there will be no significant offsite health and safety risks. The proposed FRS site will be securely fenced from the public during the construction phase.

Impacts on Residential and Commercial Amenity

The construction phase of the development will impact on residential and commercial amenity in the locality, but it will be a temporary, slight impact. The anticipated time of construction is 18 months, with construction occurring in stages in various parts of the island (i.e., not all areas are to be impacted for the full 18 months).

The construction of the embankment will require a large volume of suitable material to be transported into the area via road and the site access routes to the working area. This will have a temporary nuisance impact on the nearby residents. Impacts on traffic are further addressed in Chapter 7 of this EIAR.

Some areas of construction will occur in close proximity to homes, particularly at the rear of houses on St. Munchin's Street in St. Mary's Park. Machinery operating in close proximity to houses has the potential to disrupt the residential amenity and privacy during the construction phase.

Impacts on Recreational Amenities and Tourism

Water's edge footpath

The construction works will include disruption to and closure of the footpath close to Verdant Place and the crèche (Area A2) on the western side of St. Mary's Park. To install the flood wall, the existing embankment will need to be excavated, and the footpath, sandbags to be removed. Similarly, the footpath along the western side of the site (Area A3) adjacent to the River Shannon will be excavated during the construction of the proposed embankment. For safety reasons during construction these footpaths will be closed to the public. The alternative route to access to the north of St Mary's Park and join the existing track around the eastern side of the island will be from the public footpath on Oliver Plunkett Street and St Munchin's Street.

Sports pitches

The sports field east of Assumpta Park comprises pitches leased to Star Rovers FC (northern pitches, including an AstroTurf pitch, car park and changing rooms) and Athlunkard Villa FC (southern pitch). Due to space constraints at Star Rovers FC, and to avoid works inside the SAC (including construction access), the alignment of the embankment will require repositioning of the pitches of the football club. The construction of the embankment will also cause a temporary disruption to the users of the football pitch, on the pitch and club facilities, including the AstroTurf pitch, changing rooms and boundary fence and netting.

Construction will take place in the off-season for the club (July-August) to minimise disruptions to Star Rovers, however this is unlikely to be complete during this period. The AstroTurf and hideabout area closest to the embankment will be unusable during construction.

Tourism

The construction phase will affect recreational amenities and tourism through reduced capacity for traffic on the island during the construction phase: both foot traffic and vehicle/bicycle traffic. Foot traffic will be reduced on the south side of the island (George's quay, Sir Harry's Mall, around the Courthouse/Potato Market and King John's Castle), as well as the northern side of the island where a footpath currently exists on top of existing embankments and is used for recreational purposes. These areas will have limited access for the public during the construction phase for safety purposes.

Vehicle and bicycle traffic will also be impacted, which is described in detail in Chapter 7 of this EIAR. Reduced traffic flow has the potential to reduce the recreational and tourism desirability of King's Island during the construction phase. This effect will be not significant and temporary in nature, lasting the length of the construction phase only (approximately 18 months).

The overall impact on recreational facilities from the construction period will be high but temporary.

Impacts on Community Facilities

It is expected that there will be an impact to some community facilities during the construction phase, particularly with regard to accessibility as a secondary impact of traffic effects (described further in Chapter 7 of this EIAR). This effect will be not significant and temporary in nature, lasting the length of the construction phase only.

Impacts on Visual Amenities

During the construction phase there will likely be some impact on the visual amenity of the area due to the presence of the site compound in Area A3 close to Oliver Plunkett Street, and machinery and construction materials, however this effect will be not significant and temporary in nature, lasting the length of the construction phase only. This is further discussed in Chapter 13 - Landscape and Visual.

6.6.3 Operation Phase

Impacts on Development Context and Land Use Zoning

The proposed FRS is consistent with the existing uses in the vicinity and general character of the area. It is considered an upgrade to the existing flood defences on the island.

Impacts on Population

During the operation of the proposed FRS, King's Island will be less vulnerable to flooding, which may make the area more desirable for residents of Limerick City. The scheme will also provide additional recreational amenities for the island, having a positive impact on the local population.

Impacts on Economic Activity

During the operation of the proposed FRS, King's Island will be less vulnerable to flooding, which may make the area more desirable for business owners, having a positive impact on the local economy.

Impacts on Human Health and Safety

The scheme is designed to best engineering standards, with the purpose to protect human beings from catastrophic floods. The proposed works will result in an improved quality of life on King's Island through additional security that floods will not damage homes and businesses. This may have a cascading effect on public health through making King's Island a desirable location to live and increased pride in place.

Public safety for fishermen has been addressed in the scheme through the provision of emergency egress locations at the north end of the island.

Improvements to the flood defences and complimentary upgrades to the sewerage at the Athlunkard Boat club will have a positive impact on human health through improved water quality in the Abbey and Shannons Rivers.

The scheme has been designed to PSDP standards, and factors in the safety of people using public walkways at flood walls and on top of embankments, through the provision of guarding heights at walls, and gently sloped grassy areas downward from embankments.

No negative impacts on Human Health and Safety are anticipated when the scheme is operational.

Impacts on Residential Amenity

During the operation of the proposed FRS, King's Island will be less vulnerable to flooding, which will preserve the residential amenity of the island and may make the area more desirable for residents. There is a potential in this way to have a positive impact on the local amenity.

One part of the scheme, the embankments along the inner alignment of Area A4, have the potential to change the residential amenity and privacy in this area due to the close proximity of embankments to the rear of houses on St. Munchin's Street. This impact has been addressed through the Landscape design and is addressed further in Chapter 13 Landscape and Visual assessment.

Impacts on Recreational Amenities and Tourism

The proposed works will result in a new 3m-wide footpath and cyclepath around the Northern part of King's Island, as well as improvements the quay walls including ensuring the appropriate guarding height (1.1m) and improved access along Sir Harry's Mall. These new amenities will provide an upgrade to existing recreation and tourism opportunities around King's Island.

Impacts on Community Facilities

It is expected that there will be no significant impact on existing community facilities.

Impacts on Visual Amenities

The proposed FRS will not have a significant impact on the visual amenity of the area. As a result of the landscaping proposed, the layout and design of the proposed structure will be assimilated into the existing environment. This is further discussed in Chapter 13 - Landscape and Visual.

6.7 Mitigation Measures

The suitability of the proposed FRS is generally dependent on the sustainability of the defences in terms of their impact on infrastructure and visual amenity. The sustainability of the development has been ensured through careful and considered design and management which is discussed in the relevant sections of the EIAR.

Many of the potential impacts on population and human health relate to other environmental aspects such as noise, air and traffic. The potential impact of these aspects and the related mitigation measures are discussed within the corresponding chapters of this EIAR. Of the remaining potential impacts relating to the human environment, only those concerning health and safety require mitigation measures. These are outlined in the following sections.

6.7.1 Construction Phase

Many of the impacts during the construction phase can be addressed through appropriate planning. Potential health and safety risks associated with traffic, noise and vibrations, air quality, etc. will be minimised through the implementation by the construct of a site-specific Construction Environmental Management Plan (CEMP) which will be prepared by the contractor prior to construction. This will include provisions for managing access around construction sites, maintenance of residential amenity, working hours, and noise and dust limits, etc., to reduce impacts to residents in the area.

To manage disruptions to the users of the sports pitches (Star Rovers FC), construction will be carried out in the club's off-season when pitches are not typically in use by the club (the months of July and August), although it is unlikely to be completed during this period.

While under construction, there will be potential risks to the health and safety of construction personnel. A comprehensive Health and Safety Programme will be put in place on the site prior to commencement of construction to minimise any risks to site personnel and visitors. The requirements of the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No. 291 of 2013) will be complied with at all times. The site will also be operated under a Construction Transportation Management Plan (CTMP) which will alleviate potential impacts from the construction on the local community. The following mitigation measures are proposed during the construction phase:

- During pre-construction and construction phases safety will be managed in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No. 291 of 2013). A Project Supervisor Construction Stage (PSCS) will be appointed as part of the proposed project;
- Safety will be a primary concern during the construction phase of the proposed FRS. A contractor safety management program will be implemented identifying potential hazards associated with the proposed work including a permit to work system;
- The design of the final proposal will be subject to safety design reviews to ensure that all requirements of the project are safe. A Project Supervisor for the Design Process (PSDS) will be appointed as part of this process;
- Temporary contractor facilities and areas under construction will be enclosed and fenced off from the public with adequate warning signs of the risks associated with entry to these facilities. Entry to these areas will be restricted and will be kept secure when construction is not taking place; and
- Measures to ensure public safety, with respect to construction traffic, are detailed in Chapter 7.

6.7.2 Operation Phase

When the scheme is operational, a maintenance and monitoring schedule will be put in place to verify that the proposed flood defences are operating to the appropriate design standard. Repairs will be made as necessary. This will ensure that there is no risk to human health as the scheme ages.

The proposed FRS has been designed so that guarding heights are at an appropriate level (1.1m) along flood defence walls, and that embankments are sloped gently, to ensure that there is no risk of injury arising from typical use of quay walls and embankments.

Access and egress points have been accommodated into the design to give boat users access on the river side of the embankments in Areas A3 and A4.

6.8 Residual Impact

6.8.1 Do Nothing Scenario

The nature of the development is to protect homes and businesses from flooding, as floods have been known to cause significant damage to homes and businesses on King's Island in the past. The current defences are not adequate to protect against infrequent, high magnitude flood events, which are known to cause the most damage. If the defences are not upgraded, flooding is likely to compromise human health directly through destruction of property and contaminated floodwaters disrupting supplies of clean water and carrying waterborne diseases.

Overall, the predicted impact is the potential for a significant disruption to normal life and wellbeing for the people of King's Island.

Under the Do Nothing Scenario the impact on population and human health is likely to be Significant and Negative, with residual impacts lasting into the Long Term.

6.8.2 Construction Phase

While under construction, there will be a positive benefit to employment in King's Island, which can have cascading effects for local businesses as a result of the increased number of workers in the area. There will be potential risks to the health and safety of construction personnel. Mitigation measures in place include adequate Health and Safety standards to ensure that no injury or accidents occur during the construction phase.

The population of King's Island will experience disruptions to daily life and to their recreational facilities in St Mary's Park due to associated impacts on Traffic, Air, Noise, and the Visual amenity during the construction phase. Mitigation measures are described further in associated chapters of the EIAR. These impacts will be temporary and lasting only a part of the duration of the construction phase (i.e., most locations will not be disrupted for the entire 18-months of construction).

The residual impact of the construction phase on population and human health is predicted to be Neutral, with Temporary, Short-term effects.

6.8.3 Operation Phase

The nature of the development is to protect both homes and businesses from flooding, and to improve surface water drainage on the island. A secondary purpose of the development is to provide a cycle and footpath along the border of King's Island, which provides recreational and tourism benefits to the area. There is potential as a result of the proposed FRS for King's Island to become more desirable as a residential and business area due to the reduced risk of flooding and the new amenities. The development will also protect important tourist destinations, which are culturally and economically significant to Limerick City.

There will be a slight disruption to visual amenity for houses along St. Munchin's Street which will experience reduced visibility to the open area of the SAC due to the new embankment. Mitigation measures associated with this impact are addressed in Chapter 13 - Landscape and Visual Assessment.

There are no predicted negative impacts during the operation phase.

The residual impact to population and human health during the operation of the scheme is predicted to be Positive, with Long Term effects.

6.9 Interactions with other Environmental Effects

The potential interactions of population and human health with other environmental effects are most likely to occur during the construction phase. The potential impacts on population and human health arise from traffic, visual effects, air and noise emissions and climate change, all of which are dealt with in the following specific chapters in this EIAR dedicated to those topics.

Chapter 7 – Material Assets (Traffic)

Chapter 11 – Noise

Chapter 12 – Air

Chapter 13 – Landscape & Visual

6.10 Potential Cumulative Effects

On review of nearby proposed FRSs, there is a potential for cumulative impacts to population and human health as a result of changes to traffic, air quality, and noise during the construction phases. These impacts are discussed in the associated chapters of the EIAR.

Major developments which have recently submitted Planning Applications may be under construction in close proximity to King's Island at the same time as the proposed FRS, if planning permission is granted. These include:

- Opera Site, Limerick City (approx. 50m south of King's Island, construction expected to last between 4.5 and 6 years beginning in 2019/2020)
- Limerick Urban Centre Revitalisation - O'Connell Street (approx. 250m south of King's Island, construction expected to last 18 months)

If the construction periods of these developments are to overlap, there is a potential to impact on population and human health through disruptions to tourism, recreation and businesses in Limerick City centre. These effects will be temporary.

Once operational, the proposed FRS, when considered cumulatively with the above developments, will have a positive impact to the population of Limerick City and King's Island through improved opportunities for business, recreation and tourism in the area.

6.11 Difficulties Encountered in Compiling this Information

There were no difficulties in compiling this information.

7 Material Assets incl Traffic, Utilities and Waste Management

7.1 Introduction

Material assets (as defined by the EPA Guidelines) covers three separate aspects: Traffic, Built Services/ Utilities and Waste Management.

7.2 Traffic and Transportation Baseline

7.2.1 General

This section of the EIAR describes the existing roads, traffic and transportation system in the vicinity of and leading to the proposed King's Island FRS. This section also examines the various aspects of the construction and operation of the development which have the potential to impact on roads, traffic and transportation, and the magnitude of these impacts are considered prior to mitigation. Mitigation measures are then discussed and the residual impact (post mitigation) is outlined.

The study area for this section of the EIAR includes the immediate vicinity of the proposed scheme, and the network of public roads leading to, from, and through King's Island.

7.2.2 Assessment Methodology

This chapter describes the existing traffic situation, estimates the volume of traffic which will be generated by the proposed FRS during its construction and operation phases, determines the likely traffic distribution on the local road network and finally makes recommendations to mitigate any effects of the projected increase in traffic on the local road network.

This assessment has been undertaken using a combination of desktop studies, field surveys and consultation with statutory agencies and local authority representatives in line with current good practice and policy advice. The assessment examines the proposed FRS, including staff movements and deliveries, and the associated haul routes for materials.

Traffic volumes throughout this assessment are expressed in passenger car units (PCUs). PCUs are used as the unit of measurement rather than vehicles in order to examine and measure the relative effect on traffic networks by a variety of vehicles. Essentially, a passenger car is assumed to be the standard vehicle for the network and is therefore given a PCU value of 1. A factor is then applied to vehicles other than a standard car in order to convert their relative effects in terms of volume, speed, delay etc. to that of a car. A Heavy Goods Vehicle, for example, would have an equivalent PCU value of 2.3.

Consultation

The scope of the effects of traffic due to the proposed FRS was discussed in advance with Limerick City and County Council, including delivery routes and the impact of site traffic on the local road network during construction in particular.

The junctions assessed were agreed as part of this discussion, in addition to haul routes to the site, site compound locations, and anticipated staff numbers.

7.2.3 Existing Environment

This section describes the existing environment in terms of roads and transport in the vicinity of the proposed King's Island Flood Relief Scheme.

Roads in the Republic of Ireland are classified as motorways, national (primary and secondary), regional and local roads. Transport Infrastructure Ireland (TII) has overall responsibility for the planning and supervision of the construction and maintenance of motorways, national primary and national secondary roads. The local authorities have responsibility for all non-national roads. The hierarchy of road types throughout Ireland is outlined in

Table 7-1 below.

Table 7-1: Road Classification

Road Category	Description
Motorways	These are high quality multiple lane roads with limited grade separated junctions. They are high speed (120kph) roads predominantly provided to facilitate strategic traffic, with reduced journey times.
National Primary Roads	These are predominantly single carriageway, with some that are dual carriageway. Generally high speed (100kph) roads they also facilitate strategic traffic, with reduced journey times.
National Secondary Roads	These are medium distance through-routes connecting important towns, serving medium to large geographical areas and links to primary routes to form a homogeneous arterial network.
Regional Roads	Predominantly single carriageway roads of regional and local importance. These receive higher priority in maintenance criteria than Local Roads; hence tend to be structurally sound.
Local Roads (Primary, Secondary and Tertiary)	The local road system is operated in three tiers defining local importance, usage and maintenance priorities. They form a network of single carriageway roads of varying quality.

The existing road network in the general vicinity of the proposed King's Island Flood Relief Scheme is outlined below and shown in Figure 7-1 Regional and Local Street Network, in Volume 3. There is no motorway or national road in the immediate vicinity of the site. The M7 motorway passes approximately 3km to the south of the proposed FRS, and the N69 travels along the south docks, stopping at Sarsfield Bridge which is approximately 1km from the proposed FRS. The R463 regional Corbally Road passes through King's Island from the south to the east, crossing the River Abbey to the east of the island. The R445 regional Dublin-Ennis Road passes through the island from west to south-east, crossing the R463, and connecting to the M7 motorway to the east of Limerick City and to the N18 to the west. All other roads and streets on King's Island are local roads. The R526 connects the R445 and R463 along Charlotte's Quay, to the south of the island.

Short-period traffic counts were commissioned at nine locations in the vicinity of the proposed scheme in order to ascertain the traffic patterns which exist in the area, and to assess the impact of the proposed FRS on this traffic. A number of these junctions were assessed in more detail in relation to the effects of the proposed scheme. This is detailed in Section 7.3 below.

The traffic surveys were undertaken on Tuesday 9 April 2019 between 07.00-10.00 and 16.00-19.00. The junctions surveyed are listed below and also shown in Figure 7-2 Traffic Survey Locations and HGV Delivery Route, in Volume 3.

- Junction 1: Thomondgate/High Road/Clancy's Strand;
- Junction 2: Verdant Place/Castle Street/Thomond Bridge;
- Junction 3: Island Road/Castle Street Roundabout;
- Junction 4: R463 Athlunkard Street/R445 Island Road;
- Junction 5: R463 Corbally Road/Pa Healy Road Roundabout;
- Junction 6: Island Road/R445 Lock Quay/Charlotte's Quay;
- Junction 7: Mary Street/Charlotte's Quay/Broad Street;
- Junction 8: Bridge Street/George's Quay/Merchant's Quay; and
- Junction 9: Bridge Street/R445 Bank Place/Rutland Street/Hunt Museum.

7.2.4 Proposed FRS

As outlined above, the proposed scheme consists of the construction of new embankments and walls around the perimeter of King's Island, as well as raising existing walls, in order to provide protection to residential, amenity and commercial areas on the island. Some localised roadworks, including amending kerblines, raising levels locally, resurfacing and repaving footpaths, will also form part of the works, as will permanent walkways along embankments and temporary access tracks and site compounds. The total length of proposed embankments is approximately 2.2km, with a total length of new and amended wall construction of approximately 1.5km. A full description of the proposed scheme is included in Chapter 4.

It is anticipated that the construction phase of the scheme will take approximately 18 months. This phase will give rise to additional traffic on the local road network to and from the site. This will include:

- HGVs importing construction materials, including general fill material, materials for access tracks, drainage/ducting materials, site boundary fencing, etc;
- HGVs exporting waste/spoil materials;
- HGVs delivering plant and fuel; and
- General traffic associated with workforce cars and vans.

Although the construction works will take place around all sides of King's Island, there is one proposed compound location at the north of the island. It is therefore assumed that all construction traffic will travel to and from this location on public roads, whilst small numbers of vehicles and plant will travel through the site and works areas on a daily basis. These movements will generally occur outside of the peak hours, and will be detailed for each construction area in the CTMP.

The national road network surrounding Limerick City provides multiple potential haul routes for material to be transported to and from the site. It is currently envisaged that the preferred haul route will be to and from the M7 via the R445 and Island Road. A part of this route is shown in Figure 7-2 in Volume 3 of this EIAR.

Trip Generation

Trips generated by the proposed FRS fall under two distinct categories: staff trips to and from the site, and HGV trips for delivery and removal of material.

Staff numbers will vary throughout the construction phase; however, the maximum numbers are estimated at 40. In order to provide a robust assessment, it is assumed that all of these staff members will travel to and from the site during peak hours in single-occupancy vehicles.

The number of HGV trips has been developed based on the total cut and fill volumes required and an assumed capacity of $12m^3$ per truck. Whilst the total construction phase duration is 18 months, it has been assumed that the majority of these trips will take place during the first 12 months, and therefore for robustness the total number of HGV trips have been spread evenly across the 12 months and an 8-hour working day. In reality, it is likely that HGV movements will tend to avoid the peak hours due to traffic through the city. The total number of HGVs travelling to and from the site per day is estimated at 49, leading to a total of 98 HGV movements, of which six will occur in each direction in each of the peak hours.

Total trips generated by the proposed FRS are shown in PCUs in Table 7-2 below.

Table 7-2: Trip Generation (PCUs)

	AM (08.00-09.00)		PM (16:00-17:00)	
	Arrival	**Departure**	**Arrival**	**Departure**
Total	54	14	14	54

Trip Distribution

The two categories of trips described above are distributed in different patterns across the network. HGVs will travel to and from the site via the R445 and Island Road. Construction staff arrivals and departures have been distributed based on the existing distribution within the network, as derived from the traffic survey undertaken as part of this assessment. These are shown in Table 7-3 below.

Table 7-3. Trip Distribution Profile

Access Route	Existing Traffic Distribution	Proposed Trip Distribution
Thomondgate	1%	0%
High Road	18%	20%
Clancy's Strand	5%	5%
R463	18%	20%

Pa Healy Road	12%	10%
R445	20%	20%
Broad St	6%	5%
Bridge St	19%	20%
Merchants Quay	1%	0%

7.3 Impact of the Proposed FRS on Traffic and Transportation

7.3.1 Impact of the Proposed FRS – Construction Phase

The anticipated construction-related traffic that will be generated by the scheme on the surrounding road network, and the distribution of this traffic across the network are set out in Section 7.2.4 above. The impact of this additional traffic on the network operation has been analysed for the AM and PM peak hours by comparing link flows and junction performance for the Do Nothing (Without Development) and Do Something (With Development) scenarios.

The TII (formerly NRA) 'Guidelines for Transport Assessment' recommend these assessments be carried out in the opening year, +5 and +15 years after opening. However, in the case of this development, operational traffic volumes will be negligible, and therefore the analysis has been carried out for the construction phase only. It is anticipated that construction will commence in 2021 and the most intense construction activity will take place during the initial 12 months. In order to provide a robust assessment of the network performance, the peak construction traffic volumes were used with an assessment year of 2021.

Analysis of the local road network operation was carried out using a combination of LinSig and Junctions 9 software, which are dedicated software packages for the analysis of signalised and standard priority junctions respectively. Junctions 9 contains the PICADY and ARCADY analysis packages for priority junctions and roundabout junctions. The assessment is presented for the various scenarios below in terms of link flows and junction performances for the Do Nothing and Do Something scenarios.

Scope of Assessment

Traffic counts were carried out at nine junctions in the vicinity of the site in order to inform this assessment. Following the development of haul routes to and from the site, and estimation of the trip distribution for construction staff, a total of seven junctions were analysed using LinSig or Junctions 9 as appropriate. It is anticipated that construction traffic will not make turning movements or travel through the other two junctions surveyed, and therefore their performance will not be affected by the proposed FRS. Link flows for these sections of the network are included for completeness, however it will be noted that some of these links will experience no increase in traffic between the Do Nothing and Do Something scenarios.

Link Flows

Link flows are presented in terms of two-way traffic volumes in the AM and PM peak traffic periods, i.e. 08.00-09.00 and 16.00-17.00 respectively.

The two-way flows on links in the vicinity of the proposed FRS in 2019 are shown in Table 7-4 below.

Table 7-4. Existing Two-Way Traffic Flows (PCUs) – Base Year 2019

Link	2019 AM Peak Flow	2019 PM Peak Flow
Verdant Place	39	54
Thomond Bridge	1,330	1,367
Castle Street	1,309	1,334
Island Road West	25	48
Island Road North	168	211
Island Road Central	1,129	1,141
Athlunkard St	513	633
Island Road South	902	870
R463 West (Bridge)	977	1007

Corbally Road R463	965	1319
Pa Healy Road	650	934
R445 East	1,467	1,388
Mary Street	254	315
Broad Street	411	434
Charlotte's Quay	769	734
Bridge Street	789	780

The two-way flows on links in the vicinity of the proposed FRS in 2021 are shown in Table 7-5 below in PCUs for both the Do Nothing and Do Something scenarios. The percentage increase due to the proposed FRS, if any, is also shown in each case.

Table 7-5. Two-Way Traffic Flows (PCUs) – Construction Year 2021, DN and DS

Link	2021 AM Peak Volumes DN	2021 AM Peak Volumes DS	2021 PM Peak Volumes DN	2021 PM Peak Volumes DS
Verdant Place	40	40 (+0%)	56	56 (+0%)
Thomond Bridge	1,357	1,367 (+0.7%)	1,395	1,405 (+0.7%)
Castle Street	1,336	1,346 (+0.7%)	1,362	1,372 (+0.7%)
Island Road West	26	26 (+0%)	49	49 (+0%)
Island Road North	171	239 (+39.7%)	215	283 (+31.5%)
Island Road Central	1,153	1225 (+6.2%)	1,165	1223 (+5%)
Athlunkard St	523	533 (+1.9%)	646	654 (+1.2%)
Island Road South	921	957 (+3.9%)	888	926 (+4.3%)
R463 West (Bridge)	997	1009 (+1.2%)	1,027	1039 (+1.2%)
Corbally Road R463	985	993 (+0.8%)	1,345	1353 (+0.6%)
Pa Healy Road	664	668 (+0.6%)	953	957 (+0.4%)
R445 East	1,497	1533 (+2.4%)	1,416	1452 (+2.5%)
Mary Street	259	259 (+0%)	321	321 (+0%)
Broad Street	419	419 (+0%)	443	445 (+0.5%)
Charlotte's Quay	784	784 (+0%)	749	749 (+0%)
Bridge Street	805	815 (+1.2%)	796	804 (+1%)

Increases on most links within the network are quite low, ranging from 0.7% to 6% approximately. A number of links in the vicinity of the site will not experience any traffic increase.

It is noted that significantly higher percentage increases are expected on Island Road North, which is the section of Island Road to the north of the roundabout junction with Castle Street. Increases of between 31% and 40% are anticipated; however, these are largely as a result of existing very low volumes, and the actual increases are 68 PCUs during each of the peak hours. For comparison purposes, two-way volumes on this section of the network will remain under 300 PCUs during the peak periods in the Do Something scenario, whereas the neighbouring sections of Island Road Central (to the south of the roundabout) and Castle Street experience traffic flows in the order of three to four times these volumes.

Junction Assessment – Site 1: Thomondgate/High Road/Clancy's Strand

Site 1 is a priority staggered crossroads, which was analysed using Junctions 9. The 2021 Construction Year AM and PM results are shown below in Table 7-6 and Table 7-7, indicating Queue Length and Ratio of Flow to Capacity (RFC) values for the respective arms for both the Do Nothing and Do Something scenarios.

Table 7-6. Junctions 9 Assessment – Site 1, 2021 Construction Year, AM and PM Peaks – Do Nothing

Site 1	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Clancy's Strand	0.2	15	0.5	33
Thomond Bridge	0.6	18	2.2	46
Thomondgate	0	0	0	0
High Road	0.8	44	0.4	27

It can be seen in Table 7-6 above that this junction will continue to operate within capacity during the AM Peak period and the PM Peak period in the 2021 Do Nothing scenario.

Table 7-7. Junctions 9 Assessment – Site 1, 2021 Construction Year, AM and PM Peaks – Do Something

Site 1	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Clancy's Strand	0.2	15	0.5	33
Thomond Bridge	0.6	18	2.3	47
Thomondgate	0	0	0	0
High Road	0.9	44	0.4	28

It can be seen in Table 7-7 above that this junction will continue to operate within capacity during the AM Peak period and the PM Peak period in the 2021 Do Something scenario.

Junction Assessment – Site 3: Island Road/Castle Street Roundabout

Site 3 is a priority 4-arm roundabout, which was analysed using Junctions 9. The 2021 Construction Year AM and PM results are shown below in Table 7-8 and Table 7-9, indicating Queue Length and Ratio of Flow to Capacity (RFC) values for the respective arms for both the Do Nothing and Do Something scenarios.

Table 7-8. Junctions 9 Assessment – Site 3, 2021 Construction Year, AM and PM Peaks – Do Nothing

Site 3	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Island Road South	0.7	38	0.9	44
Castle Street	11	93	1.5	58
Island Road West	0	2	0.1	7
Island Road North	0.1	11	0.1	11

It can be seen in Table 7-8 above that this junction will be approaching capacity during the AM Peak period, in particular on the Castle Street approach, but will operate within capacity during the PM Peak period in the 2021 Do Nothing scenario.

Table 7-9. Junctions 9 Assessment – Site 3, 2021 Construction Year, AM and PM Peaks – Do Something

Site 3	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Island Road North	0.8	41	0.9	45
Castle Street	15.3	97	1.5	59
Island Road West	0.1	6	0.1	7
Island Road North	0.1	11	0.3	16

It can be seen in Table 7-9 above that this junction will approach capacity on the Castle Street approach during the AM Peak period and will operate within capacity during the PM Peak period in the 2021 Do Something scenario.

The capacity issues on Castle Street appear to be due primarily to the large volumes making a U-turn on the roundabout to and from this arm. 23% of the traffic approaching the roundabout on this arm in the AM peak makes this movement, because of banned right turns to and from Castle Street between Thomond Bridge and the roundabout. The impact of development-related traffic on the operation of the junction is minor.

Junction Assessment – Site 4: R463 Athlunkard Street/R445 Island Road

Site 4 is a signalised crossroads, which was analysed using LinSig. The 2021 Construction Year AM and PM results are shown below in Table 7-10 and Table 7-11, indicating Queue Length and Ratio of Flow to Capacity (RFC) values for the respective arms for both the Do Nothing and Do Something scenarios.

Table 7-10. Junctions 9 Assessment – Site 4, 2021 Construction Year, AM and PM Peaks – Do Nothing

Site 4	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Island Road North	17.2	84	13.3	82
Athlunkard East	5.5	62	4.2	38
Island Road South	6.7	44	11.5	74
Athlunkard West	9.0	82	11.8	79

It can be seen in Table 7-10 above that this junction will continue to operate within capacity during the AM Peak period and the PM Peak period in the 2021 Do Nothing scenario.

Table 7-11. Junctions 9 Assessment – Site 4, 2021 Construction Year, AM and PM Peaks – Do Something

Site 4	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Island Road North	18	85	15	85
Athlunkard East	5.5	62	4.3	40
Island Road South	7.2	47	11.7	74
Athlunkard West	9.8	86	12.3	82

It can be seen in Table 7-11 above that this junction will begin to experience capacity issues during the AM Peak period at Athlunkard Street West and Island Road North, and during the PM Peak period at Island Road North in the 2021 Do Something scenario. However, the impact of development-related traffic on the operation of the junction is minor.

Junction Assessment – Site 5: R463 Corbally Road/Pa Healy Road Roundabout

Site 5 is a priority 4-arm roundabout, which was analysed using Junctions 9. The 2021 Construction Year AM and PM results are shown below in Table 7-12 and

Table 7-13 indicating Queue Length and Ratio of Flow to Capacity (RFC) values for the respective arms for both the Do Nothing and Do Something scenarios.

Table 7-12. Junctions 9 Assessment – Site 5, 2021 Construction Year, AM and PM Peaks – Do Nothing

Site 5	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Pa Healy Road	0.8	43	1.4	58
Shopping Centre Access	0	2	0	0
R463 West (Bridge)	0.7	40	1.7	61
R463 Corbally Road	0.8	41	0.8	42

It can be seen in Table 7-12 above that this junction will continue to operate within capacity during the AM Peak period and the PM Peak period in the 2021 Do Nothing scenario.

Table 7-13. Junctions 9 Assessment – Site 5, 2021 Construction Year, AM and PM Peaks – Do Something

Site 5	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Pa Healy Road	0.9	44	1.4	58
Shopping Centre Access	0	2	0	0
R463 West (Bridge)	0.7	40	1.8	62
R463 Corbally Road	0.8	42	0.8	42

It can be seen in

Table 7-13 above that this junction will continue to operate within capacity during the AM Peak period and the PM Peak period in the 2021 Do Something scenario.

Junction Assessment – Site 6: Island Road/R445 Lock Quay/Charlotte's Quay

Site 6 is a signalised T-junction, which was analysed using LinSig. The 2021 Construction Year AM and PM results are shown below in Table 7-14 and Table 7-15, indicating Queue Length and Ratio of Flow to Capacity (RFC) values for the respective arms for both the Do Nothing and Do Something scenarios.

Table 7-14. Junctions 9 Assessment – Site 6, 2021 Construction Year, AM and PM Peaks – Do Nothing

Site 6	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Island Road	8.8	68	6.5	62
Lock Quay	10.3	73	14.9	89
Charlotte's Quay	6.1	71	10.6	87

It can be seen in Table 7-14 above that this junction will continue to operate within capacity during the AM Peak period but experiences some capacity issues during the PM Peak period in the 2021 Do Nothing scenario.

Table 7-15. Junctions 9 Assessment – Site 6, 2021 Construction Year, AM and PM Peaks – Do Something

Site 6	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Island Road	9.0	68	6.9	64
Lock Quay	10.8	74	14.9	88
Charlotte's Quay	6.5	75	11.9	91

It can be seen in Table 7-15 above that this junction will continue to operate within capacity during the AM Peak period, but experiences capacity issues during the PM Peak period in the 2021 Do Something scenario. The impact of development-related traffic on the operation of the junction is minor.

Junction Assessment – Site 8: Bridge Street/George's Quay/Merchant's Quay

Site 8 is a priority staggered crossroads, which was analysed using Junctions 9. The 2021 Construction Year AM and PM results are shown below in Table 8-16 and Table 8-17 indicating Queue Length and Ratio of Flow to Capacity (RFC) values for the respective arms for both the Do Nothing and Do Something scenarios.

Table 7-16. Junctions 9 Assessment – Site 8, 2021 Construction Year, AM and PM Peaks – Do Nothing

Site 8	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
George's Quay	0	0	0	0
Bridge Street North	0.3	11	0.1	7
Merchant's Quay	0	3	0.3	22
Bridge Street South	0.4	15	0.2	10

It can be seen in Table 7-16 above that this junction will continue to operate within capacity during the AM Peak period and the PM Peak period in the 2021 Do Nothing scenario.

Table 7-17. Junctions 9 Assessment – Site 8, 2021 Construction Year, AM and PM Peaks – Do Something

Site 8	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
George's Quay	0	0	0	0
Bridge Street North	0.3	11	0.1	7
Merchant's Quay	0	3	0.3	22
Bridge Street South	0.4	16	0.2	10

It can be seen in Table 7-17 above that this junction will continue to operate within capacity during the AM Peak period and the PM Peak period in the 2021 Do Something scenario.

Junction Assessment – Site 9: Bridge Street/R445 Bank Place/Rutland Street/Hunt Museum

Site 9 is a signalised crossroads with one unsignalised arm which is the entrance to the Hunt Museum site. The junction was analysed using LinSig. The 2021 Construction Year AM and PM results are shown below in Table 7-18 and Table 7-19, indicating Queue Length and Ratio of Flow to Capacity (RFC) values for the respective arms for both the Do Nothing and Do Something scenarios.

Table 7-18. Junctions 9 Assessment – Site 9, 2021 Construction Year, AM and PM Peaks – Do Nothing

Site 9	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Bridge Street	10.6	70	7.9	62
Rutland Street	9.3	71	9.1	62
Bank Place	3.8	29	3.2	25

It can be seen in Table 7-18 above that this junction will continue to operate within capacity during the AM Peak period and the PM Peak period in the 2021 Do Nothing scenario.

Table 7-19. Junctions 9 Assessment – Site 9, 2021 Construction Year, AM and PM Peaks – Do Something

Site 9	AM Peak (08.00-09.00)		PM Peak (16.00-17.00)	
Approach Arm	**Queue (PCU)**	**RFC (%)**	**Queue (PCU)**	**RFC (%)**
Bridge Street	10.6	70	8.1	64
Rutland Street	9.3	71	9.1	62
Bank Place	3.8	29	3.2	25

It can be seen in Table 7-19 above that this junction will continue to operate within capacity during the AM Peak period and the PM Peak period in the 2021 Do Something scenario.

Summary of Assessment

As described in Section 7.3, the impact on the network is generally very slight, with the severity increasing on the links and junctions closest to the proposed site compound.

The maximum increases in link flows during the Construction Year are 39.7% and 31.5% during the AM and PM peak hours respectively, both on Island Road North. However, as outlined above, these large percentage increases do not necessarily correlate to large additional volumes of traffic and are primarily due to existing low volumes. The actual flow increases are 68 PCUs during each of the peak hours. For comparison purposes, the neighbouring sections of Island Road Central (to the south of the roundabout) and Castle Street experience traffic volumes in the order of three to four times the two-way volumes on Island Road North, and therefore the percentage increases on these links are correspondingly lower.

The majority of the network continues to perform well within capacity during the Construction Year both with and without the development in place. Three junctions, Site 3 (Island Road/Castle Street Roundabout), Site 4 (Athlunkard Street/Island Road crossroads) and Site 6 (Island Road/Lock Quay/Charlotte's Quay T-junction) experience capacity issues during the Construction Year. These issues are exacerbated with the inclusion of the proposed FRS, however the increases due to the development are relatively small, with the worst-performing junction (Site 3) increasing in RFC from 93% to 97% on Castle Street. The capacity issues at this location appear to be due primarily to the large volumes making a U-turn on the roundabout to and from this arm, because of banned right turns to and from Castle Street between Thomond Bridge and the roundabout. Increases on Sites 4 and 6 are of a similar magnitude, although the overall RFCs are slightly lower.

The overall results illustrate that, while a number of locations within the network will experiencing capacity issues in the Construction Year, and/or are already experiencing difficulties, the increases due to the proposed FRS are slight to negligible and will be temporary in nature.

7.3.2 Impact of the Proposed FRS – Operational Phase

As outlined above, operational traffic volumes associated with the proposed FRS will be negligible, and therefore the above analysis has been carried out for the construction phase only. There will be no impact on the transport network due to the proposed FRS during the operational phase.

7.3.3 Mitigation Measures and Monitoring

This section outlines the various mitigation measures that will minimise or eliminate the potential impacts of the scheme in terms of traffic and transportation. Certain aspects of the development of the scheme to date have already included mitigation in terms of site compound selection and haul routes, for example.

Construction Environmental Management Plan and Construction Traffic Management Plan

A site-specific Construction Environmental Management Plan (CEMP) will be prepared by the appointed contractor in advance of the works. This will be agreed with Limerick City and County Council and An Garda Síochána. The CEMP will include a Construction Traffic Management Plan (CTMP) in addition to other measures, as set out in Table 17-1. The TMP will clearly identify the routes to be used to access the site for different types of traffic as appropriate, i.e. haul routes and construction staff access routes, as well as those sections of road which are not to be used. This will be planned and executed in accordance with best practice, including Chapter 8 of the Traffic Signs Manual.

Traffic Management Co-ordinator

The appointed contractor will provide a competent person with responsibility for traffic management coordination for the duration of the project. This person will be the main point of contact for all matters relating to traffic management on the project.

Site Induction

All workers will receive a comprehensive site induction which shall include, as appropriate, a section on traffic management and clear guidance on the routes which should and should not be used.

Signage

A system of clear signage relating to the project, both temporary and permanent, will be agreed with the planning authority. These signs will also identify those roads to be used (and not to be used) for accessing the site in line with the objectives of the CTMP.

Staff Mobility and Hours of Operation

As outlined above, this assessment represents a worst-case scenario in terms of trip generation and impact on the network. It includes for staff numbers of 40 travelling in single-occupancy vehicles at peak hours; however, staff numbers will only reach a maximum of 40 for a limited period during the overall construction phase of 18 months. Staff are likely to share vehicles to a certain extent, but this will be actively encouraged in an effort to minimise the number of vehicles travelling to site daily. It is also possible and indeed likely that construction staff will arrive on site prior to or early in the AM peak hour, and leave after the PM peak hour; however, for robustness all staff movements have been included in the peak hours.

In addition to this, HGV traffic has been assumed to mostly take place during the first 12 months of construction, and therefore the total number of HGV trips have been spread evenly across the 12 months and an 8-hour working day. In reality, it is likely that HGV movements will tend to avoid the peak hours due to traffic through the city, and this will also be encouraged and incorporated into the CTMP where possible in order to reduce the impact on the surrounding road network.

Vibration Measurements

As recommended in Chapter 11 - Noise and Vibration, vibration measurements shall be taken at the base of buildings, on the side facing the source of vibration. Where feasible, the measurement should be taken on a hard surface on the ground outside the building. A pre-condition survey will also be undertaken of all properties potentially affected by the works (likely within a 10m radius of works areas). Crack monitoring will be installed on such affected properties and monitored throughout the works.

It is considered that no mitigation measures are required for the operational stage of this development.

7.3.4 Residual Impacts – Construction Phase

As discussed above, the construction of the proposed King's Island Flood Relief Scheme will lead to additional construction traffic on the existing road network, including HGVs and light vehicles due to staff movements. The impacts of this traffic are discussed above and are considered to be slight short-term negative impacts, with no residual impact post-construction.

The additional construction traffic has the potential to have indirect impacts including the potential to negatively impact local residents and businesses. However, with the implementation of the mitigation measures outlined above it is anticipated that the works will have an imperceptible to slight indirect temporary negative residual impact on local business owing to the traffic impact.

7.3.5 Residual Impacts - Operational Phase

As outlined above, there will be no significant operational stage traffic impacts associated with the proposed FRS.

7.3.6 Interactions with Other Environmental Effects

The impact on the traffic network will be highest closest to the proposed site compound to the north-east of St Mary's Park. Residents in this area will be affected for the 18 months of construction and specific temporary traffic measures will be implemented to ensure access to their properties. The temporary diversions and raising of manholes and utility covers will be carried out at as advanced works and will be detailed in the preliminary design report. The impact on residents and workers in the study area will be short term and not significant.

7.3.7 Cumulative Impacts

A number of projects have the potential for cumulative impacts with the King's Island Flood Relief Scheme. These are described in detail in Chapter 16 Cumulative Impacts. However, the potential cumulative impacts with these schemes from a traffic and transport point of view is summarised below.

Killaloe Bypass/Shannon Bridge Crossing and R494 Improvement Scheme

This scheme has received planning permission and is located approximately 16.5km north-east of the King's Island Flood Relief Scheme site. Due to the localised and slight nature of the traffic impacts of the King's Island Flood Relief Scheme, and the distance between these developments, no cumulative traffic impacts are expected.

Limerick Northern Distributor Road

Phase 1 of this scheme has commenced, with Phase 2 currently in design stages. Phase 1 (Coonagh-Knockalisheen) is under construction and it is therefore anticipated that it will not have any cumulative impacts with the King's Island Flood Relief Scheme from a traffic point of view. Phase 2 is in the design stage but has not received planning permission and is therefore not a committed scheme. As it is not possible to state in known detail whether Phase 2 will present cumulative impacts in combination with the King’s Island Flood Relief Scheme at this stage, no detailed assessment of likely cumulative impacts can be assessed as part of the EIAR for this project.

Limerick City and Environs Flood Relief Scheme (FRS)

The proposed Limerick City and Environs FRS upgrade is currently at the ‘Further Information’ stage of its planning application. As it is not possible to state in known detail whether the Castletroy FRS upgrade will present cumulative impacts in combination with the King’s Island Flood Relief Scheme at this stage, no detailed assessment of likely cumulative impacts can be assessed as part of the EIAR for this project.

Castleconnell Flood Relief Scheme (FRS)

The proposed Castleconnell Flood Relief Scheme, Co. Limerick is in the early stages of its planning development. As it is not possible to state in known detail whether the Castleconnell FRS will present cumulative impacts in combination with the King’s Island Flood Relief Scheme at this stage, no detailed assessment of likely cumulative impacts can be assessed as part of the EIAR for this project.

Opera Site, Limerick City

The proposed regeneration of the Opera Site includes a mixed-use development, comprising offices, retail, culture, licenced premises and other ancillary uses. The Opera Site is located approximately 50m south of the King’s Island site boundary. Should the proposed Opera Site development receive permission, construction access will occur from R445 and Michael Street minimising the impact on more sensitive roads around the site (EIAR Chapter 13: Traffic & Transport). The assessment concludes that there will be a negligible effect on local traffic, pedestrian and cycle delay and public transport.

The proposed opening year for the Opera Site is 2022, whilst the heaviest construction traffic levels associated with the King's Island Flood Relief Scheme will occur during the first 12 months of construction, in 2021. The cumulative assessment of these two projects therefore concerns traffic associated with the construction stages only. The approach routes for site traffic to the proposed King's Island Flood Relief Scheme will coincide with those for the proposed Opera Site development in particular on the R445 from the east; however this is generally the case on the outskirts of the city which will dilute the cumulative effect on traffic.

The Traffic and Transport chapter of the Opera site EIAR states that 50% of construction staff traffic is expected to approach the site via the R445 through King's Island. However, this traffic would arrive and depart the site outside of the peak hours. The number of two-way HGV trips to and from the site during the peak hours and throughout the day is approximately five per hour. Although the Opera Site has not received planning permission and is therefore not a committed scheme, given the above, no likely significant cumulative impact is expected should it be granted planning permission.

Limerick Urban Centre Revitalisation - O’Connell Street

The Limerick Urban Centre Revitalisation - O’Connell Street, otherwise known as the LUCROC project, is a commitment to the revitalisation of O’Connell Street, which will result in quantifiable improvements to urban mobility and the urban environment. The project is located between the junctions of Denmark Street and the Crescent, with Phase I between Denmark Street and Cecil Street, approximately 400 metres in length. It comprises reduced traffic lane widths, relocation of on-street parking and loading, implementation of a southbound bus lane, widened footpaths and additional public realm areas. This proposed revitalisation projected is located approximately 330m south-west of the King’s Island FRS site.

Phase I of this project has recently been granted planning permission under the Part 8 planning process. The Traffic Modelling Report prepared as part of the preliminary design process indicates that traffic volumes on O'Connell Street will not reduce significantly but there will be an increase in queues and delays on the surrounding street network. It is anticipated that the LUCROC project will be constructed over twelve months commencing in mid-2020, i.e. the construction period may partially overlap with the King's Island Flood Relief Scheme. The cumulative assessment of these two projects therefore concerns traffic associated with the construction stages only. The LUCROC project lies further south than the Opera Site, and it is anticipated that any construction traffic from the west would approach the site via Shannon Bridge rather than Thomond Bridge. Given the above factors, no likely significant cumulative impact is expected.

Orchard Site Development, King's Island

The Orchard Site development consists of 27 residential units for the elderly on Old Dominick Street. This site is currently in use as a car park for King John’s Castle. A Part 8 planning application has been submitted for this application. Should it receive planning permission, it is possible that the construction period will overlap with that of the King’s Island Flood Relief Scheme. No analysis of the construction traffic impact was carried out as part of the Orchard Site planning application; however, it is expected that construction traffic would access and egress the site via Castle Street and/or Island Road. This coincides with the location where construction traffic associated with the King’s Island Flood Relief Scheme will have the greatest impact; however, the construction traffic associated with the Orchard Site is likely to be lower in volume and to mainly occur outside of the peak hours, similar to the King’s Island Flood Relief Scheme. There may be a short-term slight negative cumulative impact between these schemes in terms of traffic, depending on the construction programme for each scheme.

Mungret Local Infrastructure Housing

The Mungret Local Infrastructure Housing includes the upgrading of roads to allow for the development of 450 homes by 2021, with a potential estimate of 2,700 homes to be provided on the lands. The infrastructure will also ensure the delivery of a post primary school in the area within the next 3 years.

The development is currently in the Masterplanning stage, with a planning permission to follow. As it is not possible to state in known detail whether the Mungret Local Infrastructure Housing development will present cumulative impacts in combination with the King’s Island Flood Relief Scheme at this stage, no detailed assessment of likely cumulative impacts can be assessed as part of the EIAR for this project.

International Rugby Experience Building, O’Connell Street

The International Rugby Experience Building on O’Connell Street involves works at No. 42 O'Connell St/No.1 Cecil Street to create a rugby museum and cultural site. The site is located approximately 670m south-west of the proposed King’s Island FRS site. The International Rugby Experience Building received Conditional Permission on 14th of February 2018, with an amendment granted Conditional Permission on 2nd of April 2019.

Traffic analysis carried out as part of the Engineering Planning Report for the International Rugby Experience indicated that there will be no parking as part of the development and therefore operational traffic impacts will be widely dispersed. Construction traffic is likely to approach the site from Dock Road or Shannon Bridge via Cecil Street Lower or Sarsfield Bridge via O'Connell Street. No construction traffic is anticipated from the north and therefore no likely significant cumulative impact is expected with the International Rugby Experience Building.

Corbally Housing Development, Corbally Road

The housing development proposed within the Corbally area is located adjacent to the Corbally Road to the east and the railway lines to the north and north-east. This proposed FRS is located approximately 215m east of the proposed King’s Island FRS site.

The development is currently in the planning stage. As it is not possible to state in known detail whether the Corbally Housing Development Housing will present cumulative impacts in combination with the King’s Island FRS at this stage, no detailed assessment of likely cumulative impacts can be assessed as part of the EIAR for this project.

7.4 Utilities and Wastes Baseline

A preliminary assessment of the potential impact of the proposed scheme on existing utilities was prepared in 2017[16]. There are several material assets of natural and human origin within the study area. These are discussed in the following sections.

7.4.1 Wastewater Treatment Plants

According to Limerick City Council, there are 20,000 households within Limerick City and 6,000 households in Counties Clare and Limerick which use the city sewage system. It has been estimated that each household generated approximately 380 litres of wastewater per day.

There are two main water waste treatment plants (WWTP) in the Limerick agglomeration boundary, these are listed in Table 7-20.

Table 7-20. Wastewater Treatment Plants (WWTP) in the Limerick Agglomeration boundary

WWTP	Local Authority	Treatment Type	Status
Castletroy WWTP	Limerick City Council	Secondary Treatment with NR	Pass
Limerick City WWTP	Limerick City Council	Secondary Treatment Only	Pass

The main sewage system in St. Mary's Park is only considered adequate by the Limerick City Council. The main future goal of the system is to provide a high quality sanitary wastewater collection and treatment system to meet current and future plans. The WWTP treats 11 million litres of wastewater per day to eliminate the discharge of raw sewage into the Shannon River.

7.4.2 Foul and Storm water Sewers

Discussions with Limerick City Council found that the existing water network in St. Mary's Park is serviced by 3-inch cast iron water main network. The following details were available from the Limerick City Council Water Services Drainage Layout:

- There are four outfalls on the west and southwest edge of King’s Island which discharge into the Shannon River (two on Verdant Place, one a few metres upstream of Thomond Bridge, and one located just downstream of the Limerick City Museum). Three of the outfalls are connected to combined sewers and one is connected to a surface water sewer.
- There are six outfalls located on the south of King's Island discharging into the Abbey River. One is located on George's Quay, along Creagh Lane. There is one outfall located close to the Absolute Hotel, on the southeast portion on the Island. There are three outfalls around Baal's Bridge (two on the south portion of the bridge which connects to Limerick City and one on the north portion of the bridge which connects to King's Island). Finally, there is one located on Plais an Bhainc (Bank Place). All the outfalls are connected to combine sewers.
- There is an outfall located on the southeast of the Island, located beside the Sir Harrys Mall, the outfall is connected to a combined sewer that goes along Long Lane.
- There is one pumping station in the northern part of the Island located beyond St. Mary's Park, north of the junction of St. Munchin’s Street and Oliver Plunket Street.
- There is a surface water sewer connected to the pumping station, as well as a combined sewer. There are only a few surface water sewers on the Island, they are mostly located in the central area of King’s Island and none are connected to each other, they all connect to a combined sewer pipe.
- The Island is made up of predominately combined sewers, but the sewer is split into two.
- The north portion of the Island (St. Mary's Park) has a combined sewer system that discharges at to outfall along Verdant Place.
- The southern portion of the Island has a combined sewer system that continues towards Limerick City Centre.

16 Arup (2017). *Limerick County Council, King's Island Flood Relief Scheme, Summary of Preliminary Assessment. Version 3.*

- There is an overflow drainage surrounding the whole island edge, however, the junction points between the combines sewer and the overflow drainage are limited.
- There is also no direct connection between surface water sewers and overflow sewers.

7.4.3 Drinking Water

Limerick City Council has made potable water a priority under 'Policy WS.1 Potable Water', where Limerick City Council makes themselves responsible for continuously providing high quality drinking water to meet local demands. Limerick City Council is producing over 60,000m^3 per day of drinking water at the Water Treatment Plant in Clareville. From that production, 40,000m^3 is transported to Limerick City and approximately 20,000m^3 is delivered to other consumers in County Limerick and County Clare respectively. The source for water abstraction is the River Shannon. The Water Treatment Plant (WTP) in Clareville has been experienced ongoing renovations in order to meet present and future demands. The plant has the capacity of 87 million litres per day (MLD) water production levels, the aims is to extend facility to 140MLD.

St. Mary's Park is currently being serviced by 3-inch cast iron water main network, unfortunately, the network is not sufficient to meet the current demands and fire flow standards. Water usage in St. Mary's Park was estimated by using an average consumption rate of 135 litres per person per day, there are approximately 459 houses in St. Mary's Park (from 2-5 inhabitants per house), this resulted in an estimated expected usage of 400-600 m^3/day in the estate and approximately 183m^3/d per person (Limerick Regeneration Framework Implementation Plan, 2013).

7.4.4 Electricity

The following information was provided by ESB network on the electricity services provided on King’s Island.

Underground MV/LV (10 kV & 400V/230V) underground cable route

There are only underground lines present at on the southwest of the Island. The underground cable routes can be found on the following roads:

- Mary Street;
- Bridge Street;
- George's Quay;
- Athlunkard Street;
- Oliver Plunket Street;
- St.Columcille Street;
- St.Ita's Street;
- Island View Terrace; and
- Thomond Bridge: located over the centre of each arch, the cable is only 25cm from the surface and covered by steel plate 3m long.

Southeast of the Island

- Island Road;
- Bridge Street;
- George's Quay;
- Mary Street;
- Sir Harry's Mall; and
- Abbey Lane.

The southern portion of the Island has an extensive network of underground electricity lines, therefore, any work around these areas should follow special precautions and safety measures.

Overhead MV(10KV/20KV) Overhead Lines and LV (400V/230V) Overhead Lines

There are low voltage overhead lines scatted around St. Mary's Park estate, on the following streets:

- St. Munchins Street;
- St.Ita's Street;
- Oliver Plunkett Street;
- St.Columcille Street; and
- Bishop Street.

These overhead lines should not pose any serious risk to the scheme during construction, since they are located within St. Mary's Park estate and there are no FRS works proposed there.

There is one medium voltage overhead line at the northern section of the Island which moves across the north east section, over the Abbey River and towards Mail Road. This overhead line may pose a constraint if work on the embankment or north wall is carried out around it. Several things must be considered if work is proposed around the MV overhead line:

- Whether the height of pole is appropriate and allows for work to be carried out without obstacle;
- Whether height of wire is appropriate;
- Stability of ground;
- The possibility of resident being back fed from elsewhere if overhead line must be powered off; and
- The possibility of insulating wire.

Finally, if work is carried out on Thomond Bridge (ESB Cable over centre of arch), the location, materials and equipment (non-conductive), as well as, a safe means of access must be considered by the contractor because the work would entail being in close to water.

In areas where there may be some power disruptions as a result of works, the possibility of back feeding power to the residents from other lines should be considered. Ensure that when staff is checking for the presence of underground cables, they are following 'Avoidance of Electrical Hazards when Digging' safety document (ESB, 2005).

7.4.5 Gas Network

The following information was sourced from Bord Gais Networks who provided drawings on the gas networks on King's Island. Most of the gas pipes follow a path around the St. Mary's Park estate in the north portion of the island and surrounds the commercial and retail areas in the southern section. These are below the following streets on King's Island:

St. Mary's Park is surrounded by underground low pressure inserted pipes and underground abandoned distribution pipes. The inserted pipes run along the following streets:

- Oliver Plunkett Street;
- St.Ita's Street;
- St.Munchin's Street;
- St. Columcille Street; and
- St. Senan's Street.

The mid-section of the Island, from the beginning of Verdant Place and Island Road to Athlunkard Street is surrounded by underground low and medium pressure inserted pipes, along the following streets:

Low Pressure

- Verdant Place;
- Island View Terrace;
- Assumpta Park;
- Lee Estate;
- Barrak Street;
- Convent Street;

- Nicholas Street;
- Francis Place;
- Newgate Lane;
- St. Peter Street;
- Bishop Street; and
- Exchange Street.

High Pressure

- Thomond Bridge;
- Castle Street;
- Island Road;
- Brian Boru Square; and
- St. Augustinian Place.

The southern portion of the Island from Bridge Street/Athlunkard Street to the end of Bridge Street, Mary Street, and Island Road is surrounded by underground low and high pressure inserted pipe and an underground low pressure distribution pipe:

Low Pressure

- George's Quay (Low pressure distribution pipe);
- Mary Street;
- Emily Place;
- Creagh Lane;
- Sir Harry's Mall;
- Abbey Lane;
- River Lane; and
- Keyes Row.

High Pressure

- Island Road; and
- Bridge Street.

7.4.6 Broadband

The following information was sourced from Virgin Media. It became evident that broadband was only available in the southern part of the Island (closest to the city centre), however, no connection was available for the residences in the St. Mary's Park Estate.

7.4.7 Waste Management

The waste management in place in the Limerick/Clare/Kerry region, complies the Waste Management Act 1996. Limerick city does not operate a working landfill, therefore all municipal waste from the city is collected by private waste contractors with waste collection permits. The waste is taken to landfills in other parts of the country. The closest licenced waste facilities to King's Island is the Long Pavement Landfill Site in Monabraher managed by Limerick City and County Council and, a waste transfer station, located in Ballykeefe Townland and operated by Starrus Eco-Holding Limited.

There is a lack of recycling facilities for construction and demolition waste, as well as a lack of biological waste treatment plants in County Limerick, however, this is also a national problem. A number of private waste contractors (Mr.Binman, Recycle Right, O'Reilly Brothers Environmental, Fitzgerald Waste Management Ltd, and Derry White Skip Hire Ltd) have waste collection permits and operate as waste collection services in Limerick City and Council.

King's Island, especially St. Mary's Park Estate, does not have a sustainable waste management strategy. There is a littering problem due to limited number of public bins and lack of education. There is a strip of land on Munchin's street that was used as an illegal landfill site, where local residents have been dumping domestic refuse. This illegal dump has now been remediated by Limerick City Council.

7.4.8 Car Parks

King's Island has public car parks located on:

- Island Road;
- George's Quay;
- Sheep Street;
- St. Mary's Church; and
- A temporary car park servicing King John's Castle.

7.4.9 Athlunkard Boat Club

This boat club is located on the O Dwyer Bridge outside Limerick City. The clubhouse was built in 1925 and is still used by the rowers. The boat club was established in 1898 by locals from the parish and it currently has up to 40 active members.

The natural material assets are discussed in the relevant chapters of this EIAR:

- Ecology – Chapter 8
- Water – Chapter 9
- Soils and Geology – Chapter 10
- Landscape – Chapter 13
- Archaeology and Cultural Heritage – Chapter 14

7.5 Impacts of the Proposed FRS on Utilities and Waste

7.5.1 Impacts on Material Assets of Human Origin during Construction

The material assets of human origin e.g. sewer networks and electricity network will require identification on the ground prior to work proceeding on the scheme. Some of the underground cable routes are located underneath roads that are close to either the Abbey or Shannon River such as on George's Quay, Sir Harry's Mall or Abbey Lane, among others. Where there is a requirement to excavate or remove roadway, paving or footpaths for example, along Sir Harry's Mall or the area around the Absolute Hotel, the contractor will need to identify and locate the utilities. LCCC has the services drawings and these will be provided to the contractor prior to excavations. The proposed FRS includes the upgrading of drainage infrastructure - see Chapter 4 Areas B1/B2 and B3. In areas where it is proposed to install reinforced structures, areas for excavation will be scanned. Recently laid electricity cable routes will be marked with yellow tap 0.5 m below surface. This procedure will eliminate/reduce the number of outages that may arise during the construction of the FRS. The impact of the construction of the scheme on the human origin material assets is not expected to be significant. If a breakage of a pipe does occur or an outage of electricity arises it is anticipated that the problem will be repaired within a day. This occurrence would be classed as a temporary negative impact.

The works will cause a disruption to the daily lives of the inhabitants close to the works. The construction of the cut off wall at the Absolute Hotel will cause a disruption for people using the boardwalk to access the hotel and nearly streets. The section on the predicted traffic volumes generated during construction, particularly the northern portion of the island, demonstrates that residents will experience increases in traffic volumes during construction. This impact will not be significant and will be temporary in nature.

Work along Sir Harry Mall will cause a disruption to pubs and restaurants along the quays and access to Barringtons Hospital will be disrupted during the work. This impact can be described as not significant and temporary.

The football pitches at Star Rovers will become redundant during the construction of the FRS. However, Star Rovers will be compensated with a part relocated AstroTurf pitch and a repositioned grass pitch, as agreed with the council.

- In Area A6 (Athlunkard Boat Club) minor diversion of telecoms and power will be required as well as routing of the existing combined sewer through the RC flood wall at one location. There will be a provision of a new connection from the Boat Club through the RC flood wall which can be picked up by the Limerick Main Drainage Scheme, therefore a temporary disruption to the sewer network will be required.

- In Area A7 (Sir Harry's Mall) some of the exiting road gullies will be re-located.
- In Area A10 (Abbey Bridge to Baal's Bridge) diversion of street lighting ducts and underground electricity and telecom service is required, causing temporary disruption to utilities. The existing 150 mm outfall will be replaced with a 225 mm diameter pipe with a WaStop installed.
- Area B1/B2 (George's Quay), diversion of the water main and power lines is required at various points along the length of the proposed wall. The existing 150mm diameter pipes will be replaced with larger pipes. It is not expected that diversion of the concrete sewer will be required.
- Area B3 (Potato Market), it is proposed to raise the road levels at Merchant's Quay (the Potato market), other existing manholes, chambers and chamber lids relating to water, sewer, storm, telecoms and electrical services will also be raised to match the proposed road levels. Existing road gullies will be raised. The existing outfall to the south-west of the civic building will be increased in size with a WaSTOP or similar approved non-return valve installed. The existing outfall to the rear of the City Hall will be increased in size with a WaSTOP or similar approved non-return valve installed. Inter-tidal storage for existing paved areas behind the new glass panel and the wider contributing area will be provided adjacent the outfall such that flooding on the surface does not occur during high tide conditions in the Shannon.

The existing outfall to the south-west corner of King Johns Castle will be increased in size with a WaSTOP or similar approved non-return valve installed. As this outfall drains existing car-parking predominantly to the west of City Hall, a by-pass petrol interceptor will be constructed to enhance the water quality prior to discharge.

A general summary of disruption to utilities is include overleaf. Impact to Gas Network. Note there will be no impact to gas network or gas lines in proximity to proposed works.

Table 7-21. Impact to Electricity Network

Electricity Service	Location	Constraint/ Comment
Underground medium voltage/low voltage (MV/LV) electrical cable	A3; Ch 1+170	Runs from an ESB sub-station at the north side of St. Munchin's Street to a pole located at the north of the Island at Ch. 1+170, both of which are within the footprint of the proposed embankment. From this pole an overhead MV electrical line runs east along a number of poles before crossing the Abbey River.
Electrical	A6; 2+600	Narrow construction area
Electrical	A10	Ducting to electrical boxes (3 nr). 5m length adjacent to wall
Electrical	B1/B2	Adjacent to wall/ full length; diversion required
Electrical	B3	1000mm at closest point adjacent to wall; full length of wall
Electricity, including 2 no. electricity boxes	B3	Wall adjacent to Bridge Street junction

Table 7-22. Impact to Water Network

Water Service	Location	Constraint/ Comment
Water main	A5; 2400	Possible scour main to river under embankment
Watermain	B1/B2	500mm at closest point adjacent to wall; diversion required

Table 7-23. Impact to Telecommunications network

Telecommunications Service	Location	Constraint/ Comment
UPC/Virgin	A6; 2+550 - 2+600	Narrow construction area
Telecom	A10	Ducting to electrical boxes (1 nr.) approx. 250mm from wall
Telecom	B3	600mm at closest point adjacent to wall; full length of wall

Table 7-24. Impact to Sewer Network

Sewerage Service	Location	Constraint/ Comment
Outfall pipe	A2; Ch. 0+308	Should be considered at detailed design stage
Outfall pipe	A3; Ch 1+220	42m from the edge of existing embankment. Should be considered at detailed design stage.
Manhole	A3; Ch 0+380	
Combined Sewer	A6; 2+250-2+525	Under proposed footprint
Combined Sewer	A6; 2+525 to 2+600	Narrow construction area
Storm water	A8	Services connected to unknown manholes
Storm water	A10	2 no. outfalls through wall
Storm water	B1/B2	3 No. outfalls through wall
Concrete sewer	B1/B2	2.5m at closest point to the wall; Manhole may require local design changes
Foul sewer	B4	2.5m at closest point adjacent to wall in Courthouse boardwalk area; Full length of wall at Courthouse boardwalk; Few Manhole adjacent to wall
Storm Water	B4	1.5m at closest point adjacent to wall in Courthouse boardwalk area; 2.4 m at closest point adjacent to wall North of Courthouse; Full length of wall at Courthouse; 30m along proposed mass concrete North of Courthouse Few Manholes adjacent to wall
Combined sewer	B4	1 no. outlet north of Courthouse boardwalk

Table 7-25. Other Services

Other Service	Location	Constraint/ Comment
Public Lighting	A6; 2+410 - 2+500	Section under proposed footprint of embankment
Public Lighting	A6; 2+550 - 2+600	Narrow construction area
Public Lighting	A8	Lam posts adjacent to wall
uPVC	B3	Adjacent to wall; passes underneath existing wall
Ground light	B4	1m at closest in Courthouse section; Full length of section
Unidentified 100mm diameter PVC pipe	B4	300mm at closest point adjacent to wall; North of Courthouse boardwalk, identified by slit trench

The temporary diversions and raising of manholes and utility covers will be carried out at as advanced works and will be detailed in the preliminary design report. The impact will be short term and not significant.

7.5.2 Impacts on Material Assets of Human Origin during Operation

The impacts of the FRS during operation will be positive as it will provided protection to the material assets of human origin in the area.

7.5.3 Impacts on Material Assets of Natural Origin during Construction

The impacts on material assets of natural origin are described in the relevant chapters of the EIAR.

The construction phase of the development of flood relief infrastructure could pose a threat to the water quality in the River Shannon.

- Release or run-off of excessive amounts of suspended solids from site preparation or development of construction.
- Accidental escapement of bulk liquid cement from the site to the Shannon or Abbey River.
- Unintentional discharge of oil from the site to the Shannon or Abbey River.
- Unintentional discharges of Japanese Knotweed during the construction of the embankments at the rear of the houses along St. Munchin's Street (Area 4 North Eastern Embankments).

A CEMP will be produced by the appointed Contractor for the construction works.

7.5.4 Impacts on Material Assets of Natural Origin during Operation

The impacts of the scheme when operational is discussed in the relevant chapters of this EIAR.

7.6 Mitigation measures to reduce/remedy the significant impacts

The contractor will take all actions to avoid unplanned disruptions to any services during the construction phase of the project. The contractor will be responsible for identifying the location of all utility infrastructure within the work areas. They will be responsible for ensuring that all works undertaken in and around known utility services will be carried out using strict and robust Method Statements. The major services suppliers will be contacted in advance of ground works proceeding in an area to ensure that all protocols and procedures are correct and are complying with the service providers requirements.

Services disruptions impacting on residents or commercial outlets will only happen where unavoidable. In this scenario, residents and commercial outlets will be given advanced warning of the date, time and expected duration of the disruption.

The contractor will be responsible for all underground services for which diversions are not required.

During the operation of the scheme it is not anticipated that significant impacts on utilities will arise. The operators of the scheme will ensure that the conditions attached to the foreshore licence will be complied with.

The site-specific CEMP will ensure that the natural material assets will be protected during construction. The CEMP will cover natural material assets such as groundwater protection, surface water protection, work practices close to the SAC, protection of habitats and species, waste management, noise and traffic management.

A new access track will be provided into the northwest corner of the Athlunkard Boat Club.

7.7 Residual Impacts

The residual impacts on the major utilities are imperceptible.

7.8 Cumulative Impacts

In addition to the proposed FRS for King's Island there are a number of additional developments proposed in the vicinity of King's Island. These have been considered in terms of cumulative impacts. These projects include the following:

- Corbally Housing Development, Corbally Road;
- The International Rugby Experience Building, O'Connell Street;
- Limerick Urban Centre Revitalisation – O'Connell Street; and

- Opera Site, Limerick City.

There are a number of flood schemes proposed with 10 km of King's Island, for example, the Limerick City and Environs Flood Relief Scheme, the Castleconnell Flood Relief Scheme and the Springfield Flood Relief Scheme. These are remote from King's Island and the cumulative impacts from these schemes and the proposed King's Island project is anticipated to be neutral.

The housing development proposed within the Corbally area is located adjacent to Corbally Road to the east. This housing development will comprise of 27 housing units, along with vehicle and pedestrian access and other ancillary features. This proposed FRS is located approximately 215m east of the proposed King's Island FRS site. The cumulative impacts from these schemes and the proposed King's Island project is anticipated to be neutral.

The site of the proposed International Rugby Experience Building in O'Connell Street is located approximately 670 m south-west of the King's Island Site. This development was granted planning in April 2019 and it is expected that the development will be completed before work on King's Island commences. Therefore, the cumulative impact is neutral.

The Limerick Urban Centre Revitalisation- O Connell Street (LUCROC) is currently in the Feasibility Concept Stage and has yet to be granted planning. It is likely that this project and the King's Island project may coincide. The project is approximately 330 m south west of King's Island, but it is anticipated that the cumulative impacts will be neutral.

The Opera Site development in Limerick City is located 50 m to the south of King's Island. A planning application has been submitted to An Bord Pleanála in March 2019. Access routes to the Island particularly for the haulage and construction of the embankments at the north and centre of the island will be different to the routes taken for the Opera Site. It is anticipated that the cumulative impacts of this development and the King's Island FRS will be neutral.

It is not considered that any additional mitigation measures are required to account for cumulative impacts.

7.9 The 'Do Nothing' Impacts

In this scenario we address the impacts if the development did not proceed. LCCC has identified the requirements to upgrade some of the services in the area and these will be undertaken as part of this FRS.

8 Biodiversity

8.1 Introduction

This chapter relates to the potential ecological impacts of the proposed King's Island Flood Relief Scheme, considering designated sites and Key Ecological Receptors (KER), such as habitats, flora and protected/notable species, within the Zone of Influence (ZoI). The aim of this chapter is to identify the key ecological receptors within the study area, determine their ecological value, assess the potential impacts of the scheme upon them and propose mitigation to offset any identified impacts.

King's Island is surrounded by the waters of the tidal rivers, River Shannon and Abbey River. Ecological receptors within the study area can be strongly linked to the water environment and hydromorphological factors, and this chapter will give cognisance to the inter-relationships between these aspects.

8.1.1 Relevant Legislation and Policy Context

This assessment has had regard to the following policy documents and legislation:

National and International Legislation

- The Planning & Development Act 2000 & the Planning and Development (Amendment) Act, 2010 (as amended) hereafter referred to as the Planning Acts;
- The Wildlife Act 1976 as amended by the Wildlife (Amendment) Act, 2000 (as amended) hereafter referred to as the Wildlife Acts;
- European Communities (Environmental Impact Assessment) Regulations 1989 to 2001.
- European Commission (EC) Habitats Directive 92/43/EEC (as amended);
- EC Birds Directive 2009/147/EC;
- European Communities (Birds and Natural Habitats) Regulations 2011 (as amended) hereafter referred to as the Birds and Habitats Regulations;
- Flora (Protection) Order, 1999;
- Environment (Miscellaneous Provisions) Act 2011;
- The Fisheries (Consolidation) Act 1959; and
- The Local Government (Water Pollution) Act, 1977 (as amended by Sections 3 and 24 of the 1990 Act.

Relevant Policies and Plans

- National Biodiversity Plan, 2017-2021;
- Ireland's National Strategy for Plant Conservation -Progress towards 2020;
- Mid-West Area Strategic Plan 2012 - 2030;
- Limerick City Development Plan 2010 - 2016;
- Strategic Integrated Framework Plan for the Shannon Estuary 2020;
- Limerick City Council Biodiversity Plan 2012;
- Issues Paper Proposed Limerick City and County Heritage Plan 2017 – 2030; and
- Limerick City Walls and Conservation Management Plan 2008.

Relevant Guidance

- Invasive Species in Ireland (NPWS, 2004)[17.;]

[17] Stokes, K., O'Neill, K. & McDonald, R.A. (2004) Invasive species in Ireland. Unpublished report to Environment & Heritage Service and National Parks & Wildlife Service. Quercus, Queens University Belfast, Belfast

- Guidelines for Ecological Impact Assessment in the United Kingdom: Terrestrial, Freshwater and Coastal Environments (Chartered Institute of Ecology and Environmental Management, 2nd Edition 2016, revised 2018);
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (Dept. of HPLG, August 2018)[18]
- Guidelines on the information to be contained in Environmental Impact Assessment Reports (Draft) Environmental Protection Agency (EPA 2017);
- Environmental Impact Assessment of National Road Schemes – A Practical Guide (NRA, 2008)[19];
- Guidelines for Assessment of Ecological Impacts of National Road Schemes (NRA, 2009)[20]
- NRA Environmental Assessment and Construction Series Guidelines (NRA, 2006- 2009);
- Guidelines for the Treatment of Badgers Prior to the Construction of National Road Schemes (National Roads Authority, 2005);
- Guidelines for the Treatment of Otters Prior to the Construction of National Roads Schemes (NRA, 2008)[21];
- Badgers: Guidance on surveys and mitigation for development projects. Natural England (2015);
- Bat Surveys: Good Practice Guidelines (Bat Conservation Trust UK, 2012);
- Bats & Lighting Guidance Notes for Planners, engineers, architects and developers (Bat Conservation Ireland, December 2010);
- Bats in Buildings Guidance Notes for Planners, engineers, architects and developers (Bat Conservation Ireland, December 2010);
- Bat Mitigation Guidelines for Ireland (NPWS, 2006);
- Bat Mitigation Guidelines (English Nature, 2004);
- Guidelines on the Protection of Fisheries during construction works in and adjacent to water. (Inland Fisheries Ireland, 2016); and
- Riparian breeding bird surveys methods (Cummins et. al, 2010)[22].

8.2 Methodology

An ecological walkover survey of the area was conducted by JBA Consulting ecologists on 09/09/2015 (resurveyed 2019) to record the habitats and flora of the scheme as part of the EIAR Constraints Study. The purpose of this survey was also to detect the presence or likely presence of protected species that may be impacted by the scheme and identify the need for further surveys, if necessary. The survey was chiefly concerned with recording habitats suitable for protected habitats and species; and notes were also made on other flora and fauna. The more detailed ecological surveys and species-specific surveys were carried out during 2016, 2017, 2018 and 2019 (re-surveying) for the proposed scheme, by a team of specialist ecologists and other technical specialists as seen in Table 8-1.

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[18] Government of Ireland (2018) *Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment.* Department of Housing, Planning and Local Government. Available at: https://www.housing.gov.ie/sites/default/files/publications/files/guidelines_for_planning_authorities_and_an_bord_pleanala_on_carrying_out_eia_-_august_2018.pdf

[19] NRA (2008). *Environmental Impact Assessment of National Road Schemes – A Practical Guide*. Available at: https://www.tii.ie/technical-services/environment/planning/Environmental-Impact-Assessment-of-National-Road-Schemes-Practical-Guide.pdf

[20] NRA (2009) *Guidelines for Assessment of Ecological Impacts of National Road Schemes*. Available at: https://www.tii.ie/technical-services/environment/planning/Guidelines-for-Assessment-of-Ecological-Impacts-of-National-Road-Schemes.pdf

[21] NRA, 2008. *Guidelines for the Treatment of Otters Prior to the Construction of National Road Schemes*. National Roads Authority. Available at: https://www.tii.ie/tii-library/environment/construction-guidelines/Guidelines-for-the-Treatment-of-Otters-prior-to-the-Construction-of-National-Road-Schemes.pdf

[22] Cummins, S., J. Fisher, R. Gaj McKeever, L. McNaghten & O. Crowe (2010). *Assessment of the distribution and abundance of Kingfisher Alcedo atthis and other riparian birds on six SAC river systems in Ireland*. Unpublished Bird Watch Ireland report to the National Parks and Wildlife Service. Kilcoole, Co Wicklow.

8.2.1 Habitat and Protected Flora Surveys

Ecological Survey methods were in general accordance with those outlined in the following documents:

- Heritage Council (2011)[23]. Best Practice Guidance for Habitat Survey and Mapping;
- Phase 1 Habitat Survey methodology (Joint Nature Conservation Committee (JNCC), 1990, revised 2003)[24]; and
- Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes (NRA, 2009)[25]

Habitats were classified under the national habitat classification system of Fossitt (2000)[26]. Within each general habitat type the dominant flora was recorded in order to determine general species composition and distribution. It should be noted that September is a sub-optimal period for conducting botanical surveys, but it is still possible to record the habitat type and dominant species present. The relationships of these habitats to EU Annex I habitats (European Commission, 2013)[27], were discussed in the context of areas of possible high conservation importance where relevant.

Plant names follow Stace (2010)[28]. Flora of particular ecological interest, including non-native invasive species such as Japanese Knotweed (*Reynoutria japonica*), Giant Hogweed (*Heracleum mantegazzianum*) and Himalayan Balsam, and/or protected species such as Opposite-leaved Pondweed (*Groenlandia densa*) were recorded and mapped when observed during all surveys. Records of invasive species were determined to be substantial enough to require further surveying and an invasive species management plan (JBA, 2019)[29]. Relevés of Marsh habitat were carried out using standard methodology using the Domin scale, adapted from Perrin et al (2014)[30].

8.2.2 Protected Species Surveys

Walkover surveys were designed to detect the presence, or likely presence, of a range of protected and/or notable species.

Mammals (Otter & Badger)

Otter (*Lutra lutra*) are listed on Annex II and IV of the EC Habitats Directive (92/43/EEC)[31], Appendix 1 of CITES[32] and Appendix II of the Bern Convention (Council of Europe, 1979)[33]. Intensive surveys (including 2019 re-surveying) were carried out to establish the value of the area to Otter using the NRA (2009)[34] guidelines 'Ecological Surveying Techniques for Protected Flora and Fauna during the planning of National Road Schemes' and the 'Guidelines for the Treatment of Otters Prior to

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[23] Heritage Council (2011). *Best Practice Guidance for Habitat Survey and Mapping.* The Heritage Council

[24] JNCC (Joint Nature Conservation Committee) (2010*). Handbook for Phase 1 habitat survey: A Technique for Environmental Audit.* Peterborough: JNCC

[25] NRA (2009). *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes.* National Roads Authority. Available at: https://www.tii.ie/technical-services/environment/planning/Ecological-Surveying-Techniques-for-Protected-Flora-and-Fauna-during-the-Planning-of-National-Road-Schemes.pdf

[26] Fossitt, J. (2000) *A Guide to Habitats in Ireland.* The Heritage Council

[27] European Commission (2013). *Interpretation Manual of European Union Habitats, version EUR 28*. European Commission.

[28] Stace C. (2010). *New Flora of the British Isles*. 3rd Ed. Cambridge University Press, Cambridge.

[29] JBA (2019) *King's Island Flood Relief Scheme- Invasive Species management Plan.* Unpublished report.

[30] Perrin, P.M., Barron, S.J., Roche, J.R. & O'Hanrahan, B. (2014). Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. Irish Wildlife Manuals, No. 79. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland. [online] Available at: https://www.npws.ie/sites/default/files/publications/pdf/IWM79.pdf

[31] European Union Habitats Directive (1992). *Council Directives 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.* European Union.

[32] *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES). Appendices I, II and III (valid from 2017) [Available at: https://www.cites.org/eng/app/appendices.php]

[33] *Convention on the Conservation of European Wildlife and Natural Habitats* (Bern Convention) Appendix II (1979). [Available at: https://rm.coe.int/168078e2ff]

[34] NRA (2009). *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes.* National Roads Authority. Available at: https://www.tii.ie/technical-services/environment/planning/Ecological-Surveying-Techniques-for-Protected-Flora-and-Fauna-during-the-Planning-of-National-Road-Schemes.pdf]

the Construction of National Roads Schemes' (NRA, 2008)[35]. These guidelines included indirect survey methods for identifying spraints/scats, tracks, feeding remains, slides, holts and couches.

Badger (*Meles meles*) are protected under the Wildlife Act (1976) and Wildlife Amendment Act (2000). Badger was searched for, in order to establish if lands at and adjacent to the proposed works may be used by Badger, e.g. embankments etc. Indirect observations of Badger activity were searched for during the survey, including setts, latrines, prints and signs of Badger foraging. This survey was carried out following best practice guidance outlined in NRA (2009)[36] and the 'Guidelines for the Treatment of Badgers Prior to the Construction of National Roads Schemes' (NRA, 2005)[37].

Bats

Bats are protected species under the Wildlife Act (1976) and Wildlife Amendment Act (2000). All bat species are protected under Annex IV of the EU Habitats Directive, while the Lesser Horseshoe bat is listed under Annex II.

Any structures and trees likely to be impacted by preparatory site works and construction works were inspected to determine their potential value for roosting bats during a daytime survey, using the methods specified in the Bat Conservation Trust (BCT) *Bat Surveys for Professional Ecologists - Good Practice Guidelines* (3rd ed.) (Collins, 2016)[38]. Any Potential Roosting Features (PRFs) were identified during this survey. Following on from identifying PRFs, dusk emergence and/or dawn re-entry surveys were conducted at any PRFs. Static detector systems were then used to confirm suspected commuting routes and foraging areas within suitable foraging habitats near linear features.

Birds (Wintering & Breeding)

Wintering surveys were carried out to establish the use of Kings Island by wintering waterbirds including target species of the Special Protection Area (SPA) downstream. Wintering bird survey methods used included the 'look – see' method as used in the I-Webs Irish Wetland Bird Survey (Crowe & Holt 2013)[39], during the period of September to March. Birds sighted during the survey were recorded in an international, national and local context to identify species of conservation importance. The wintering bird surveys concentrated on the areas of Kings Island most likely to be used by wintering birds, such as the wetland of the Special Conservation Area (SAC) and the amenity areas of the island, which were noted to be regularly used by wading birds.

The breeding bird survey methodology requires a minimum of two bird count visits (Bibby, 2000)[40] carried out during early and late periods of the breeding season, to increase the chances of detection of early and late migrant species, and to improve estimates of resident species. The riparian breeding bird surveys methods followed Cummins et. al, 2010[41] .The breeding status of birds encountered within the site were classified into three categories: confirmed, probable and possible breeders. All birds observed, visually and / or by sound, were recorded on field maps at an appropriate scale (approximately 1:2,500). Countryside Bird Survey (CBS) species codes and standard symbols (e.g. Marchant et. al, 1990)[42] were used to mark registrations and breeding

[35] NRA, 2008. *Guidelines for the Treatment of Otters Prior to the Construction of National Road Schemes*. National Roads Authority. Available at: https://www.tii.ie/tii-library/environment/construction-guidelines/Guidelines-for-the-Treatment-of-Otters-prior-to-the-Construction-of-National-Road-Schemes.pdf
[36] NRA (2009). *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes*. National Roads Authority. Available at: https://www.tii.ie/technical-services/environment/planning/Ecological-Surveying-Techniques-for-Protected-Flora-and-Fauna-during-the-Planning-of-National-Road-Schemes.pdf
[37] NRA, 2005. *Guidelines for the Treatment of Badgers Prior to the Construction of National Road Schemes*. National Roads Authority. Available at: https://www.tii.ie/tii-library/environment/construction-guidelines/Guidelines-for-the-Treatment-of-Badgers-prior-to-the-Construction-of-a-National-Road-Scheme.pdf
[38] Collins, J. (ed.), 2016. *Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edn)*. The Bat Conservation Trust, London.
[39] Crowe, O. and Holt, C. (2013) *Estimates of waterbird numbers wintering in Ireland, 2006/07–2010/11*. *Irish Birds* 9: 545-552
[40] Bibby, C.J., Burgess, N.D., Hill, D.A. & Mustoe, S.H. 2000. *Bird Census Techniques*. Academic Press, London.
[41] Cummins, S., J. Fisher, R. Gaj McKeever, L. McNaghten & O. Crowe (2010). *Assessment of the distribution and abundance of Kingfisher Alcedo atthis and other riparian birds on six SAC river systems in Ireland*. Unpublished Bird Watch Ireland report to the National Parks and Wildlife Service. Kilcoole, Co Wicklow.
[42] Marchant, J.H., Hudson, R., Carter, S.P. & Whittington, P.A. (1990) *Population Trends in British Breeding Birds*. BTO,

evidence was noted. The watercourses that fall within the survey extent were surveyed for any breeding bird activity with a focus on riparian vegetation and woodland. Areas of scrub along the ditches were also surveyed for breeding activity where it was possible to gain access. Bridges and other structures offering nesting opportunities within the survey extent were also examined for nesting birds.

Amphibians

There are two terrestrial reptile species in Ireland: the viviparious lizard (*Lacerta (Zotoca) vivipara*) and the non-native Slow-worm (*Anguis fragilis*); and three species of amphibians: The Natterjack toad (*Bufo (Epidalea) calmita*), Common (smooth) newt (*Triturus (Lissotriton) vulgaris*) and Common frog (*Rana temporaria*). Amphibian and reptile species identified as present during the desktop survey through the National Biodiversity Data Centre's website were surveyed in the field using methods adapted from the following guidance:

- Common Standards Monitoring Guidance for Reptiles and Amphibians. Joint Nature Conservation Committee (JNCC 2004)[43] and
- Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes (NRA, 2009)[44].

Invertebrates (terrestrial)

Any field signs of notable invertebrates (e.g. bees) were noted during habitat surveys in 2019.

Fish

A desktop review was carried out to identify the areas that were important to fish within the study area and immediate environs. This included the fish species designated as conservation objectives under the Lower River Shannon SAC (listed below) as well as other species of conservation interest, European eel *Anguilla anguilla,* Smelt *Osmerus eperlanus* and estuarine fish species. The site surveys obtained detailed information at the specific flood relief working areas detailed in Chapter 4. Inland Fisheries Ireland (IFI) provided information on the fisheries status of the River Shannon and Abbey River overlapping the drainage scheme works areas.

Triturus Environmental Services were appointed by JBA Consulting engineers to conduct a fisheries impact assessment of the Lower River Shannon and adjoining Abbey River (Lower River Shannon SAC) in Limerick City (Figure 8-1). The Lower River Shannon was surveyed between Parteen Railway Bridge and Sarsfield Bridge. The entire length of the Abbey River was surveyed. The surveys contextualised and evaluated the fish habitat value of both rivers in the context of the proposed flood relief works at King's Island and informed the fisheries impact assessment.

Fish habitat mapping provided an overview of the key areas of importance for fish species utilising the lower River Shannon and Abbey River. River profile maps bearing target notes on any areas of special fisheries importance were created.

Tring.

[43] Common Standards Monitoring Guidance for Reptiles and Amphibians. Joint Nature Conservation Committee (JNCC 2004) [online] http://jncc.defra.gov.uk/pdf/csm_reptiles_amphibians1.pdf

[44] (NRA (2009). *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes.* National Roads Authority. Available at: https://www.tii.ie/technical-services/environment/planning/Ecological-Surveying-Techniques-for-Protected-Flora-and-Fauna-during-the-Planning-of-National-Road-Schemes.pdf

Summary of Ecological Surveys

Table 8-1. Details of specialised ecological surveys conducted in 2015 - 2019

Name	Company	Role	Ecological Receptor	Dates
Anne Murray	JBA Consulting	Ecologist and Bird Specialist	Breeding Birds and Wintering birds	December 2015 & January 2016 May & July 2016 /
Dr. Kieran Connolly	Kieran Connolly	Botanist	Invasive species and Flora	January 2015
Niamh Sweeney & Catalina Herrera	JBA Consulting	Ecologist and Aquatic Specialist; Environmental Scientist	Invasive species	January 2017
Tanya Slattery & Catalina Herrera	JBA Consulting	Ecologist and Botanist; Environmental Scientist	Large Mammals and Flora	January, March & April 2017
Ross Macklin	Triturus Environmental Services	Fisheries Scientist	Fisheries	September 2016
Dr Tina Auchney	Bat Eco Services	Bat Specialist	Bats	July 2016
Dr. Joanne Denyer & Tanya Slattery	Denyer Ecology and JBA Consulting	Aquatic plant specialist and Botanist	Opposite-leaved Pondweed *Groenlandia densa*	April 2017
Tanya Slattery	JBA Consulting	Ecologist and Botanist	Detailed habitat survey of Sir Harry's Mall Habitat	8 March 2018
Niamh Burke, Patricia Byrne & Hannah Mulcahy	JBA Consulting	Ecologists and Botanist	Detailed habitat survey of North of Island for impact assessment	April 2019
William Mulville & Hannah Mulcahy	JBA Consulting	Ecologists	Wintering birds Amphibians Otter	April 2019
Hannah Mulcahy & Jean Hamilton	JBA Consulting	Botanists	Botanical survey (north-eastern section)	May 2019
William Mulville & Hannah Mulcahy	JBA Consulting	Ecologists	Detailed invasive species survey	July 2019

Invasive Species Survey

Invasive species present within the site boundary include Japanese Knotweed, Giant Hogweed, and Himalayan Balsam. They can spread rapidly over suitable habitat, including riverbanks, wetlands or disused waste land. Section 49 and 50 of Part 6 of the European Communities (Birds and Natural Habitats) Regulations 2011 restricts the dispersal, spread and transportation of these invasive species.

Following the Flora and Habitats surveys, the requirement to conduct specific invasive species surveys was identified. Data gathered during the preliminary invasive species survey on King's Island during September 2015, was supplemented with results from the surveys conducted during

July 2016 and May 2019. These results formed the basis for the King's Island Invasive Species Management Plan (JBA, 2019)[45].

Summary

The proposed FRS for King's Island has been designed to specifically avoid, reduce and minimise effects wherever possible on all KERs. In cases where potential effects on KERs are predicted, mitigation has been outlined in order to avoid, reduce and decrease the likelihood and intensity of such effects.

The proposed best practice design and mitigation measures to be put in place are specifically set out and are realistic in terms of their cost and practicality. They have been subject to detailed design and will effectively buffer the potential effects predicted for the identified KERs. The potential adverse effects of the proposed flood relief scheme were assessed to ensure that all adverse effects on KERs are suitably addressed and no significant residual adverse effects are likely to remain following the implementation of the best practice guidance and mitigation measures.

Limitations

The detailed information provided within this EIAR chapter accurately and comprehensively describes the baseline ecological environment; provides an accurate prediction of the likely ecological effects of the proposed flood relief scheme; outlines mitigation as necessary and describes the residual ecological impacts. All specialist studies, analysis and reporting have been conducted in accordance with the appropriate guidelines.

No significant limitations in the scope, scale or context of the assessment have been identified.

8.3 Existing Environment

King's Island is predominantly a low lying urban/suburban environment, but with a significant portion of the north-east side of the island occupied by wetland habitats most of which are included within the Lower River Shannon SAC. The River Shannon and the Abbey River bound King's Island to the west and east respectively and are tidal in nature at this point.

The habitats and species within the receiving environment are described in detail in the following sections.

8.3.1 Desktop Study

A desk-based assessment was carried out to collate information regarding protected/notable species and statutorily designated nature conservation sites in, or within close proximity to, the study area. A data search for protected and notable species was conducted using the National Biodiversity Data Centre Mapping System (National Biodiversity Data Centre, 2019).

Data has also been collected from a range of sources, including:

- NPWS website (www.npws.ie);
- National Biodiversity Data Centre website (www.biodiversityireland.ie/);
- BirdLife International (www.birdlife.org);
- BirdWatch Ireland (www.birdwatchireland.ie);
- Limerick County Development Plan (www.limerick.ie/council/county-development-plan);
- Water Framework Directive Fish Stock Survey of Transitional Waters in the Shannon International River Basin District (Kelly et al., 2015)[46];

[45] JBA (2019) *King's Island Flood Relief Scheme- Invasive Species management Plan.* Unpublished report.
[46] Kelly, F.L., Connor, L., Matson, R., Coyne, J., Feeney, R., Morrissey, E. and Rocks, K. (2015) *Water Framework Directive Fish Stock Survey of Transitional Waters in the Shannon International River Basin District – Shannon Estuary, Fergus Estuary and Limerick Docks 2014*. Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24, Ireland.

- Whooper *Cygnus Cygnus* and Bewick's *C. columbianus* Swans in Ireland (Bolland et al., 2010) [47];
- National Otter Survey (Bailey et al., 2006)[48];
- Water Framework Directive Fish Stock Survey of Transitional Waters in the Shannon International River Basin District (Kelly et al., 2015)[49];
- 2010/2011 Waterbird Survey Programme as undertaken by The National Parks & Wildlife Service (Cummins and Crowe, 2011)[50];
- Irish Wetland Bird Survey (I-WeBS) data;
- Limerick City Development Plan 2010 - 2016;
- Limerick City Biodiversity Plan;
- Environmental Protection Agency (EPA) online databases on water quality (Available online at http://gis.epa.ie/Envision [Accessed 2016-2019];
- Limerick Regeneration Framework Implementation Plan Environmental Report for the purposes of Strategic Environmental Assessment (HRA/Limerick City and County Council 2013)[51] ;
- Limerick City Walls Conservation and Management Plan (Collins et al. 2008)[52] ;
- Ordnance Survey Mapping available from www.osi.ie ;
- Information on the Shannon River Basin District from www.wfdireland.ie ;
- Information on soils, geology and hydrogeology in the area available from www.gsi.ie ;
- Birdwatch Ireland and British Trust for Ornithology Bird Atlas 2007-2011 online database[53]
- Protected and rare species data provided by the National Parks & Wildlife Service Research Branch;
- Review and Assessment of Waterbird Data from the Shannon-Fergus Estuary (Lewis, Burke, and Crowe 2016)[54];
- Botanical Society for the British Isles website – Species Distribution Maps; at http://www.bsbi.org.uk/ Accessed on various dates;
- All Ireland Red Data lists for vascular flora, mammals, butterflies, non-marine molluscs, dragonflies & damselflies, amphibians and fish (NPWS website);
- Shannon Estuary Strategic Integrated Framework Plan (http://www.shannonestuarysifp.ie/);
- Sampling Fish for the Water Framework Directive Transitional Waters 2008 Limerick Dock (The Central and Regional Fisheries Boards, 2008)[55]; and

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[47] Boland, H,G. McElwaine, G. Henderson, C. Hall, A. Walsh and O. Crowe. *Whooper Cygnus cygnus and Bewick's C. Columbianus bewickii Swans in Ireland: results of the international census, January 2010*. 2010. Irish Birds 9, 1-10.
[48] Bailey M. and Rochford, J. (2006) *National Otter Survey*. [online] https://www.npws.ie/sites/default/files/publications/pdf/IWM23.pdf]
[49] Kelly, F.L., Connor, L., Matson, R., Coyne, J., Feeney, R., Morrissey, E. and Rocks, K. (2015) *Water Framework Directive Fish Stock Survey of Transitional Waters in the Shannon International River Basin District – Shannon Estuary, Fergus Estuary and Limerick Docks 2014*. Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24, Ireland.
[50] Cummins, S. & Crowe, O. 2011. *Collection of baseline waterbird data for Irish coastal Special Protection Areas 2010/11*. BirdWatch Ireland Report for NPWS, June 2011
[51] HRA/Limerick City and County Council (2013) *Limerick Regeneration Framework Implementation Plan* [Available on line: https://www.limerick.ie/council/services/housing/regeneration/limerick-regeneration-framework-implementation-plan]
[52] Collins, T., Darmody, N., O'Mahony, B., Lynch, L.G. and Coyne, F. (2008) Limerick City Walls Conservation and Management Plan [Available online: https://www.limerick.ie/sites/default/files/limerick_city_walls_conservation_management_plan_may_2008_0.pdf]
[53] Birdwatch Ireland and British Trust for Ornithology Bird Atlas 2007-2011 online database [Available at: [http://app.bto.org/mapstore/StoreServlet?id=46
[54] Lewis, I., Burke, B. and Crowe, O. (2016). Review and Assessment of Waterbird Data from the Shannon-Fergus Estuary.[online] http://www.shannonestuarysifp.ie/wp-content/uploads/2016/11/SIFP-Bird-Data-Review-May-2016.pdf
[55] The Central and Regional Fisheries Boards (2008) *Sampling Fish for the Water Framework Directive Transitional Waters 2008 Limerick Dock*.[http://www.wfdfish.ie/wp-content/uploads/2009/09/Limerick-Docks.pdf

- International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (available online at http://www.iucnredlist.org).

Desktop study

King's Island spans across four 2km national grids on the National Biodiversity Data Centre's map viewer; R55U, R55T, R55E and R55Y (Figure 8-7, Volume 3).

Protected Fauna

The most recent records and locations of protected and notable mammal species available from the National Biodiversity Data Centre for these 2km grid areas include European Otter (*Lutra lutra*), Eurasian Badger (*Meles meles*), West European Hedgehog (*Erinaceus europaeus*), Eurasian Pygmy Shrew (*Sorex minutus*).

Protected Flora

The following protected plant species have been noted in the four 2km grid squares:

- Opposite-leaved Pondweed (*Groenlandia densa*) in the Limerick Canal to the south east of the site and in a small area to the south by O'Callaghans Strand; and
- Triangular Club-rush (*Schoenoplectus triqueter*) to the north-west of the island and to the south by O'Callaghans Strand.

Within the 10km grid square R55 two protected bryophyte species have been recorded

- Fine-leaved Marsh Feather-moss (*Campyliadelphus elodes*) (last recorded in 1979) and
- River Bristle-moss (*Orthotrichum rivulare*) (recorded in 2005)

These three groups of species represent high conservation elements (sub-types) of the Annex 1 habitat Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation [3260]

1. Groenlandia densa (L.) Fourr., Opposite-leaved Pondweed

2. Schoenoplectus triqueter (L.) Palla, Triangular Club-rush

3. Bryophyte-rich streams and rivers

The first two sub-types are associated with tidal reaches of rivers, while the latter sub-type is found in fast-flowing stretches of unmodified streams and rivers (NPWS, 2012)[56]. The sub-type Bryophyte-rich streams and rivers is represented in the Lower Shannon SAC in 13km of the Bilboa River in the Mulkear catchment. However, the tidal reaches of the Shannon and Abbey rivers around King's Island are unlikely to represent this habitat.

Designated Nature Conservation Sites

Sites of international importance including Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) are collectively known as Natura 2000 sites. Designated sites, which also include Natural Heritage Areas (NHAs) and proposed Natural Heritage Areas (pNHAs), which are national designations, were also identified within the proposed FRS's Zone of Influence. The designated search area was 15km from the development for Natura 2000, NHA and pNHA sites. This distance defines the 'Zone of Influence ' of the proposed works for protected sites.

[56] NPW (2012). Lower River Shannon SAC (site code 2165). Conservation objectives supporting document- Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (habitat code 3260). Available at: https://www.npws.ie/sites/default/files/publications/pdf/002165_Lower%20River%20Shannon%20SAC%20Water%20Courses%20Supporting%20Doc_V1.pdf

European Designated - Natura 2000 Sites (SACs / SPAs)

Best practice guidance (DoEHLG 2009, 2010 revision)[57] recommends that all Natura 2000 sites within 15km of a project be initially screened for impacts. There are eight SACs and two SPAs that are within a 15km radius of the flood relief project at King's Island, Limerick shown in Table 8-2 and Figure 8-2.

Table 8-2. European sites within 15 km of site

Site Name	Designation	Site Code	Approximate Distance to Development Site
Lower River Shannon	SAC	002165	<0.1km
Slieve Bernagh Bog	SAC	002312	14.7km
Askeaton Fen Complex	SAC	002279	15.0km
Tory Hill	SAC	000439	13.8km
Glenomra Wood	SAC	001013	8.3km
Ratty River Cave	SAC	002316	13.0km
Danes Hole Poulnalecka	SAC	000030	12.7km
Clare Glen	SAC	000930	14.9km
River Shannon and Fergus	SPA	004077	0.6km
Slievefelim to Silvermines Mountains	SPA	004165	14.5km

Only two of the Natura 2000 sites listed above are within the 15km zone of influence and are hydrologically linked to the plan at King's Island (Figure 8-2, Figure 8-3, Volume 3);

- Lower River Shannon SAC (002165)
- River Shannon and Fergus SPA (004077)

Both sites may be impacted through surface water, groundwater, and air and land pathways. These are considered in detail in the Natura Impact Statement that accompanies this EIAR.

Nationally Protected Sites

There are three nationally protected sites (Natural Heritage Areas or NHAs) within 5km of King's Island, listed below (Table 8-3 & Figure 8-4, Volume 3). Site details and conservation objectives are not listed for these sites on the NPWS website.

Table 8-3. Natural Heritage Areas (NHA) and proposed Natural Heritage Areas

Site Name	Designation	Site Code	Approx Distance to Development Site
Knockalisheen Marsh	pNHA	002001	0.2km
Fergus Estuary and Inner Shannon Estuary, North Shore	pNHA	002048	0.0km
Inner Shannon Estuary, South Shore	pNHA	000435	1.3km

Knockalisheen Marsh NHA is located in Knocklisheen, County Clare across the River Shannon, approximately 400m from Kings Island. It is composed mainly of wet grassland (79%) and contains dry meadows and grassy verges (21%). In the Irish Semi-natural Grasslands Survey, it was found not contain any Annex I habitats (Martin et al., 2013).

Fergus Estuary and Inner Shannon Estuary, North Shore pNHA extends from Thomond Bridge, directly adjacent to Kings Island, along the north shore, and habitats include mudflats of the River Shannon, as far as Foynes. It includes the estuary up to Clarecastle in County Clare.

[57] DoEHLG (2009, 2010 revision) Appropriate Assessment of Plans and Projects in Ireland Guidance for Planning Authorities. Department of the Environment, Heritage and Local Government. Available at; https://www.npws.ie/sites/default/files/publications/pdf/NPWS_2009_AA_Guidance.pdf

Inner Shannon Estuary, South Shore pNHA includes the southern banks and habitats of the River Shannon from the docks in Limerick City, to Foynes. It includes a portion of the River Maigue towards Faha.

Habitat and Flora Field Survey Results

The main habitats recorded are listed in Table 8-4. The habitat map of the proposed scheme is seen in Figure 8-5, Volume 3. Photographs of habitats and species (Ecology Plates) are found in Appendix C1.

Table 8-4. Habitats recorded in and adjacent to the proposed site (* = Priority habitat).

Habitat	Fossitt Habitat code	EU Annex 1 habitat code
Tidal Rivers and Estuaries	CW2 & MW4	1130
Riparian woodland	WN5	
Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)		91EO*
Tall Herb swamps	FS2	
Drainage ditches	FW4	
Marsh	GM1	
Wet Grassland	GS4	
Improved agricultural grassland	GA1	
Treelines	WL2	
Amenity Grassland	GA2	
Dry Meadows and Grassy Verges	GS2	
Recolonising Bare Ground	ED3	
Buildings and Artificial Surfaces	BL3	

(CW2) Tidal Rivers & (MW4) Estuaries [1130])

The River Shannon and River Abbey are tidal rivers that surround King's Island (Plate 8-1, Appendix C1). The Shannon Estuary is located downstream of King's Island.

(WN5) Riparian Woodland/Alluvial Forests *[91E0]

The riparian woodland within the survey area is of the 'gallery' type, which encompasses river margin woodlands that are subject to frequent flooding, or where water levels fluctuate due to tidal movements in the lower reaches of rivers. This habitat category includes the Annex I habitat Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-padion, Alnion incanae, Salicion albae)* (91E0) (Fossitt, 2000)[58].

Riparian woodland fringes the edge of King's Island (Plate 8-2). This habitat extends northwards along the eastern margin, from O'Dwyers Bridge to the north western edge. This riparian woodland is dominated by stands of Willow (*Salix spp.),* the total cover of which is generally at least 10% and frequently substantially greater - and includes Osier (*S. viminalis*), Crack-willow (*S. fragilis*), Grey Willow (*S. cinerea subsp. Oleifolia*) and Almond Willow (*S. triandr*). Alder (*Alnus glutinosa*) and Ash (*Fraxinus excelsior*) are generally occasional throughout.

Among the herbaceous species in the understory are Cuckooflower (*Cardamine pratensis*), Water Horsetail (*Equisetum fluviatile*), Meadowsweet (*Filipendula ulmaria)*, Yellow flag (*Iris pseudacorus*), Water Mint (*Mentha aquatica*), Hemlock water-dropwort (*Oenanthe crocata*), Reed Canary-grass (*Phalaris arundinacea*), Creeping Buttercup (*Ranunculus repens*), Water Figwort (*Scrophularia auriculata),* and Common nettle (*Urtica dioica*). Marsh-marigold (*Caltha palustris*) and the nationally rare Summer Snowflake (*Leucojum aestivum)* (Plate 8-3) are common, typically in wetter ground near the riverbank. The moss, *Leskea polycarpa*, which characteristically grows on the branches and trunks of trees in the flood zones of lowland rivers and streams, is present on trees in the

[58] Fossitt, J. (2000) *A Guide to Habitats in Ireland.* The Heritage Council

habitat. Other species include Club rush (*Schoenoplectus* sp.), Bindweed (*Calystegia sepium*), Bramble (*Rubus fruticosus agg*.) and Willowherb (*Epilobium sp*.). Himalayan Balsam (*Impatiens glandulifera*), which is an introduced and invasive species, is abundant throughout the riparian woodland habitat.

Fossitt (2000)[59] describes the affinity of the wet woodland type, Wet pedunculate oak-ash woodland WN4, with the priority Annex I habitat 'Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-padion, Alnion incanae, salicon albae*) (91E0)', but does not recognise similar affinity between that Annex I habitat and Riparian woodland, WN5. However, the definition of the Annex I habitat in the Interpretation Manual of European Union habitats (European Commission, 2013)[60] indicates clear floristic affinities with the woodland type surveyed here, while also emphasising the constant characteristic of occurrence on heavy soils that are periodically inundated by the annual rise of a river level, as is the case with the Riparian woodland at King's Island.

A habitat specific survey was conducted on this habitat to assess its potential as the Annex I Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae*) 91E0* Priority feature. Much of this habitat was found to represent the Annex I habitat, which is also rare in a national context and consequently of significant conservation value.

(FS2) Tall-herb swamps

The riparian woodland becomes somewhat discontinuous near the northern end of King's Island where there are some small patches of riverbank vegetation in which tree cover is greatly reduced or absent, and the habitat may be considered as Tall-herb swamp (FS2). Tall-herb swamps are stands of herbaceous vegetation that occur in wet areas where the water table is above the ground surface for most of the year, or where water levels fluctuate regularly as in the case of tidal sections of rivers (Fossitt, 2000)[61]. Herbaceous vegetation is similar to that found within the adjacent riparian woodland, comprising species such as Meadow-sweet (*Filipendula ulmaria*), Himalayan Balsam (*Impatiens glandulifera*), Water Mint (*Mentha aquatica*) and Hemlock Water-dropwort (*Oenanthe crocata*), although some species such as Reed Sweet-grass (*Glyceria maxima*) and Yellow flag (*Iris pseudacorus*) become significantly more common here.

A habitat specific survey was conducted on this habitat to assess its potential as the Annex I habitat 6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels. Due to the absence of a range of typical species this habitat was not found to represent the Annex I habitat in question.

(FW4) Drainage ditches

There are a number of ditches on the island. The main drainage ditches run along the inside of the embankment on King's Island and are mainly for land drainage purposes. The drainage ditch on the west (Plate 8-4) has two outflows into the Shannon River, though one is blocked at present. The drainage ditch on the east of the island has one outflow (Green Lady) to the Abbey River.

Vegetation within and on the banks of the drainage ditch on the west included Reed Sweet-grass (*Glyceria maxima*, Yellow Iris, Water Horsetail (*Equisetum fluviatile*) and Bulrush (*Typha latifolia*). A section of this drainage ditch contains the protected species Opposite-leaved pondweed (*Groenlandia densa*) and so was surveyed and characterised further by an aquatic specialist (Section 0)

Nearby borehole and trial pit investigations have shown that the ditch is located in an area of relatively impermeable clay, underlain by sands and gravels. The existing ditch is fed both by surface water run-off from surrounding lands and groundwater through the lower sand/ gravels layer (Denyer, 2019)[62.]

The ditch section with *G. densa* had relatively clearwater with low overall algal cover at the time of survey. Aquatic macrophytes were abundant in the channel and the ditch had a shallow eastern

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59 Ibid [36]

60 European Commission (2013). *Interpretation Manual of European Union Habitats, version EUR 28*. European Commission.

61 Fossitt, J. (2000) *A Guide to Habitats in Ireland.* The Heritage Council

62 Denyer J. (2019) Section 21 Application *Groenlandia densa* Methods Statement.

bank, grading into wet grassland to the east. There was no shading by scrub or tall vegetation and the ditch was in mid-successional stage with small amounts of open water and a mixture of submerged, floating and emergent vegetation. Water sampling shows that the ditch has a pH between 7.5 and 8 (highly calcareous) and is neither brackish nor highly polluted (Denyer, 2017)[63].

Six shallow drainage channels run across marsh habitat to the east of the site (Plate 8-5). The drainage ditch at the south east of the site flows north into the flood plain (Plate 8-6).

(GM1) Marsh

The more extensive area of wet fields on the eastern side of the site (and to the west of the Abbey River and adjacent embankment) contains habitat that can be classified as marsh. The water levels fluctuate regularly here, and the water table may be above ground for much of the year. One of the surveys, carried out in early summer, found the water level to be relatively low with little standing water. The marsh is grazed by local horses (Plate 8-7). The marsh floods extensively in winter (Plate 8-8).

Species recorded during the summer survey included Creeping Bent (*Agrostis stolonifera*), Wild Angelica (*Angelica sylvestris*), Fool's Water-cress (*Apium nodiflorum*), Cuckooflower (*Cardamine pratensis)*, Reed Sweet-grass (*Glyceria maxima*), Yellow Iris (*Iris pseudacorus*), Water Mint (*Mentha aquatica*), Lesser Spearwort (*Ranunculus flammula*) and Creeping Buttercup (*Ranunculus repens*). The complementary survey carried out in spring 2019 also recorded Starwort (*Callitriche* sp.), Marsh Ragwort (*Senecio aquaticus*), Marsh Yellow-cress (*Rorippa palustris*), Red Bartsia (*Odontites vernus subsp. vernus*), Marsh Horsetail (*Equisetum palustre*), Water Parsnip (*Berula erecta*), White Clover (*Trifolium repens*), Common Sedge (*Carex nigra*), Summer Snowflake (*Leucojum aestivum*), Common Bent (*Agrostis capillaris*), Red Fescue (*Festuca rubra*), Broad Dock (*Rumex obtusifolius*) and Curly Dock (*Rumex crispus*).

The channelised areas through the marsh was dominated by Reed Sweet grass, Yellow Iris, Water-Plantain (*Alisma plantago-aquatica*), Water Horsetail (*Equisetum fluviatile*), Branched Bur-reed (*Sparganium erectum*), Bulrush (*Typha latifolia*), Water Mint, Red Bartsia and Algae spp. Bulrush (*Typha latifolia*) was present, particularly in wet channels in the northern part of the habitat. The understorey of wetland plants in this habitat could not be assessed due to access restrictions.

The marsh vegetation was resurveyed in July 2019 using the Domin scale in 2x2 m relevés at four locations along the boundary of the marsh and the planned eastern embankment, in the area that the embankment will be placed. Results of this survey are seen in Table 8-5. Locations are marked on the habitat map in Figure 8-5, Volume 3. The table shows the overall species list from the four relevés, with minimum, median, and maximum Domin cover scale for each species, and the frequency. Creeping Buttercup was the most dominant and most frequent species, with a cover of more than 50% in all four relevés. Reed Sweet-grass occurred in all four relevés but had a low cover. Broad Dock and Yellow Iris occurred in 3 relevés with a high coverage. Creeping Bent and Yorkshire Fog (*Holcus lanatus*) were the only grasses recorded, with a low median cover of less than 4%. Water Mint, Water Forget-me-not (*Myosotis scorpioides*), Curly Dock and Fool's Watercress were frequently found during the survey.

The relevé data was entered into ERICA software hosted by NBDC. It was found that Releve 1 related to Irish Vegetation Community (IVC) habitat FE3C (Common Spike-rush – Creeping Bent marsh/fen), Relevé 2 and 3 were GL2A (Creeping Bent – Creeping Buttercup marsh-grassland), and Relevé 4 was GL2C (Yorkshire-fog – Perennial Rye-grass grassland), although all of these except Relevé 2 were considered transitional.

GL2A (Biodiversity Ireland, 2019)[64] has affinities with Fossitt GM1 Freshwater Marsh and the EU Annex 1 habitat 6430 (Hydrophilous tall herb). In lowland areas of Ireland the community of this Annex 1 habitat is dominated by tall hydrophilous herbs, such as Wild Angelica, Meadowsweet (*Filipendula ulmaria*), Yellow Iris, Yellow loosestrife (*Lysimachia vulgaris*), Purple-loosestrife (*Lythrum salicaria*) and Common Valerian (*Valeriana officinalis*) (NPWS, 2019) [65]. Horsetails such

[63] Denyer, J. (2017) King's Island *Groenlandia densa* Survey, June 2017. Unpublished report

[64] Biodiversity Ireland (2019) Irish Vegetation Classification (IVC). Community synopsis. *Agrostis stolonifera – Ranunculus repens* marsh-grassland. Available at: http://www.biodiversityireland.ie/wordpress/wp-content/uploads/GL2Ai.pdf]

[65] NPWS (2019). The Status of EU Protected Habitats and Species in Ireland. Volume 2: Habitat Assessments.

as Water Horsetail (*Equisetum fluviatile*) and Marsh Horsetail (*E. palustre*) can also occur. However, the range of species was assessed as insufficient in the Marsh area on King's Island to link it to this Annex 1 habitat.

Table 8-5. Relevé data from four sites on marsh habitat on flood plain

Common name	Species	Cover Min (med) max	Frequency
Creeping Buttercup	*Ranunculus repens*	8 (8.5) 9	v
Reed Sweet-grass	*Glyceria maxima*	1 (4.5) 5	v
Broad Dock	*Rumex obtusifolius*	1 (4) 8	iv
Yellow Iris	*Iris pseudacorus*	4 (4) 5	iv
Creeping Bent	*Agrostis stolonifera*	2 (3) 6	iv
Yorkshire Fog	*Holcus lanatus*	+ (3) 5	iv
Water Mint	*Mentha aquatica*	5 - 7	iii
Water forget-me-not	*Myosotis scorpioides*	3 (5) 7	iii
Curly Dock	*Rumex crispus*	2 (2.5) 3	iii
Fool's Water-cress	*Apium nodiflorum*	+ (2.75) 5	iii
Cleavers	*Galium aparine*	2	iii
Marsh Bedstraw	*Galium palustre*	2	iii
Marsh Yellow-cress	*Rorippa palustris*	4 - 9	ii
Toad Rush	*Juncus bufonius*	3	ii
Brooklime	*Veronica beccabunga*	3	ii
White Clover	*Trifolium repens*	3	ii
Sharp-flowered Rush/ Jointed Rush	*Juncus articulatus/ acutiflorus*	2	ii
Lesser Stitchwort	*Stellaria graminea*	2	ii
Chickweed	*Stellaria media*	2	ii
Meadow Foxtail	*Alopecurus geniculatus*	2	ii
Wavy Bittercress	*Cardamine flexuosa*	2	ii
Gypsywort	*Lycopus europaeus*	1	ii
Greater Plantain	*Plantago major*	1	ii
Starwort sp.	*Callitriche sp.*	1	ii
Bog Stitchwort	*Stellaria alsine*	1	ii
Redshank	*Persicaria maculosa*	+	ii
Hoary Willowherb	*Epilobium parviflorum*	+	ii

(GS4) Wet grassland

Wet grassland habitat occurs on wet or waterlogged mineral or organic soils that are poorly drained or, in some cases, subjected to seasonal or periodic flooding. On sloping ground, wet grassland is mainly confined to clay-rich gleys and loams, or organic soils that are wet but not waterlogged (Fossitt, 2000)[66]. Wet grassland habitat on King's Island is mainly located to the north of the island. A narrow strip of wet grassland habitat exists along the western edge of the island (Plate 8-9) which is bordered by a treeline. This wet grassland habitat was dominated by grasses such as Yorkshire-fog and Creeping Bent. Rushes (*Juncus spp*.), Horsetails (*Equisetum* spp.), Yellow Iris and Reed

Unpublished NPWS report. [online] Available at: https://www.npws.ie/sites/default/files/publications/pdf/NPWS_2019_Vol2_Habitats_Article17.pdf

[66] Fossitt, J. (2000) *A Guide to Habitats in Ireland.* The Heritage Council

Sweet-grass were abundant in patches within the wet grassland habitat. Broadleaved herbs such as Creeping Buttercup, Spearwort (*Ranunculus flammula*), Marsh Thistle (*Cirsium palustre*), Meadowsweet, Water Mint, Ribwort Plantain (*Plantago lanceolata*), Dock (*Rumex sp*.), Figwort (*Scrophularia spp*.) and Clover (*Trifolium spp*.) and Willowherbs (*Epilobium spp.).* Himalayan Balsam is abundant in the wet grassland habitats to the east of the island.

(WL2) Treelines

The treelines within the island consist of Ash (*Fraxinus excelsior*), Sycamore (*Acer pseudoplatanus),* Horse Chestnut (*Aesculus hippocastanum*), Elder (*Sambucus nigra*), willows (*Salix spp*.) and limes (*Tilia spp.).* A treeline of immature willow is located adjacent to the ditch to the north of the island (Plate 8-10).

Improved agricultural grassland GA1

The area to the east of St Mary's estate between the garden walls and the marsh habitat is largely grassland. There are some areas of bare soil where the ground has been poached by horses Plate 8-11). Species include Bent grasses (*Agrostis spp.*), Annual Meadow-grass (*Poa annua*), Dock and Daisy (*Bellis perennis*), with some Nettle (*Urtica dioica*) in places.

At the time of the 2017 ecological survey, bare and recolonising ground existed between the residential housing of St Mary's estate and SAC boundary as demolition works had just taken place. By 2019 the area had mostly recolonised.

(GA2) Amenity Grassland

Amenity grassland is situated around the areas of residential housing on King's Island (Plate 8-12). These areas include greens to the west of the island and playing pitches to the east.

(GS2) Dry meadows and grassy verges

A thin strip of GS2 exists either side of the footpath along the embankment on King's Island. This grassy verge is slight wet in nature given its location on King's Island. This is dominated by Nettle, Common Knapweed (*Centaurea nigra*), Willowherb, Bramble (*Rubus fruticosus agg*.), clovers and ragworts (*Senecio spp*.). The only grass that was discernible was Cock’s-foot.

(BL3) Buildings and artificial surfaces

This category is dominated by residential housing on King's Island. A tarmac footpath runs around the perimeter of the Island, inside the embankment, and steel sheet piling (Plate 8-13) has been erected on the north of the Island to stabilise the embankment.

(BD3) Recolonising bare ground

A pathway, worn to bare ground, was recorded to the north of the sheet piling, connecting surfaced paths on the east and west embankments (Plate 8-13).

Protected Flora

Opposite-leaved Pondweed

Opposite-leaved Pondweed was recorded in the ditch to the north west of the site during the walkover survey on the 17/01/2017 by botanist Tanya Slattery (JBA) (Plate 8-14, Appendix C1). This area is outside of the Lower River Shannon SAC. As this plant is protected under the Flora Protection Order, confirmation of the species identification, based on photographs taken during the survey, was obtained by aquatic macrophyte specialist Dr Joanne Denyer. Dr Denyer proceeded to obtain a derogation licence from the NPWS to survey and confirm the extent of its range within this area (see Appendix C3-1) and develop possible translocation or alternative habitat development plans in consultation with the NPWS.

Opposite-leaved Pondweed is normally found in calcareous waters of rivers, streams, canals, ditches and ponds. In Ireland, this species is typically associated with areas that are periodically disturbed, including canals, drains and tidal stretches of rivers. It is one of the subtypes of one of the qualifying features of the Lower River Shannon SAC (NPWS 2012a)[67] and can tolerate a certain level of disturbance. It had not previously been identified on King's Island or within the said drainage ditch.

Figure 8-6 in EIAR Volume 3 shows the main areas of Opposite-leaved Pondweed observed in a section of the ditch approximately 200m in length (mapped using GPS). In the southern section of the ditch (where the transect was located), Opposite-leaved Pondweed was present throughout the channel and only particularly dense populations have been mapped. The plants appeared healthy at the time of survey and had been present in the ditch during January, suggesting they had overwintered in the ditch.

To the north and south of the section containing Opposite-leaved Pondweed the ditch is infilling and overgrown suggesting that no ditch clearance had been undertaken recently. To the north the channel is shaded by scrub and dense patches of Duckweed (*Lemna spp*.) and litter dominate the water surface. To the south, the ditch channel is dominated by Bulrush, Reed Sweet-grass and Bur-reed (*Sparganium spp*.) Opposite-leaved Pondweed was not recorded from these overgrown ditch sections.

Macrophytes growing with Opposite-leaved Pondweed at the time of surveys included Common Stonewort (*Chara vulgaris*), Thread-leaved Water-crowfoot (*Ranunculus cf trichophyllus*) (not flowering), Blue-fruited Water-starwort (*Callitriche cf obtusangula*) (not flowering or fruiting), Reed Sweet-grass, Bur-reed (not flowering), Least Duckweed (*Lemna minuta*) Common Duckweed (*Lemna minor*), Water Horsetail, filamentous algae, Brooklime (*Veronica beccabunga*), Pink Water-speedwell (*Veronica catenata*) and Yellow Iris.

The area to the north-west of the Island was examined for the presence of the protected species, Triangular Club-rush, however no specimens were identified during the surveys. Access was restricted to certain areas of the site and, due to the time of year that the survey was conducted, this species may not have been observable and may still be present. However potential Triangular Club-rush was recorded during the fisheries surveys (see Section 8.3.6) between Thomond Bridge and Curragower falls on the west of King's Island.

Opposite-leaved Pondweed is protected by Section 21 of the Wildlife Act (1976) and is listed on the Flora (Protection) Order (2015)[68.] It is listed as 'Near Threatened' on the Irish Vascular Plant Red List (Wyse Jackson et al., 2016)[69;] and is identified as one of the three high conservation elements (sub-types) of the Feature of Interest of the Annex I habitat Water courses of plain to montane levels with the *Ranunculion fluitanis* and *Callitricho-Batrachion* vegetation [3260] within the Lower River Shannon Special Area of Conservation (SAC) (NPWS, 2012[70]).

Opposite-leaved Pondweed was not visibly apparent in the ditch or recorded by JBA ecologists during the re-surveying of habitats on King's Island in spring/summer of 2019. However, this result does not preclude the presence of the species, which may still occur within the ditch.

8.3.2 Terrestrial Mammals

Otter & Badger Surveys

The habitats surrounding King's Island, with tall herb swamps, riparian woodland, treelines and the adjacent Shannon and Abbey Rivers, provide extensive potential habitat for breeding or resting locations for Otter. A mammal survey was conducted on the 17/01/2017 and was resurveyed on

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[67] NPWS (2012a). Lower River Shannon SAC (site code 2165). Conservation objectives supporting document- Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (habitat code 3260) [Available at: https://www.npws.ie/sites/default/files/publications/pdf/002165_Lower%20River%20Shannon%20SAC%20Water%20Courses%20Supporting%20Doc_V1.pdf

[68] S.I. No. 356/2015 - Flora (Protection) Order, 2015.[Available at: http://www.irishstatutebook.ie/eli/2015/si/356/made/en/print]

[69] Wyse Jackson, M., FitzPatrick, Ú., Cole, E., Jebb, M., McFerran, D., Sheehy Skeffington, M. & Wright, M. (2016) Ireland Red List No. 10: Vascular Plants. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Dublin, Ireland [Available at: https://www.npws.ie/sites/default/files/publications/pdf/RL10%20VascularPlants.pdf]

[70] NPWS (2012) Lower River Shannon SAC 002165 Conservation Objectives [online] https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO002165.pdf

the 04/04/2019. Evidence of Otter was not observed during either survey or noted on any of the other ecological surveys conducted, however this may be due to several factors. The bank of the river, where many of the normal traces of otter would be observed, is within a tidal zone and so is regularly inundated with water. Furthermore, this area is frequently disturbed by human and domestic animal activity so evidence of Otter that could be present within these areas is likely to be destroyed. The rivers surrounding King's Island should still be considered suitable foraging and commuting habitats (NPWS, 2013)[71] .

Several mammal holes (Plate 8-15) were observed in the embankment along the north side of the football pitches, directly adjacent to a drainage ditch. A Badger (Plate 8-17) was captured on video in May 2019 from overnight camera traps set up near these mammal holes. Badger droppings were recorded in the middle of the marsh habitat in April 2019.

No field signs of Hedgehog or Pygmy Shrew were recorded.

8.3.3 Bats

A daytime survey was undertaken by Dr Tina Aughney on 12th July 2016 to identify any Potential Roosting Features (PRFs) in mature trees and to determine the potential usage of the site by foraging bats. Twelve mature trees along the eastern-side of the walking track were identified to have low-medium Potential Bat Roost (PBR) value i.e. Value B and C. An additional three trees in the boat house facility were also deemed to have low-medium PBR value.

Dawn & Dusk Survey

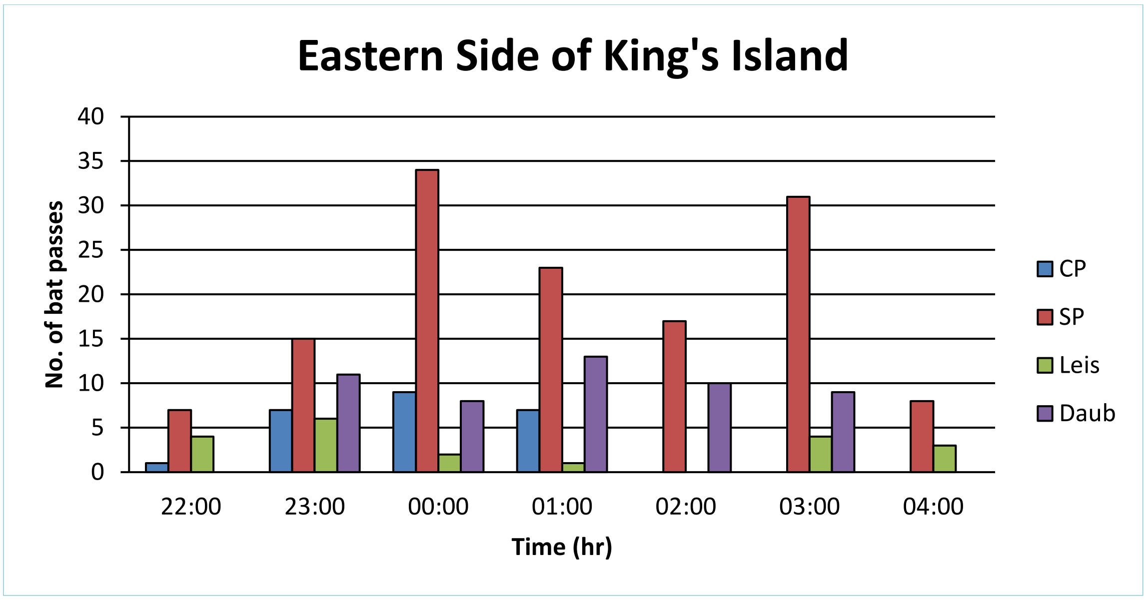
During the perimeter walk of the southern end of King's Island during the Dusk and Dawn survey, bat activity was determined to be principally confined to the rivers. A medium level of bat activity was observed along the perimeter for the following bat species: Common Pipistrelle (*Pipistrellus pipistrellus*), Soprano Pipistrelle (*Pipistrellus pygmaeus*), Leisler's Bat (*Nyctalus leisleri*) and Daubenton's Bat (*Myotis daubentonii*). Leisler's bats were detected commuting to feed over King's Island, particularly towards the northern end, possibly over the grassland areas. Soprano Pipistrelles and Common Pipistrelles commuted from buildings within King's Island to the rivers to feed, therefore there are roosting sites located here. However, due to the short survey time, bat roosts in buildings located away from the river areas were not surveyed. Daubenton's Bat activity was confined to the rivers, particularly along the River Abbey where there was a higher level of tree and shrub vegetation along the riverbanks.

Static Surveillance

Eastern Side of King's Island (SM2)

A total of four species of bat were recorded during surveillance (7 hours) on the eastern side of King's Island along the walking track adjacent to the ESB footbridge. Soprano Pipistrelles were the most frequently recorded bat species at this surveillance site (Graph 8-1) while Daubenton's Bat were recorded throughout the night feeding along the River Shannon. Common Pipistrelles and Leisler's Bats were also recorded but in lower numbers.

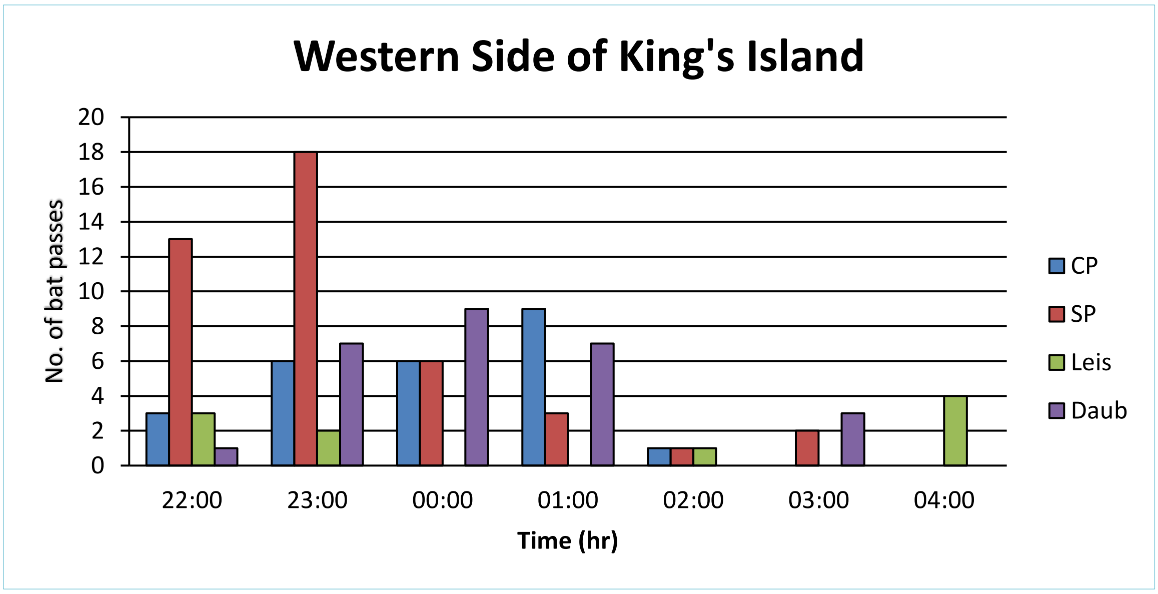
[71] NPWS (2013). Site Synopsis: Lower River Shannon SAC 002165. National Parks and Wildlife Service / Department of Arts, Heritage and the Gaeltacht. [online] https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY002165.pdf.



Graph 8-1: Number of bat passes recorded on SM2 located on the Eastern Side of King's Island on 17th July (Dusk) to 18th July (Dawn) 2016.

Western Side of King's Island (SM1)

A total of four species of bat were recorded during surveillance (7 hours) of the western side of King's Island along the walking track adjacent to the Abbey River. As on the eastern side of King's Island, Soprano Pipistrelles were recorded in the highest numbers at this surveillance site (Graph 8-2) while Daubenton's Bats and Common Pipistrelles were recorded throughout most of the night feeding along the River Abbey. Leisler's Bats were recorded in lower numbers, reaching their peak level at around 4am when no other bats were recorded at this location.



Graph 8-2: Number of bat passes recorded on SM2 located on the Western Side of King's Island – on 17th July (Dusk) to 18th July (Dawn) 2016.

Summary

In summary, four species of bats were recorded foraging and commuting within the survey area and there were no roosting sites recorded within the current flood defence walls. All four of these bat species (Common Pipistrelle, Soprano Pipistrelle, Daubenton’s Bat and Leisler’s Bat), are considered common bat species.

Despite the lack of bat roosts within the current flood defence walls, the ecology and presence of these species indicates that both the terrestrial and aquatic environment on King's Island are important foraging and commuting routes for bats. There were 13 trees identified along the walkway that have bat roost potential.

8.3.4 Birds

Desktop study

King's Island spans across four 2km national grids on the National Biodiversity Data Centre's map viewer; R55U, R55T, R55E and R55Y (Figure 8-7, Volume 3). The most recent records and locations of protected and notable bird species available from the National Biodiversity Data Centre for these 2km grid areas are provided in Table C-1 in Appendix C2.

Wintering Bird Surveys

Part of King's Island occurs within the Lower River Shannon SAC and comprises a marsh that is used by wintering birds on the north eastern side of the island especially during flood periods. Although Kings Island is not part of the SPA, some of the wintering birds that use the marsh SAC are designated features of the River Shannon and River Fergus Estuaries, a Special Protection Area that occurs further downstream of King's Island. These include Whooper Swan, Pintail, Lapwing and Black-headed Gull. The surveys took place during a time of very high flooding and heavy rains over Dec 2015 and Jan 2016 when a prolonged period of flooding occurred in the marsh SAC area.

Tables 8-6 and 8-7 list the species (in order of conservation importance) which were recorded during the surveys in relation to the proposed Flood Scheme area and adjacent habitat. Table 8-6 relates to the marsh area to the north east of King's Island and Table 8-7 to the amenity grassland area to the north west of King's island. The marsh area was resurveyed in April 2019 and results are given in Table 8-8.

Table 8-6. Wintering bird species on North East Kings Island on the flooded SAC marsh and adjacent areas (Nov 2015 - Feb 2016).

Species	Latin Name	Conservation Status			Average No.	Comments
		EU Annex I Species	Conservation Listed Species	Important Riparian Birds		**Flood/High Water**
Mute Swan	*Cygnus olor*	-	Amber	✓	20	Flooded Marsh
Whooper Swan	*Cygnus cygnus*	Annex I	Amber	✓	40	Flooded Marsh
Coot	*Fulica atra*	-	Amber	✓	10	Flooded Marsh
Lesser Black-backed Gull	*Larus Fuscus*	-	Amber	-	40	Back of houses Flooded Marsh Football Pitch
Black headed gull	*Chroicocephalus ridibundus*	-	Red (Breeding)	-	120	Back of houses Flooded Marsh Football Pitch
Heron	*Ardea cinerea*	-	Green	-	2	Flyover Abbey River
Lapwing	*Vanellus vanellus*	-	Red	-	40	Flooded Marsh
Great Black-backed Gulls	*Larus marinus*	-	Amber	-	8	Flooded Marsh Football Pitch
Gadwall	*Anas strepera*	-		-	24	Flooded Marsh
Tufted Ducks	*Aythya fuligula*	-	Red	-	4	Flooded Marsh
Cormorant	*Phalacrocorax auritus*	-	Amber	✓	4	River Shannon Abbey River
Pintail	Anas acuta	-	Red	-	2	Flooded Marsh
Golden Eye	*Bucephala clangula*	-	Red	-	6	Flooded Marsh

Table 8-7. Wintering bird species on North West Kings Island on the amenity grasslands fronting Oliver Plunkett St. (Nov 2015 - Feb 2016)

Species	Latin Name	Conservation Status			Average No.	Comments
		EU Annex Species	Conservation Listed Species	Important Riparian Birds		Flood/High Water
Oystercatcher	*Haematopus ostralegus*	-	Amber	-	60	Amenity Grassland
Black-headed gull	*Chroicocephalus ridibundus*	-	Red (Breeding)	-	40	Amenity Grassland
Lesser Black-backed Gull	*Larus Fuscus*	-	Amber	-	6	Amenity Grassland
Rook	*Corvus frugilegus*	-	Green	-	12	Amenity Grassland
Hooded Crow	*Corvus cornix*	-	Green	-	8	Amenity Grassland

Table 8-8. Wintering bird species on North East Kings Island on the flooded SAC marsh April 2019

Species	Latin Name	Conservation Status			Average No.	Comments
		EU Annex I Species	Conservation Listed Species	Important Riparian Birds		Flood/High Water
Mute Swan	*Cygnus olor*	-	Amber	✓	20	Wetland area
Coot	*Fulica atra*	-	Amber	✓	7	Wetland area
Lesser Black-backed Gull	*Larus Fuscus*	-	Amber	-	16	Wetland area
Cormorant	*Phalacrocorax auritus*	-	Amber	✓	14	Flying

Breeding Bird Species Count

Table 8-9 lists the notable breeding bird species (in order of conservation importance) which were recorded during the surveys in the proposed FRS area and adjacent habitats (see Table C-2 in Appendix C2 for full list). The breeding status has also been provided in the table, based on the criteria provided in Sections 8.2.2. The survey area encompassed the entire riparian area from the northern part of King's Island as far south as Georges Quay including adjacent bridges, walls and structures and also included areas where construction access routes and compounds may be located. The comments in Table 8-9 below assume that the FRS and/or associated works will not extend beyond the existing embankment on Kings Island and therefore will not directly impact on nesting habitats beyond the existing embankment such as Alluvial woodland, riverside wet grassland, riverside marsh etc.

Table 8-9. Notable Annex, Red or Amber-listed Bird species recorded within the survey area.

Common Name	Latin name	Conservation Status			Breeding status	Comments	Habitat
		EU Annex Species	Conservation Listed Species	Riparian Action Plan Species			
Kingfisher	*Alcedo atthis*	Annex I	Amber	✓	Possible	Kingfisher observed flying along Shannon further north of Kings Island. No nesting banks found on within FRS	Likely to nest on opposite bank of Shannon and Abbey Rivers. Historically noted on Shannon further north
Little Egret	*Egretta garzetta*	Annex I	Green	✓	Possible	Observed foraging south of Kings Island at Clancy's Strand. No nesting within FRS	No evidence of nesting in marsh or woodland of Kings Island. Urbanised location may make it unsuitable.
Grey Wagtail	*Motacilla cinerea*	-	Red	✓	Confirmed	Observed in suitable habitat, nest in wall at Thomond Weir at Brown's Quay. No nesting found within FRS	Foraging for food and nest in between crevices in wall.
Mute Swan	*Cygnus olor*	-	Amber	✓	Confirmed	Female on nest on river marsh on north edge of Kings Island beyond embankment	Marsh Habitat
Cormorant	*Phalacrocorax carbo*	-	Amber	✓	Unlikely	Group of 5 No nesting within FRS they may be part of the nesting colonies at Bunlicky further south.	5 Observed on gravelly area below Parteen Railway
Coot	*Fulica atra*		Amber	✓	Possible	One male calling from river edge reeds on Abbey River No nesting within FRS	Alluvial Woodland
Swift	*Apus apus*		Amber		Not breeding	Flyover only	
Black-headed Gull	*Chroicocephalus ridibundus*	-	Red		Not breeding	Roosting on playing pitches	
Swallow	*Hirundo rustica*	-	Amber		Possible	Observed feeding over wet grassland of SAC on Kings Island	Near sheds and buildings

Amphibians

Amphibian surveying for Common Frog (*Rana temporaria*) was conducted by JBA ecology staff in conjunction with the Otter survey during April 2019. All suitable aquatic habitats were surveyed for sightings of live individuals (immature and adult stages) as well as any late season spawning. The survey confirmed that no amphibians were inhabiting the waterways of the King's Island site.

8.3.5 Invertebrates

Insects - Bees

Entrance holes to the nests of solitary bees were recorded extensively in flood defence sandbags on top of the wall on the embankments surrounding the northern part of King's Island (Plate 8-18). The vertical face of sand offers suitable nesting habitat for these insects. The bag material is made of plastic, which is deteriorating.

There are 101 bee species in Ireland. Nineteen of these species are bumblebees, and more than half of these bumblebee species are in decline. Ireland has one native honeybee species. Most of the other 81 bee species in Ireland are solitary. Nearly half of these solitary species are in decline. A regional Red Data List of bees has been produced and indicates which bee species are in most danger in Ireland. Six species are critically endangered (CR), 7 are endangered (EN), 16 are vulnerable (VU) and 13 are near threatened (NT) (NBDC, 2019)[72].

In the desk-study, Large Red-Tailed Bumble Bee (*Bombus (Melanobombus) lapidarius*) and Moss Carder-bee (*Bombus (Thoracombus) muscorum*) were recorded within NBDC 2km square R55Z. Both these bees are Near Threatened species.

8.3.6 Fish

A desktop review was carried out to identify the areas of importance for fish within the study area and immediate environs. This included the fish species designated as conservation objectives under the Lower River Shannon SAC (listed below in Table 8-10) as well as other species of conservation interest; European eel (*Anguilla anguilla*), Smelt (*Osmerus eperlanus*) and estuarine fish species. Conservation Objective Fish Species in the Lower River Shannon SAC include the following species;

- Sea Lamprey (*Petromyzon marinus*) [1095]
- River Lamprey (*Lampetra fluviatilis*) [1099]
- Brook Lamprey (*Lampetra planeri)* [1096]
- Atlantic Salmon (*Salmo salar*) [1106]

Table 8-10. Status of fish species in adjoining river habitats listed as Conservation Objectives in the Lower River Shannon SAC (002165).

Species	Annex	ICUN Status (Ireland) King et al., 2011	Presence in vicinity of King's Island	Life strategy	Recorded by Inland Fisheries Ireland (2008, 2014)
Sea Lamprey	II	Least concern	Yes	Anadromous Migrant (migrates to sea)	No (but likely present spring & early summer)
Brook Lamprey	II	Least concern	Status unknown	Not strictly migratory	No (but may be present in Abbey River and River Shannon above weirs)
River Lamprey	II & VI	Least concern	Status unknown	Anadromous migrant (migrates to sea)	No (but may be present in Abbey River and

72 National Biodiversity Data Centre (2019) The State of Ireland's Bees. [Available at; http://www.biodiversityireland.ie/wordpress/wp-content/uploads/The-state-of-Irelands-Bees.pdf]

					River Shannon)
Atlantic Salmon	II	Least concern	Yes	Anadromous migrant (migrates to sea)	Yes, recorded by IFI, 2008

A desktop review was undertaken on the composition of fish populations of the River Shannon and Abbey River in the vicinity of King's Island, to categorise the importance of the channels to support those populations.

Physical characteristics

The Lower River Shannon (IE_SH_060_0900) is located in Hydrometric Area 25 and is contained within the Shannon International River Basin District. The River Shannon in Limerick City can be considered a tidal channel as the river is subject to tidal fluctuation and thus salinity changes but still receives high volumes of freshwater from upstream. The transitional water quality of the Limerick Docks site that includes the study area (EPA Code: E_SH_060_0900) as measured between 2010-2012, is considered as being of 'Good Status' or having unpolluted water according to the Water Framework Directive monitoring. The geology of the Limerick Dock's and King's Island is situated on Visean Limestone (undifferentiated) per the Geological Survey of Ireland.

Riparian habitat

The riparian zone of the River Shannon and the Abbey River in the vicinity of King's Island possess good quality natural and semi-natural habitat but the southern end of King's Island is progressively more built up with residential and commercial properties. The natural riparian zones of the channel according to Fossitt classification (2001) were locally defined by marsh vegetation (GM1), non-native scrub (WS3), mixed sediment shores (LS5) and more localised tall reed and herb vegetation (FS1). Other riparian features included treelines (WL1), sea walls (CC1) and amenity grassland (GA2), improved grassland (GA1) and wet grassland (GS4). Upstream of Thomond Bridge riparian areas were encroached by invasive non-native scrub (WS3) comprising Himalayan Balsam, Japanese Knotweed and Giant Hogweed.

The riparian habitat of the Lower River Shannon between Thomond Bridge and Corbally Bridge was largely of built ground (BL3) with small riparian fringes of vegetation fronting the waterlines. On the right-hand bank between Thomond Bridge and Curragower Falls there was a small area of FS1 comprising Club-rush vegetation (*Scirpus spp.).* However, it is most likely Triangular club-rush which is protected under the Wildlife Acts (1976 and 2000), as it is listed on the Flora Protection Order 1999. The species has been confirmed in this area near Curragower Falls (Reynolds, 2013)[73]. The mixed sediment shores (LS5) of Clancy's Strand comprised cobble, coarse gravel and mud with limited vegetation apart from some sparse Triangular Club Rush and Purple Loosestrife on the littorals with Sea Plantain (*Plantago maritime*) on the more open sediment.

The quay walls and bridge aprons contained Valerian (*Valeriana officinalis*), Maiden Hair Spleenwort (*Asplenium trichomanes*) and more localised Buddleia (*Buddleia daviddi*) and Figwort.

Macrophyte plant species were typically scarce in the channels of the Lower River Shannon and Abbey River, with low surface area cover given the fast current and high turbidity. Common Water Starwort (*Calitriche stagnlais*) was present in very small and localised stands upstream of Curragower Falls on the River Shannon along with very common *Cladophora* spp. Very localised areas of Horned Pondweed (*Zanichellia palustris*) were seen in the Lower Abbey River as with Eurasian Water-milfoil (*Myriophyllum spicatum*). Some emerging Water Plantain was also present. The aquatic moss species *Fontanalis antipyretica* was very abundant in the Lower River Shannon between Thomond Bridge and Curragower Falls.

Opposite-leaved Pondweed was not observed between Thomond Bridge and Sarsfield Bridge but is highly likely to occur in the slack water areas of the Abbey River. It was however known to thrive in the adjoining Park Canal, east of Baal's Bridge (Reynolds et al., 2006)[74.]. Littoral macrophytes included Brooklime, Water Mint, Cuckoo Flower and Fool's Watercress which were locally common upstream of Curragower Falls.

[73] Reynolds, S. (2013) *Flora of County Limerick*. National Botanic Gardens
[74] Reynolds, S., Conaghan, J. and Fuller, J. (2006) *A survey of rare and scarce vascular plants in County Limerick*. Unpublished report to the National Parks and Wildlife Service

Fish Habitat Mapping

Fish habitat mapping was prepared to provide a snapshot of the areas of importance for the species utilising the lower River Shannon and Abbey River. Typically, glide habitat dominated the main Channel of the River Shannon downstream of Thomond Bridge (at low tide), constituting 60% of the habitat, with pool and riffle comprising 30% by surface area and Curagower Falls the remaining 10% (Figure 8-8). Glide and pool habitats accounted for 45% each of the surface area of the Abbey River with artificial weir habitat accounting for the remaining 10% of the total habitat area. Upstream of Baal's Bridge the Abbey River becomes exclusively deeper pool habitat with localised marginal shallows. Similarly, the Lower River Shannon upstream of the historical Salmon traps is predominantly deeper pool habitat (Figure 8-9).

The substrates in both the main channel of the River Shannon and lower Abbey River (i.e. downstream of Athlunkard Bridge) were dominated by boulder and cobble with coarse gravels. Mud, silt and sand mixtures dominated the Abbey River upstream of Athlunkard Bridge, with mixed sediment shorelines at Clancy's Strand downstream of Thomond Bridge on the Lower River Shannon. Some localised soft sediment banks were also present adjoining the reeded littorals of the Lower River Shannon upstream of the historical Salmon traps (Figure 8-10).

Lower River Shannon SAC (Fish)

Of the listed species (Table 8-9), Atlantic Salmon and Sea Lamprey will occur within the river channels overlapping the proposed works areas as they are both anadromous fish species, meaning they are obligate migrants through the river channel. The other conservation objective fish species, Brook and River Lamprey, are not known as estuarine fish species but may occur in the Abbey River (Figure 8-8, Figure 8-9) given the presence of localised beds of sand and silt.

Atlantic Salmon in the Lower River Shannon

The River Shannon is listed on the Quantification of the Freshwater Salmon Habitat Asset as containing 3.28% of the national fluvial accessible habitat to Atlantic Salmon (McGinnity et al., 2003)[75.] The diversion of water from the main river channel in 1929 caused a profound impact on the salmonid spawning habitat of the Lower River Shannon (Went, 1970)[76,] while the dam construction cut the catchment in half. This was reflected by the declining numbers of returning Salmon. During 2003, 1904 Salmon were counted at the Ardnacrusha / Parteen counters compared with 23,322 fish in 1963 at the nearby Thomond weir (Salmon trap here now closed). Most recently the Standing Scientific Committee on Salmon (2016) have stated that the passage of fish above the dams in the Lower River Shannon SAC is below 5% of the conservation limit (CL) meaning that the escapement of fish is extremely low and thus favourable conservation status is not being met.

River Shannon has the largest wetted area catchment upstream of any dammed river system in Ireland (30,895,619 m^2) meaning the conservation limit (CL) value is comparably large at 49,638 salmon (SSCS, 2016)[77.] However, the 2011-2015 data on fish passage illustrates a figure of 2,148 salmon passing through the dams, a mere 4.3% of the conservation limit value.

The most important recreational salmon fishery exists at Castleconnell, 11km upstream of Limerick City which contains six beats (800m long) each. The River Shannon Management Plan initiated by the ESB in 1992, helps sustain the fishery by releasing 150,000 adipose fin clipped salmon every year (ESB, 2011)[78], with these fish forming the bulk of those passing through the dams (i.e. fin clipped fish; SSCS, 2016).

The Lower River Shannon between Thomond Bridge and Sarsfield Bridge contains important transitory holding pool habitat for adult Salmon. Some large pools exist directly downstream of Thomond Bridge and also downstream of Curragower falls (Figure 8-8). Salmon run in phases

[75] McGinnity, P., Gargan, P., Roche, W., Mills, P. & McGarrigle, M. (2003) Quantification of the Freshwater Salmon Habitat Asset in Ireland using data interpreted in a GIS platform. Irish Freshwater Fisheries Ecology and Management Series: Number 3, Central Fisheries Board, Dublin, Ireland.

[76] Went, A.E.J. (1970*) Salmon investigations on the River Shannon*. In Atlantic Salmon Association Centennial Award fund. Series of Lectures, 17-22. Quebec. Atlantic Salmon Association

[77] SSCS (Standing Scientific Committee on Salmon) (2017) *The Status of Irish Salmon Stocks in 2016 with Precautionary Catch Advice for 2017*. Independent Scientific Report to Inland Fisheries Ireland.

[78] ESB (Electricity Supply Board) (2011) Shannon Fishery Partnership Plan.

throughout the year, therefore these holding pool habitats, downstream of Thomond Bridge and Curragower Falls may contain salmon throughout the year. The Salmon season is generally closed from October to March to include the spawning season. The most sensitive time for impacts to Salmon at the Link's Island location is likely to be during April when smolts move downstream. Given that smolts are the future run of Salmon to the river, they are highly important for future recruitment of the stock. Given the estuarine nature of the waters surrounding King's Island, smolt are more likely to be impacted than developing larvae or emerging alevin, which would occur further upstream. Salmon ascending in spring could also be impacted at this location. Refer to Table 8-11 for the seasonal sensitivity periods for fish species present in the Lower River Shannon and Abbey River.

Following the construction of the Shannon H.E.P Scheme and dropping water levels, the nature of the river bed in the Lower River Shannon changed and it took time for new spawning habitat to form following the natural regrading of river gravels. In recent years, returning spawning Salmon use areas upstream of King's Island on the Lower River Shannon to spawn including Castleconnell, Doonass, Plassey and Corbally (Reale, 2011)[79]. Thus, the adjoining areas of habitat in the Abbey River and Lower River Shannon are not considered of importance for spawning as those areas identified upstream are considered the most significant spawning areas in addition to upstream tributaries such as the Mulkear River. The Mulkear River also remains a critically important tributary contributing to the spawning Salmon stock in addition to being one of Ireland's finest lamprey habitats.

Brown Trout

Brown trout populations in Ireland are considered to be genetically diverse with numerous strains (Taggart et al. 1981[80],Ferguson, 2006[81], Massa-Galluci et al., 2010[82]) and, thus, are important for the wider conservation and management of the species in Europe. The estuarine Limerick Dock's area, including King's Island, is an important area for a phenotype of Brown Trout (*Salmo trutta*), known as the Slob Trout. Slob Trout are not considered the same as true Sea Trout despite living in brackish water (Kennedy & Fitzmaurice, 1971[83]), as they do not migrate to sea (smoltifying) before returning to freshwater. Other phenotypes of Brown Trout include Sea Trout.

According to O'Connor (unpublished data)[84], traps set between 1991-1996 on the Lower River Shannon and Mulkear River failed to identify large numbers of Sea Trout smolts moving downstream, indicating that the Sea Trout escapement from the catchment is poor. Thus, unusually, Slob Trout appear to be the more significant phenotype population of Brown Trout present in the tidal reaches of the Lower River Shannon. The survey areas assessed in this report are considered good quality Slob Trout habitats. The pool and glide habitats would contain larger adult cohorts while the riffle habitat would contain younger Trout, as would typically be encountered in riverine habitat.

European Eel

The critically endangered European Eel (Freyhoff & Kottelat, 2010[85]) are considered to be the most threatened fish species in Ireland in a recent red-listed publication on Irish Fish (King et al. 2011)[86].

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[79] Reale, A. (2011) *The Shannon Scheme and its Effect on the Shannon Fisheries*. Unpublished document prepared as part of the History & Folklore Project in conjunction with FÁS, Limerick Civic Trust (2009-2011).
[80] Taggart, J, Ferguson, A., Mason, F.M. (1981) Genetic variation in Irish populations of brown trout (*Salmo trutta*); electrophoretic analysis of allozymes. *Journal of Physiology & Biochemistry* part B: Comparative Biochemistry 69(3): 393-412.
[81] Ferguson, A. (2006) Genetic differences among brown trout, Salmo trutta and their importance for the conservation and management of the species. *Freshwater Biology* 21(1): 35-46.
[82] Massa-Gallucci, A., Coscia, I., O' Grady, M., Kelly-Quinn, M. & Mariani, S. (2010) Patterns of genetic structuring in a brown trout (*Salmo trutta* L.) metapopulation. *Conservation Genetics*, 11: 1689 1699.
[83] Kennedy, M. & Fitzmaurice, P. (1971) Growth and food of brown trout Salmo trutta L. in Irish waters. *Proceeding of the Royal Irish Academy*, 71 (section B), (18), 269-352.
[84] www.ecofact.com
[85] Freyhof, J. & Kottelat, M. (2010). *Anguilla anguilla*. In: IUCN 2013. *IUCN Red List of Threatened Species*. Version 2013.2. <www.iucnredlist.org>. Downloaded on 01 April 2014.
[86] 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.

The European Eel has protective status under the European Eel Regulation EC No. 1100/2007 to facilitate the recovery.

The recruitment of juvenile eel has been subject to a steady decline in the Lower River Shannon but this section of the Shannon (i.e. below the hydroelectric dams) has a relatively good density of adults compared to the remainder of the Shannon catchment (Cullen & McCarthy, 2007)[87.] While there has been an observed decline in the escapement of silver eel, glass eels appear to be returning in large numbers for the past three years to European rivers (Jackoby & Gollock, 2014)[88] and also to the Lower River Shannon based on unpublished observational studies.

Of the important zones for European Eel within the vicinity of King's Island, between Thomond Bridge and Sarsfield Bridge, the deep holding pools downstream of both Thomond Bridge and Curragower Falls are considered important areas for holding migratory silver eel in the autumn. The entire habitat of the River Shannon adjoining King's Island exhibits good quality Eel habitat with abundant large cobble that provide refugia for eel. The Abbey River also supports good quality Eel habitat for adults in the lower reaches with juvenile Eel habitat upstream in the softer sediment area.

European Eel elvers can bury in soft sediment habitat similar to lamprey and it can often be under estimated as an important nursery habitat for elver as there is limited data in the literature on its importance. The habitat upstream of Baal's Bridge on the Abbey River becomes dominated by softer sand and silt habitat in which elvers can bury and emerge to feed at night. Ecofact Consultants recorded European Eel at all five of the survey stations on the lower Abbey River (Ecofact, 2011).

The most sensitive time of year for Eel is during the glass eel migrations into the River Shannon. Glass Eel are considered sensitive to pollution given their fragility as juvenile larvae and as such March to early May is considered the most critical time to prevent any water quality related impacts to eel stock (Table 8-11).

Lamprey Species

All three species of lamprey, Brook, River and Sea Lamprey are known to occur in the Lower River Shannon (Igoe et al. 2004)[89]. The tidal water in the Limerick Dock's area, downstream of Curragower Falls, would be less suitable for lamprey ammocoetes as there is limited soft burrowing substrata and the salinity levels may be unfavourable to the species. Both Brook and River Lamprey may occur in the softer sediment present in the middle and upper Abbey River, as well as in the margins of the Lower River Shannon upstream of the historical salmon traps. Lamprey ammocoetes River/Brook and Sea Lamprey have been recorded by Ecofact consultants (Ecofact, 2011).

Sea Lamprey are a panmictic anadromous fish, and thus move from sea water to freshwater to spawn. The pool habitat below Curragower falls, downstream of King's Island/Thomond Bridge would be an important transitory resting area for Sea Lamprey moving upriver on the Shannon to known spawning areas such as in the Mulkear River tributary at Annacotty and below the hydroelectric dams on the Lower River Shannon at Castleconnell.

According to Igoe et al. (2004) large numbers of Sea Lamprey were also harvested annually at Plassy (upstream of King's Island near the University of Limerick Campus). The tributaries of the Lower River Shannon, particularly the Mulkear and the main channel of the Lower River Shannon between Plassey and Parteen Dam, where suitable spawning exists are considered important areas of the Lower River Shannon for adult lamprey (Igoe et al. 2004, Curd, 2009[90).]

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[87] Cullen, P. & McCarthy, T.K. (2004) Eels (*Anguilla anguilla* (L.)) of the Lower River Shannon, with particular reference to seasonality in their activity and feeding ecology. *Proceedings of the Royal Irish Academy*, Vol 107B(2), 87-94.
[88] Jacoby, D. & Gollock, M. (2014). *Anguilla anguilla*. In: IUCN 2014. *The IUCN Red List of Threatened Species*. Version 2014.1. <www.iucnredlist.org>.
[89] Igoe F., Quigley D.T.G., Marnell F., Meskell E., O'Connor W. & Byrne C., 2004. The Sea lLmprey *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* 104B: 43–56.
[90] Curd, A. (2009) OSPAR Commission. Background Document for Sea Lamprey Petromyzon marinus.

Suitable spawning habitat likely also exists downstream of Ardnacrusha Dam where large numbers of juvenile lamprey species (unspecified) have been captured during glass eel surveys (Igoe et al. 2004). In summary habitat adjoining King's Island, particularly downstream of Curragower Falls would be an important migratory holding area for lamprey moving upstream to spawning grounds as stated. Additionally, the soft sediment littorals of both the Abbey River and River Shannon upstream of the weir provides habitat for ammocoetes (likely all three species).

Smelt

Smelt are primarily an estuarine fish that move into freshwater to spawn and thus may be considered anadromous (Quigley et al., 2004)[91]. Recently King et al., (2011)[92] classified Smelt under the ICUN Red List category as of Least Concern in Ireland given more recent evidence of a more widespread spawning population in Irish estuaries.

Smelt are known to form spawning aggregations in March in the Lower River Shannon (Table 8-11). The absence of multiple cohorts within spawning aggregations make Smelt more vulnerable to perturbations from pollution (Quigley et al., 2004[93]; King et al., 2011[94]). The spring and summer distribution of Smelt in the River Shannon is known to occur a short distance downstream of King's Island, between Callaghan's Strand and Clancy's Strand. It is therefore important to prevent any indirect impacts from flood defence works to the downstream sediments on which Smelt spawn, and also to prevent any works being undertaken during the spawning period in March when large aggregations of spawning adults may gather (Figure 8-8, Volume 3).

[91] Quigley, D.T.G., Igoe, F., & O'Connor, W. (2004) The European Smelt *Osmerus eperlanus* L. in Ireland: General Biology, Ecology, Distribution and Status with Conservation Recommendations. In *Biology and Environment: Proceedings of the Royal Irish Academy* (pp. 57-66). Royal Irish Academy.

[92] 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.

[93] Quigley, D.T.G., Igoe, F., & O'Connor, W. (2004) The European Smelt *Osmerus eperlanus* L. in Ireland: General Biology, Ecology, Distribution and Status with Conservation Recommendations. In *Biology and Environment: Proceedings of the Royal Irish Academy* (pp. 57-66). Royal Irish Academy.

[94] 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.

Table 8-11. Calendar of sensitivities for fish species present in the Lower River Shannon (Limerick City) (Source: Macklin & Brazier, 2018[95])

Species	Notes	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Atlantic Salmon	Spawning areas upstream of King's Island	Late spawning	Close season	Close season	Emergence from redds & smolts	Smolts					Adults running river	Adults running river	Peak Spawning
Brown Trout	Slob trout phenotype in Abbey River & Lower River Shannon	Close season	Close season	Close season	Emergence from redds	Fry growth					Adults running river	Peak Spawning	Spawning
European Eel	Good habitat throughout Lower River Shannon & Abbey River (adults & elvers)				Glass eel migration into estuary	Glass eel migration into estuary					Sea migration down river of silver eel	Sea migration down river of silver eel	Sea migration down river of silver eel
Sea Lamprey	Spawning areas unknown in tidal areas. Important areas upstream in Mulkear River & below dams					Spawning	Spawning	Spawning					
Smelt	Spawning at Clancy's Strand			Spawning									

[95] Macklin, R. & Brazier, B. (2018) *King's Island Flood Relief Scheme (Fisheries Impact Assessment)*. Unpublished Report.

Inland Fisheries Ireland surveys

During 2008 and 2014, as part of Water Framework Directive fish monitoring, Inland Fisheries Ireland sampled the Lower River Shannon in the vicinity of Limerick City Docks. The sampling was undertaken using beach seine netting, beam trawling and fyke netting, both upstream and downstream of King's Island (within a 2km radius). Beam trawls were carried out at King's Island on the River Shannon (above Thomond weir, approx. <1km upstream Verdant Place) and fyke nets were set in the Abbey River in Corbally. Beach seines were used downstream of Thomond Bridge (approx. 500m downstream Verdant Place).

Approximately sixteen species of fish were captured over both survey periods, including Flounder, Smelt, Three-spinded Stickleback, Roach, European Eel, Sprat, Dace, Perch, Sand Goby, Brown Trout, lamprey spp., Plaice, Thick-lipped Grey Mullet, Common Goby, Pike and Atlantic Salmon. Flounder were the most common species captured in both years (n=42; n=247), followed by Roach (n=29; n=38) and European Eel (n=21; n=30). A large number of Smelt (n=138) were recorded in 2014.

With the exception of European Eeel, Atlantic Salmon and Brown Trout, none of the other species captured by Inland Fisheries Ireland during their surveys are considered commercially valuable apart from their value as angling species (e.g. Perch, Pike, Roach and Dace). Typically, Pike, percids and cyprinid fish species (i.e. those mentioned above) are more tolerant of poor water quality than salmonids (e.g. Brown Trout and Atlantic Salmon) and are thus considered less vulnerable to water pollution associated with flood relief works.

Invasive Non-native Species

Invasive non-native species were recorded along the river walls, existing embankment, riparian habitats and in the undeveloped land of King's Island, both within and outside of the designated areas. The main invasive species noted on Kings Island include:

- Japanese Knotweed (*Reynoutria japonica);*
- Giant Hogweed (*Heracleum mantegazzianum*);
- Himalayan Balsam (*Impatiens glandulifera*);
- Buddleia (Butterfly Bush) (*Buddleja davidii);*
- Winter Heliotrope (*Petasites fragrans*);
- Common Ragwort (*Senecio jacobea*);
- Broad-leaved Dock (*Rumex obtusifolius*); and
- Spear thistle (*Cirsium vulgare*).

Japanese Knotweed, Giant Hogweed and Himalayan Balsam are listed in the Third Schedule (Part 1) of the European Communities (Birds and Natural Habitats) Regulations 2011. Japanese Knotweed and Giant Hogweed are being treated on King's Island under an invasive species management plan (JBA, 2019)[96], as they are a risk in preventing the conservation objectives of the designated sites from being reached. Regulation 49 and 50 restrict the dispersal, spread and transportation of these invasive species. Buddleia and Winter Heliotrope are amber listed by Invasive Species Ireland. Common Ragwort, Broad-leaved Dock and Spear Thistle are noxious weed under the Noxious Weed Act 1936. Details on invasive species are given in Invasive species management plan (JBA, ibid) and a map showing their distribution on King's Island is found in Figure 8-11, Volume 3).

Japanese Knotweed and Giant Hogweed were recorded at various locations on King's Island. A bund of buried Japanese Knotweed is present beside the marsh habitat. Numerous stands of Japanese Knotweed are located along the boundary line of the SAC and adjoining housing estate. The location of Giant Hogweed was contained to the outer fringe of the island, among the riparian woodland and wet grassland areas in 2017. However, by 2019 it was recorded on either side of the pathway on the western embankment (Figure 8-11, Volume 3), on the embankment itself and in the ditch that contains the protected species Opposite-leaved pondweed.

[96] JBA (2019) *King's Island Flood Relief Scheme- Invasive Species management Plan.* Unpublished report

Himalayan Balsam is abundant along the edges of the island within the riparian woodland and wet grassland habitats. Winter heliotrope was observed during the survey in January 2017 and may only be a more recently established plant. It was observed along grassy verges and embankments to the south-east of the site where Himalayan Balsam was previously observed.

8.4 Assessment Methodology

Habitats and species were assessed in accordance with the guidance contained in the documents Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2018)[97] and NRA (2009)[98].

Defining importance: The relative importance of each ecological feature has been defined on a geographical scale, from international importance, to having relevance only in the context of the site boundary. It should be noted that professional judgement has been employed in the allocation of a level of importance to each feature as it occurs on the site. In other words, the value of the feature is presented in the context of its actual status within the site. Therefore, a single individual of a species which is protected under the EU Habitats Directive would not automatically be of European (international) Importance but would be evaluated in the context of its relationship to the overall population.

As stated in CIEEM (2018), 'The importance of an ecological feature should be considered within a defined geographical context'. Accordingly, each feature has been assessed based on the scale described in Table 8-12 below.

Defining impact: Impacts were assessed using the EPA Impact Classification terminology as published in the EPA guidance document (EPA 2017)[99] and as set out in Chapter 1.

Residual impact: Following the application of mitigation measures, impacts to each ecological feature are reassessed, and any residual impacts are reported.

Table 8-12. Criteria for Establishing Receptor Sensitivity/Importance in a geographic context

Importance	Ecological Valuation
International	Sites, habitats or species protected under international legislation e.g. Habitats and Species Directive. These include, amongst others: SAC's, SPA's, Ramsar Sites, Biosphere Reserves, including sites proposed for designation, plus undesignated sites that support populations of internationally important species.
National	Sites, habitats or species protected under national legislation e.g. Wildlife Act 1976 and amendments. Sites include designated and proposed NHAs, Statutory Nature Reserves, National Parks, plus areas supporting resident or regularly occurring populations of species of national importance (e.g. 1% national population) protected under the Wildlife Acts, and rare (Red Data List) species.
Regional	Sites, habitats or species which may have regional importance, but which are not protected under legislation (although Local Plans may specifically identify them) e.g. viable areas or populations of Regional Biodiversity Action Plan habitats or species.
Local/County	Areas supporting resident or regularly occurring populations of protected and red data listed-species of county importance (e.g. 1% of county population), Areas containing Annex I habitats not of international/national importance, County important populations of species of habitats identified in county plans, Areas of special amenity or subject to tree protection constraints.
Local	Areas supporting resident or regularly occurring populations of protected and red data listed-species of local importance (e.g. 1% of local population), Undesignated sites or features which enhance or enrich the local area, Sites containing viable area or populations of local Biodiversity Plan habitats or species, local Red Data List species etc.

[97] CIEEM (2018*) Guidelines for Ecological Impact Assessment for the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine*. CIEEM.
[98] NRA (2009). *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes*. National Roads Authority. Available at: https://www.tii.ie/technical-services/environment/planning/Ecological-Surveying-Techniques-for-Protected-Flora-and-Fauna-during-the-Planning-of-National-Road-Schemes.pdf]
[99] Environmental Protection Agency (August 2017) *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* (Draft)

8.4.1 Evaluation

The evaluation of ecological features (habitats and species) which could be affected by the Project includes:

Any statutory designated areas, with the exception of Natura 2000 sites, which are situated within 10km of the Project Site that have potential ecological connection (s) with the Site;

- Any surface or groundwater bodies that have hydrological connectivity with the Site;
- Any habitat type recorded within the Site; and
- Any species of conservation importance which has been confirmed as occurring within the Site.

The value of the feature is defined with reference to the geographical context of the scheme i.e. the specific importance of the scheme to each of the habitats or protected species populations identified as being present within it or making use of it. This assessment of value is based on the condition of the site during the survey period, although, where information is available, reference is made to these. The evaluation takes into account any statutory or non-statutory conservation status, its extent (or population size) within the site compared to the resource elsewhere and whether it has characteristics which either elevate or depress its importance in comparison with a 'typical' example (for example, whether a habitat is particularly species rich, or depleted in species). Common and widespread species or habitats, therefore, only have a level of importance in respect to the biodiversity of their immediate area (taken in this case to be represented by the boundary of the Site).

Some protected species may, under certain circumstances (such as a single example occurring within the Site, as part of a much larger local population) be considered to only be of importance within the Site itself. Such species, on the basis of legal and planning regulation compliance, are included within the Impact Assessment and, (if necessary) dedicated impact mitigation measures are provided.

The following geographic frame of reference (NRA, 2009)[100] (Table 8-13) has been used when determining value:

- International importance;
- National importance;
- County importance (or vice-county in the case of plant or insect species);
- Local importance (higher value); and
- Local importance (lower value).

Table 8-13. Classifying the Geographical Importance of Key Ecological Features

Key Ecological Features	Importance	Rationale
Designated sites		
Lower River Shannon SAC	International	As this site is designated under the European Communities (Birds and Natural Habitats) Regulations 2011, made under European Habitats Directive, it is considered to be of international importance. This feature (SAC) is thus carried forward into the design mitigation and impact assessment sections.
River Shannon and River Fergus Estuaries SPA	International	As this site is designated under the European Communities (Birds and Natural Habitats) Regulations 2011, made under European Habitats Directive, it is considered to be of international importance. This feature (SPA) is thus carried forward into the design mitigation and impact assessment sections.
Fergus Estuary and	National	This site is directly adjacent to the area of works,

[100] NRA (2009). *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes*. National Roads Authority. Available at: https://www.tii.ie/technical-services/environment/planning/Ecological-Surveying-Techniques-for-Protected-Flora-and-Fauna-during-the-Planning-of-National-Road-Schemes.pdf]

Key Ecological Features	Importance	Rationale
Inner Shannon North pNHA		overlaps the Lower River Shannon SAC and is designated for the same habitats and species so it is considered to be of equivalent ecological value and is therefore covered by SAC assessment.
Inner Shannon Estuary South pNHA	National	This site is 1.5km downstream of the area of works, overlaps the Lower River Shannon SAC and is designated for the same habitats and species so it is considered to be of equivalent ecological value, and is therefore covered by SAC assessment.
Habitats and Flora		
River Shannon/Shannon Estuary	International/National/Local	The River Shannon /Shannon Estuary, being the principle watercourse in the locality and the longest river in Ireland, is considered to be locally, nationally and internationally important. Despite modifications to the river and a high level of social, commercial and industrial activity it supports a large variety of floral and faunal species and is internationally designated.
Estuarine and Intertidal mudflats	International/local	Given that Estuarine and Intertidal habitats are Qualifying Features of the Lower River Shannon SAC as they support a variety of species while being ecologically important in their own right, areas containing this habitat are considered to be of equivalent ecological value to the Natura 2000 site. These feature (habitats) are carried forward into the design mitigation and impact assessment sections.
Abbey River	International/local	The Abbey River, encloses the east side of King's Island and is hydrologically interlinked to the Lower River Shannon SAC, therefore, it is considered to be of equivalent ecological value. This feature (habitat) is carried forward into the design mitigation and impact assessment sections.
Marsh	International/local	Marsh habitat occurs on a floodplain within the SAC and, as it is supporting habitat to the Shannon and Abbey rivers, it is considered of International and local importance. This feature (habitat) is carried forward into the design mitigation and impact assessment sections.
Grasslands	Local	The grassland types within the proposed scheme include Amenity Grassland, Wet Grassland and a thin strip of Dry meadows and grassy verges habitat. Amenity grassland is of no ecological importance, and Dry meadows and grassy verges are considered of relatively low biodiversity value on King's Island. These habitats are not considered further in this assessment. Wet grassland is considered to be of Local importance and this feature (habitat) is carried forward into the design mitigation and impact assessment sections.
Woodland	International/local	Alluvial woodland, present along the banks of the River Shannon on the edge of Kings Island is patchy and at risk from anthropogenic impacts at this location. As this is a priority habitat and one of the qualifying features of the SAC it is considered Internationally important. This feature (habitat) is carried forward into the design mitigation and impact assessment sections
Urban Environment	Local (lower)	The heavily developed nature of Kings Island results in its assessment of being of less than local ecological value and is not considered further in this assessment
Drainage ditches	National/Local	There are a number of drainage ditches on King's Island, one of which supports the protected species Opposite-leaved Pondweed. Ditches on the proposed site are therefore considered of national and local importance, and this feature (habitat) is carried forward into the design mitigation and impact

Key Ecological Features	Importance	Rationale
		assessment sections
Opposite-Leaved Pondweed	National/local	The protected species Opposite-leaved Pondweed is present in a ditch on King's Island. The species is listed as 'Near Threatened' on the Irish Vascular Plant red List (Wyse Jackson et al., 2016)[101] and is protected under the Flora (Protection) Order, 2015. It is considered of National and local importance. This feature (species) is carried forward into the design mitigation and impact assessment sections
Mammals		
Otter	Regional / County	Otter are listed on Annex IV of the Habitats Directive and also on the Wildlife Acts. It is considered that the River Shannon contains a population of Otter and although not recorded as present on Kings Island during the surveys, may use it for foraging and commuting. The Otter population within the scheme are therefore, considered to be of regional / county importance. This feature (species) is thus carried forward into the design mitigation and impact assessment sections.
Badger	Site	Badger was recorded during 2019 along the southern boundary of the marsh habitat. Badger is protected by the Wildlife Acts. It is considered likely that this species will be affected by unmitigated development activity. This feature (species) is thus carried forward into the design mitigation and impact assessment sections.
Bats	Regional / County	All four of the bat species recorded feeding and commuting through/within the site (Common Pipistrelle, Soprano Pipistrelle, Daubenton's Bat and Leisler's Bat), are considered common bat species. Despite the lack of bat roosts within the current flood defence walls, ecology and presence of these species indicates that both the terrestrial and aquatic environment on Kings Island are important foraging and commuting routes for bats. This emphasises the importance of these habitats for the suite of bat species recorded on-site. In view of the nature of the species recorded, their legal protection and the numbers of the commoner species present, the populations within this scheme are considered to be of Regional / County importance. This feature (species) is carried forward into the design mitigation and impact assessment sections.
Birds		
Overwintering wetland birds	International	Given that River Shannon and River Fergus SPA is primarily designated for its overwintering wetland bird populations, this group of species is considered to be of equivalent ecological value and international importance. This feature (species) is carried forward into the design mitigation and impact assessment sections.
Other bird populations	Local (higher)	The scheme provides some habitats to a range of common bird species and so the valuation of local importance is applied. The riverbank area is considered to be of higher local value due to the suitability of habitat for the Red listed - Grey Wagtail, the Important Riparian Bird species - Dipper and the potential for the Annex I species - Kingfisher to use the area. This feature (species) is carried forward into the

[101] Wyse Jackson, M., FitzPatrick, Ú., Cole, E., Jebb, M., McFerran, D., Sheehy Skeffington, M. & Wright, M. (2016) Ireland Red List No. 10: Vascular Plants. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Dublin, Ireland [Available at: https://www.npws.ie/sites/default/files/publications/pdf/RL10%20VascularPlants.pdf]

Key Ecological Features	Importance	Rationale
		design mitigation and impact assessment sections.
Fish		
Salmon and lamprey	International, local	The River Shannon and Abbey River are productive rivers for Salmon and lamprey species, which are qualifying interests for the Lower River Shannon SAC. In view of their protected status the populations within this scheme are considered of International and local importance. This feature (species) is carried forward into the design mitigation and impact assessment sections
Brown Trout, European Eel and Smelt	National, local	Suitable habitat for Brown Trout, European Eel and Smelt occurs in the Abbey and Shannon rivers. Considering their conservation status populations at the proposed site are considered of national and local importance. This feature (species) is carried forward into the design mitigation and impact assessment sections.
Sticklebacks and course fish	Local	Suitable habitat for sticklebacks and course fish occurs in ditches on King's Island. In view of local biodiversity these features are carried forward into the impact assessment and mitigation sections.
Invertebrates		
Bees	Local	Extensive nesting habitat for solitary bees was found in sandbags along the top of the embankment wall during the 2019 surveys. Bees are in decline nationally. This habitat is considered of local importance. This feature (species) is carried forward into the design mitigation and impact assessment sections

King's Island is subject to both pluvial and fluvial inputs and while there are some groundwater inputs, surface water inputs dominate. The Lower River Shannon SAC, an EU Designated Natura 2000 site, is hydrologically linked to the proposed works with a potential for land, air, and surface and ground water impacts. Some of the qualifying interests of River Shannon and River Fergus Estuaries SPA use King's Island and these species could also be impacted by the proposed works.

These qualifying interests will be assessed separately under the requirements of the Habitats Directive and Articles 6(3) and 6(4) of the Habitats Directive which have been transposed into Irish legislation by means of the Habitats Regulations, 1997 (S.I. No. 94 of 1997) and the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 / 2011). Therefore, a Natura Impact Statement will accompany this EIS to address potential impacts on Lower River Shannon SAC and River Shannon and River Fergus Estuaries SPA.

Other protected sites in the zone of influence of the Kings Island Flood Relief Scheme include Fergus Estuary and Inner Shannon Estuary North pNHA and Inner Shannon Estuary South pNHA, proposed Natural Heritage Sites (pNHAs) which are located in, or within 2km of, the Scheme. These are designated for the same habitats and species as Lower Shannon SAC, so they are considered to be of equivalent ecological value, and are therefore covered by SAC assessment.

Non-native invasive species are not an ecological receptor that require an assessment of value, they will however be considered throughout this assessment in terms of management as a negative indicator for ecological receptors. Invasive species can spread easily and compete with native species and they are prevalent on this site.

8.4.2 Identification of Potential Sources of Impact

This section examines the potential sources of impact that could potentially result in adverse effects on the biodiversity and protected habitats and species that occur within the zone of influence of the propose scheme. These potential sources of impact could arise during both the construction and operational phases but require complete source > pathway > receptor changes for adverse impacts to arise.

Physical Damage

Physical damage includes degradation to, and modification of, protected habitats. It can occur in working areas and along access routes where construction works are undertaken, and it may be temporary or permanent.

The construction of the flood defences around Kings Island could potentially result in direct physical damage to the designated habitats should works encroach within the boundaries of these habitats. The footprint of the construction works, which will be slightly greater than the finished footprint of the defences may encroach on the Lower River Shannon SAC in the area of the flood plain at the north east King's Island, resulting in potential physical damage to adjacent marsh habitat. Works at the north western outfall could impact riparian woodland.

Changes in Physical Regime

This source of impact may result in changes to physical processes that can alter the present characteristics of the SAC and SPA (e.g. estuarine, fluvial and geomorphological processes, salinity levels, tidal regimes, erosion, deposition, sediment transport and accumulation).

Changes in Hydrological Regime

Certain activities may result in changes to the current hydrological regime. For example, a reduction or increase in the frequency, extent, duration and/or depth of flooding may affect estuarine, riverine and floodplain habitats. Activities which may affect surface and groundwater levels, such as impoundments or defence construction, may also have adverse impacts on water dependant habitats and species.

Disturbance (noise, visual)

A number of activities can result in disturbance, including visual and noise. This is more frequently associated with construction activities but could also be associated with some aspects of the operational phase (e.g. structure maintenance, public access). Disturbance can cause sensitive species, such as birds, to deviate from their normal, preferred behaviour, resulting in stress, increased energy expenditure and, in some cases, species mortality.

Changes in Water Quality

A number of activities can impact upon water quality, in particular nutrient status and turbidity levels. For example, inundation of contaminated/nutrient enriched land and sediment mobilisation can all impact on water quality. This can adversely impact on habitats and also species, for example by impacting upon macroinvertebrate communities.

Pollution

Certain activities, in particular construction works, may lead to the release of pollutants into water, air or the ground. This can impact upon habitats directly and also the species they support.

Invasive Species

Invasive species have legal implications if left untreated, including Japanese Knotweed, Giant Hogweed, and Himalayan Balsam. They can spread rapidly over suitable habitat, including riverbanks, wetlands or disused waste land.

8.5 Predicted Impacts

Impacts associated with the proposed works have been defined and their significance assessed in relation to their implications on ecological features, defined in terms of their geographical extent (Table 8-12).

8.5.1 Construction Phase Impacts

The key construction phase impacts assessed are:

- Habitat loss/disturbance;
- Species loss (Flora);
- Disturbance to faunal species; and

- Reduction in water quality.

Potential direct and indirect impacts are discussed in detail below. Where potentially significant adverse impacts are identified, avoidance and mitigation measures are proposed to offset these impacts.

The description of the proposed FRS is seen in Chapter 4 and the Outline Construction Method Statement is described in Appendix A.

Construction Phase Impacts in relation to the Lower River Shannon SAC

Lower River Shannon SAC surrounds King's Island and includes most of the marsh area at the north east of the island. The works will take place largely outside the boundary of the SAC in the northern part of King's Island; The existing sandbags, footpath, and concrete plinth along the western embankment, which is also along the SAC boundary, will be removed and proposed embankment will be located inside the existing embankment. The proposed embankment works here will therefore be outside the SAC. The proposed eastern embankment will be located at the boundary of the SAC bordering the marsh habitat, but again outside the SAC. A concrete wall to the west of the creche is again just outside the boundary of the SAC. Works on the quay walls are also at the boundary of the SAC.

However, works will take place within the SAC at four locations:

- At the north west end of King's Island where sheet piling will be cut (albeit outside the marsh habitat).
- Within the marsh area of the SAC to the east of St Mary's Estate where an existing shallow drain will be deepened and widened.
- At the north west of the site where a proposed storm outfall with non-return valve will bring drainage water from the new channel/swale (for Opposite-leaved Pondweed) to the River Shannon. Works here will also incorporate a new access ramp/path for fishermen to existing moorings.
- Within the Abbey River at Area A9 and Shannon River B3, where jack-up rigs will be temporarily located.

These works and their impacts are described in the sections below along with other elements of the works having impacts.

8.5.2 Construction Impacts 1: Habitat Loss/Disturbance

Riparian/alluvial woodland

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

The proposed flood defence scheme entails considerable construction activity on King's Island, including movement of machinery and workers on the embankments and flood defence walls. Alluvial woodland within the River Shannon SAC is located adjacent to the embankments and walls and is at risk of being damaged from disturbance.

Characterisation of unmitigated impact on the feature

A proposed outfall pipe into the River Shannon will be constructed to the north west of the island. This will require excavating through the original embankment and extending the pipe through an area of river bank within the SAC to the outfall point into the River Shannon. A 50m replacement fisherman's path (of which 25m will be within the riverbank area of the SAC) will allow access from the path on top of the embankment to existing mooring points along the River Shannon in Area 3 between Ch. 0+850 and 0+950. The proposed path will require excavations 600mm deep and 3m wide, with an additional 500mm either side of path for a battered slope to stabilise the excavation.

Riparian/alluvial woodland is located on the riverbank side of the embankment to the north of the works and could be damaged by encroachment of the works.

Rationale for prediction of effect

Vegetation clearance and excavations could damage the plants and root structure and reduce the area of riparian/alluvial woodland

Effects without mitigation

Damage to Alluvial woodlands will cause a significant effect at an international level.

Marsh

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

Construction of the proposed eastern embankment will take place during a two year period along the boundary of the Lower River Shannon SAC adjacent to the flood plain/marsh habitat. Marsh habitat both within and outside the River Shannon SAC will be disturbed to facilitate construction of the embankment. This habitat is not a qualifying interest of the SAC but it supports the Estuaries habitat within the Shannon River SAC.

The cutting of sheet piling, if carried out from the marsh side of the piling, could also impact the marsh.

Characterisation of unmitigated impact on the feature

The construction of the proposed eastern embankment does not follow the existing embankment but will be located to the east of the housing estate (St Munchin's Street) between the back of the houses and the SAC boundary. Because of the constricted nature of the area between the back of the estate housing and the boundary of the SAC, works during the construction phase will encroach into the SAC. Without mitigation this will lead to permanent loss and physical damage to marsh habitat on the floodplain. Runoff from earth works on the proposed eastern embankment will also reach the marsh habitat causing change in makeup of soil structure and species composition.

The cutting of sheet piling, if carried out from the marsh side of the piling will result in machines ploughing up the soft soil and disturbance to the marsh habitat.

Works also intend to extend two open drains on the marsh habitat to the proposed head wall of the filter drain on the west side of the proposed eastern embankment. These will be fitted with non-return valves. This will allow water draining off the west side of that embankment to drain into the flood plain/marsh habitat. This will require a slight widening (to 2.5m) and deepening (0.5m) of a section of two pre-existing open drains by JCB across grassland and marsh habitat resulting in a temporary physical impact on the marsh/ditch habitat. The northern drain will be approximately 50m in length and 45m of that will be through the SAC. The southern drain will be approximately 20m in length and will not extend into the SAC. The area of marsh temporarily affected by the widening and deepening of drains is likely to be approximately 275m², with 112.5 m² of that within the SAC.

Rationale for prediction of effect

The importation of large amounts of fill material and the use of large machines for the construction of the proposed embankment will encroach on the marsh habitat along the edge of the SAC causing material to spill over onto the habitat and machines to plough up the soil and vegetation. This will cause an increase in the flood plain level and effect the rise and fall of the flooding regime and vegetation composition of marsh.

Marsh is distributed widely in Ireland. The area of marsh habitat on the flood plain, is approximately 12ha and acts as a supporting habitat to the Shannon and Abbey Rivers. There will be some loss of marsh habitat to the embankment (7,082 m² or 5.85%) as agreed in consultation with NPWS, where this marsh area is above the flood level. This area of marsh is relatively higher than the remaining lands, 2.4mOD against 1.8-2mOD and will not impact on the functioning of the marsh environment.

The widened and deepened drains on the flood plain will revert to marsh and those works will result in an imperceptible impact.

Effects without mitigation

The design of the proposed embankment will not impinge on the functioning of the flood plain but mitigation must be put in place during construction to prevent works extending into areas outside the embankment boundary. Unfettered access and addition of new soil material will affect the level of flood plain and flooding regime and cause a change in vegetation composition of the marsh habitat, with a significant effect at an international level.

Treeline/scrub, wet grassland and ditches

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

Wet grassland, treeline/scrub and ditch habitat will be lost during the construction of the proposed western and northern embankments. The proposed embankment will be constructed inside the existing embankment resulting in a treeline being removed, the ditch being infilled, and the wet grassland being covered by the proposed embankment. A ditch on the eastern side of the island between the proposed new all-weather pitches and the existing embankment is also due to be infilled.

The ditch at the north of the island supports the protected species Opposite-leaved Pondweed. The loss of the ditch (and possibly the adjoining wet grassland) and the biophysical changes brought about, will have a profound impact in terms of ecosystem structure and function on the supporting habitat for this protected species.

Characterization of unmitigated impact on the feature

Loss of treeline/scrub habitat (length approximately 240m) will be restricted to that growing between the footpath and the ditch on the proposed western embankment. The loss of ditch along the base of the embankment on the west/north side of King's Island extends to 760m. The loss of the area of wet grassland to the south of this ditch is approx. 11,960m². The loss of the ditch to the east of the proposed all weather pitches is 310m in length.

Rationale for prediction of effect

Tree lines/scrub habitat of the type due for removal is distributed widely locally and in Ireland. It is considered that effects to treeline/scrub habitat are discrete and wholly reversible.

Ditches and wet grassland are also common features widely distributed locally and in Ireland. However, the hydrology of the western ditch and associated wet grassland is unusual in that it is fed by surface and groundwater and supports the protected species Opposite-leaved Pondweed.

Effect without Mitigation

The extent of treeline/scrub and wet grassland habitat loss arising from this project is considered to be of reversible short-term significance at a local level. However, the loss of the western ditch is assessed as having a significant impact at a national level due to its association with the protected species Opposite-leaved Pondweed. Without adequate design of land area adjacent to new channel there is potential loss of natural gradient of habitats from watercourse to drier grasslands, leading to significant impact of loss of wet grassland habitat and local biodiversity at a local level.

8.5.3 Construction Impacts 2: Species Loss (Protected Flora)

Opposite-leaved Pondweed - *Groenlandia densa*

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

The permanent infilling of the ditch at the base of the western embankment to enable the construction of the proposed embankment inside the old one, will result in the loss of the only population of the protected species Opposite-leaved Pondweed on King's Island. The species requires particular conditions in which to survive which are not available in the other ditches and watercourses on King's Island (Denyer, 2017)[102].

Characterisation of unmitigated impact on the feature

Infilling of the ditch will result in the complete loss of the population of Opposite-leaved Pondweed on King's Island.

Rationale for prediction of effect

[102] Denyer, J. (2017) King's Island *Groenlandia densa Survey, June 2017. Unpublished report*

Opposite-leaved Pondweed is a protected species and only occurs in one section of ditch on King's Island. It was known to occur in Limerick's Park Canal to the south east of the site (though it has not been recorded there since 2006), in a small area to the south of the King's Island by O'Callaghan's Strand (NBDC) and in other areas of Limerick (Reynolds, 2013)[103]. As this is the only population of Opposite-leaved Pondweed on the island, the infilling of the ditch will result in the loss of this species in the area.

Effects without mitigation

The permanent infilling of the ditch and subsequent loss of this species on King's island will result in a significance impact at local and national level.

8.5.4 Construction Impacts 3: Disturbance to Species

Otter

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

Construction phase over a two-year period will include noise/vibration disturbance during the day, and the site may require additional lighting at night at times. Though no confirmed Otter field signs were noted during the surveys; the habitat of the river bank offers suitable commuting routes and resting areas for Otter and they are known to occur in the Lower River Shannon. Any reduction in Otter activity could impact on the success of local populations.

Characterization of unmitigated impact on the feature

Ecological impacts to Otter will be through disturbance from noise from machinery removing sandbags, footpath, and concrete plinth along the western embankment adjacent to the riverbank, and any additional lighting required at night during the construction phase of project.

Rationale for prediction of effect

Increased urbanisation, noise and light pollution can reduce the activity level of Otter and can negatively impact on commuting routes. The river area provides a suitable habitat in terms of foraging value. Lighting during the hours of darkness will reduce the quality of foraging for locally based Otter.

Effects without mitigation

The unmitigated effect from noise disturbance and from any additional lighting required during the construction phase will result in minor temporary impacts to species of high local sensitivity and importance. Otter are mobile and can move away from disturbance. However, Otter are protected under the Irish Wildlife Acts (1976 – 2012) and are also listed on the EU Habitats Directive. As such, there is an identified, potential for a breach of relevant legislation. Noise disturbance and additional lighting required for working at night will have a significant though short-term level of impact on Otter at a local level.

Badger

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

Construction phase will entail construction of new embankment to the south of marsh habitat. Badger activity has been noted here, and mammal holes indicate a potentially active or outlier sett. Disturbance of badger setts and foraging habitat during the construction phase could negatively affect the badger population in this area and give rise to a negative impact for the local badger population through the following mechanisms:

- Loss of the treeline and vegetation which are a seasonal habitation and foraging area for the species.
- Disturbance to Badger sett, with collapse of underground passageways from weight of new embankment material. Increased noise and human activity along the boundary area and within the site during the period of the proposed works.

[103] Reynolds, S. (2013) *Flora of County Limerick*. National Botanic Gardens

Characterization of unmitigated impact on the feature

Embankment works in the vicinity of the Badger sett will result in damage to the sett and disturbance to the Badger population. This is the only recorded sett on King's Island, though it is deemed a probable outlier due to its location in an area prone to flooding. Three sighting of Badger within 3km of King's Island have been recorded on the NBDC website.

Rationale for prediction of effect

Heavy machinery can disturb the tunnel systems if within 30m of a sett. Given the limited resources for other undisturbed habitat suitable for setts within King's Island, it is considered important to ensure that resident existing populations are accommodated at a self-sustaining level.

Effects without mitigation

Embankment works in the vicinity of the badge sett will have a significant short to long-term impact on resident Badger population at a local level. Badger are protected under the Irish Wildlife Acts (1976 – 2012). As such, there is an identified potential for a breach of relevant legislation

Bats

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

Construction phase over a two-year period may require additional lighting at times. Despite the lack of bat roosts within the current flood defence embankments, the presence of bats in the area indicates that King's Island is important for commuting routes and foraging for bats. Any reduction in bat activity could impact on the success of local populations.

Characterization of unmitigated impact on the feature

Potential ecological impacts to bats are likely to be through disturbance from any additional lighting required at night during the construction phase of project.

Rationale for prediction of effect

Increased urbanisation and light pollution can reduce the activity level of bats and can negatively impact on selection of flight routes. The river area provides a suitable habitat in terms of foraging value. Lighting during the hours of darkness will reduce the quality of foraging for locally based bats.

Effects without mitigation

The unmitigated effect from additional lighting required during the construction phase will result in minor short-term impacts to species of high local sensitivity and importance. All bat species are protected under the Irish Wildlife Acts (1976 – 2012) and they are also listed on the EU Habitats Directive. As such, there is an identified, potential for a breach of relevant legislation. Any additional lighting required for working at night will have a significant though short-term level of impact at a local level.

Wintering Waterbirds

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

Construction works along the boundary of the designated site will generate noise/vibration and disturbance as a result of machinery operation and workforce movement during the two year phase of the project. This will impact upon the wintering waterbirds using the flood plain area of the site and the areas of amenity grassland fronting Oliver Plunkett St. Based on bird surveys and best scientific judgement it is assumed these birds are most likely part of the populations of wintering waterbirds designated as part of River Shannon and River Fergus SPA. During cold spells in the winter the effect of disturbance on these birds could be particularly severe, resulting in increased stress and additional energy expenditure.

Characterisation of unmitigated impact on the feature

If works were to take place in the winter months during times of flooding, disturbance from construction works is likely to cause the displacement of wintering birds from the flood plain area. Wintering bird surveys identified some bird species that are listed as conservation interests of the

SPA within the vicinity of the working area of the project; Tufted duck, Gadwall, Coot and Whooper Swan.

Rationale for prediction of effect

The effect of noise/disturbance arising from works near the area of flood plain will be temporary and carried out in two phases. Connections of proposed embankment filter drains to two open drains will be done prior to the construction of the proposed eastern embankment. This will have to be done during a period when the marsh habitat is not under water and, as water birds are not likely to be there then, no significant impacts are predicted.

However, disturbance during construction of the proposed eastern embankment will entail movement and noise from machinery and construction workers. This will have having a significant but short-term impact on wintering water birds if present during periods of excess water on the flood plain.

Effect without Mitigation

The impact of disturbance on wintering birds is assessed as significant on an International level.

Breeding birds

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

The potential for ecological impact to the breeding bird group is largely due to vegetation and habitat removal (treelines, scrub clearance) prior to construction of new embankments.

Potential effects to bird species include a negative biophysical effect to vegetation availability which may disturb breeding birds, their nests and reduce available forage.

Characterization of unmitigated impact on the feature

The construction of the proposed western embankment will require the removal of the treeline and scrub adjacent to the path along the north of Kind's Island and along ditch to south of flood plain, with potential discrete loss of nests and available nesting and foraging habitat to local terrestrial birds. These do not include Grey wagtail, Kingfisher and Dipper which are associated with river habitat and will not be affected by the works. Noise and vibration are not seen as likely impacts on breeding birds as removal of treeline/scrub will have temporarily reduced the limited areas of vegetation for breeding birds in any case.

Rationale for prediction of effect

It is considered that effects to treeline and scrub are discrete and wholly reversible. Minor losses of foraging and breeding treeline habitat are unlikely to cause stress to this group given the abundance of habitat (riparian/alluvial woodland) within the local setting. On a precautionary basis, it is considered likely that this temporary impact will negatively affect the local bird population.

Effects without mitigation

The unmitigated effect to this feature will result in a short-term impact to species of low-medium local sensitivity and importance. The majority of bird species are protected under the Wildlife Acts (1976 – 2012) where it is an offence to hunt, interfere with or destroy their breeding or resting places unless authority is obtained via statutory licence provision.

Mining Bees

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

The removal of sandbags along the length (approx. 1km) of the western embankment will cause destruction of suitable habitat for mining bees.

Characterization of unmitigated impact on the feature

Removal of sandbags will result in destruction of any bee nests including solitary bee larvae within the sand. Adult female bee makes a nest, lays eggs and provides honey and pollen food supply. She then dies with onset of cold weather. Bee larvae overwinter in nests and emerge in early spring.

The young bees must fend for themselves (solitary bees). Bees mate and the cycle starts again. The adults may only live for two weeks (NBDC, 2019)[104].

Rationale for prediction of effect

Nearly half of solitary bee species are in decline nationally. Habitat loss is one of the main causes of decline in bee populations.

Effects without mitigation

The impact on solitary bee population is assessed as a short-term impact on species of local importance.

Fish - Juvenile Lamprey

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

During the upgrading of the flood defence walls a jack-up rig will be temporarily deployed in the Abbey River and Shannon River at Areas A9 and B3 respectively. Both these areas of the rivers are within the Lower Shannon SAC.

The legs of the rig (1.5m x 1.5m base plate) will be placed on the riverbed in order to provide support to the rig. The rig itself will be approximately 12m wide x 20m long. As the works progress the rig will be moved along the defence walls, requiring the legs to be repositioned. The length of walls affected are 37m at Area A9 and 300m at Area A3. Works at A9 on the Abbey River in front of the Absolute Hotel requires 2x setups with duration of works of 2-3 months, resulting in approximately 18m² area of substrate being affected. Works at B3 on the Shannon River in front of the Court House requires 3x setups, with duration of works 5-6 months, resulting in approximately 27m² area of substrate being affected.

The whole area beneath the rig will not be affected, only that beneath the leg base. The pressure from the legs base will compress the sediment and impact on any burrowing juvenile lamprey species present. Juvenile lamprey or ammocoetes live as burrowing filter feeders in the sediment for up to five years or more. Lamprey play a role in river ecosystems both biologically (nutrient recycling) and physically, where they are considered 'ecosystem engineers'. They are therefore an important element of river/estuarine ecosystem structure and function. Three species of lamprey are qualifying interests of the Lower River Shannon SAC.

Adult lamprey, Salmon, Brown Trout, European Eel and Smelt will not be significantly impacted by jack-up rig as they can swim around the legs of the rig. They will be impacted by any reduction in water quality, which is discussed in Construction Impacts 4: Water Quality.

Characterisation of unmitigated impact on the feature

Whilst the launch site and jack-up rig will be temporary, they could result in the loss/damage of juvenile lamprey living in the sediment of the river bed. As juveniles live for up to five years in the sediment, several years of lamprey cohorts could be damaged at once.

Rationale for prediction of effect

Lamprey are known to occur in the Shannon and Abbey Rivers (Lower Shannon SAC) as does sediment habitat suitable for juvenile lamprey. Though the footprint of the legs of the jack-up rig is relatively small against the area of the river base, the potential damage to several cohorts of juvenile lamprey at once make for greater sensitivity of the species. The location of the rig legs 12m out from the flood walls in the Abbey River is in deeper water, with less suitable substrate for juvenile lamprey due to high current velocity. It is unlikely that jack-up rigs will therefore affect 9m² of mid-river substrate under the feet bases. Overall the area that will be affected is 9m² at Area A9 and 27m² at Area B3.

Effects without mitigation

The effect of the damage to lamprey habitat, though small in size (36m^2), could result in a negative effect on several years of juvenile cohorts, resulting in a significant impact at an International level.

[104] National Biodiversity Data Centre (2019) The State of Ireland's Bees. [Available at; http://www.biodiversityireland.ie/wordpress/wp-content/uploads/The-state-of-Irelands-Bees.pdf]

Sticklebacks, Coarse Species and European Eel

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

The draining and permanent infilling of the ditches (at the base of the proposed western embankment and to the east of Star Rovers pitches) to enable the construction of the new embankment inside the old one, will result in the loss of any extant fish (sticklebacks, coarse fish) or Eels within these waterbodies.

Characterisation of unmitigated impact on the feature

Infilling of the ditches will result in the loss of any fish or Eels in the ditches.

Rationale for prediction of effect

Until 2014 the western ditch was connected with the ditch on the east side of King's Island, which has an opening to the Abbey River. This would have permitted fish and Eels to enter the western ditch, and thus become trapped after closure of the connection. The ditch is unlikely to be of value to any fish species apart from stickleback, coarse species and European Eel. European Eel are considered of special conservation value and thus are an important species to salvage from the ditch habitat.

Effects without mitigation

Without mitigation there will be a significant impact on European Eel at a local and national level.

8.5.5 Construction Impacts 4: Water Quality

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

During site preparation, the excavation and construction of proposed embankments, paths and new drainage system, and the upgrading of the flood defence walls, there is potential for accidental release of suspended solids, nutrients and pollutants into the groundwater and watercourses within King's Island and associated habitats over the two-year construction period. Ditches, channels and areas of floodplain will act as pathways for contaminated material to reach the designated Lower River Shannon and Abbey Rivers, thus affecting the water quality of the rivers and Shannon.

Mudflats and sandflats habitat, also a qualifying interest within the Shannon Estuary, will also be impacted by silt runoff and pollutants.

The potential for ecological impact to receiving surface and groundwater receptors, in the absence of mitigation focuses on the following factors:

- Groundwater effects;
- Surface water effects;
- Direct effects on the adjacent rivers including water quality deterioration due to release of discharge from site containing high levels of sediment, or due to accidental spills and possible knock-on effects for aquatic species that are reliant on high water quality;
- Significant repair works such flood defence wall installation or reparation works may give rise to the release of suspended solids downstream;
- Pollution spills – potential oil, fuel or other pollutant spillages may impact aquatic animal species within receiving waters, causing mortality or other sub-lethal effects such as reduced juvenile recruitment rates and / or juvenile survival;
- Sedimentation - deposition of silt can alter the mud/sand substrate, smother fish eggs, fry and benthic macroinvertebrate communities (food sources for fish and Otter);
- Other indirect impacts may occur on species that forage in the River;
- Increased macrophyte and algal growth – causing oxygen depletion, alteration of invertebrate / fish populations which serve as food sources, vegetation changes causing alterations to fish habitats;
- Impacts of dust and site runoff (sediments, fuel, etc.);
- Impacts on groundwater from site construction works;
- Potential Release of Hydrocarbons / Chemicals;

- Potential Release of Cement-Based Products; and
- Groundwater and Surface Water Contamination from Wastewater Disposal.

Accidental spillage during refuelling of plant with petroleum hydrocarbons is a significant pollution risk to groundwater, surface water and associated freshwater/estuarine and terrestrial ecosystems. Hydrocarbon compounds are highly toxic to all flora and fauna, including fish, and do not break down readily in the environment. Chemicals such as paints and detergents also pose a threat to the aquatic environment.

Characterisation of unmitigated impact on the feature

The characterisation of unmitigated impacts uses the 'worst case' impact magnitude scenario in all cases. Impacts could be direct, indirect and/or cumulative e.g. release of suspended solids over time. Impacts could potentially be mitigated by dilution e.g. hydrocarbon spills and effects may be considered to be reversible depending on the severity of a pollution incident.

Rationale for prediction of effect

The lack of outfalls from the site to the Shannon and Abbey Rivers limits the potential impact on water quality of these watercourses from works inside the old embankments. There is only one outflow (Green Lady) to the Abbey River from the ditch on the east side of King's Island. Runoff from the site will have to cross the floodplain/marsh habitat and enter the ditch before entering the Abbey River through the outfall channel. During flood events, when the marsh area is covered in water, silt or pollutants are more likely to be retained in the marsh habitat area.

The two outflows on the west side of King's Island are closed off at present and this will limit any pollution impacts from the western side of the island during construction. However, there is one location where a new outfall from the new swale will require excavation through the western embankment and through an area of riverbank within the SAC to allow the pipe to reach the River Shannon. This will require excavation to 2m depth through the original embankment, with dimensions of 2m at base, widening to 5m at the top. In this location it is planned to construct a 50m length replacement fisherman's path from top of embankment to the river edge where existing moorings exist. Both these operations have the potential to temporarily expose bare soil on the river bank, where surface water runoff with suspended matter could directly impact on the water quality of the Shannon River.

After the filter drains have been connected to the outfalls, and prior to the embankments and grassland areas being revegetated, runoff from bare soil will enter the filter drains and bring suspended matter into the river. The central structural core of the embankment will comprise an impermeable clay which will prevent any leachate contributing to runoff in the long term once revegetation has taken place.

The cutting of the sheet piling, which is within the SAC to the north of the marsh and adjacent to the riverbank of the Abbey River, will take place from the river side of the piling to prevent damage to the marsh. However, access to cut sheet piling requires movement of machinery and excavation of soil 300mm either side of piling. Construction of new path (connecting paths on new western embankment to path of old eastern riverside embankment), will also require excavation of 350mm depth x 2.4 width of soil. These works will expose bare soil which, during inclement wet weather, could allow surface sediment to flow off the embankment directly into the Abbey River.

The replacement of concrete barriers with a 70m new concrete wall near Verdant Place crèche is directly adjacent to the riverbank of the Shannon River and is on the SAC boundary. The works also require piling. The river is therefore susceptible to impacts from surface runoff from disturbed soil and concrete spillages.

Excavation and removal of existing sandbags, footpath, and concrete plinth is to take place along the length (approx. 1km) of the western embankment which borders the riverbank of the SAC. The proposed embankment is higher than the existing embankment. The works will expose bare earth and if carried out during a period of wet weather could result in surface runoff of silt down a slope and across the riverbank into the Shannon River.

Decommissioning of old outfall at north west of island will involve removing pipe from existing drain and infilling the hole with soil. Exposure of bare soil could result in surface runoff of silt into water courses.

The upgrading of the flood defence walls along the southern part of King's Island involves cleaning vegetation from the face of the existing wall, removing loose mortar and pointing the existing wall with mortar. Any spillages of material from works or from machinery involved in works falling into the river will result in reduction in water quality.

Launch of jack-up barge, with transfer of machinery within, in a fast-flowing river prior to stabilisation and erection at areas A9 and B3, introduces risk of capsize and/or machinery falling into river and polluting water with oils/hydrocarbons.

Tidal and river flow will bring suspended particles and pollutants both upstream and downstream within the river/estuary. Due to the large volumes of water the Shannon River will have a dilution effect and it is assessed that likely significant effects will not reach beyond 2km downstream.

Effect without Mitigation

Polluting materials from accidental spills could enter the rivers/estuarine waters and have a deleterious effect on water quality and on the various community types living within the Annex 1 Mudflats and sandflats habitat, either through direct toxicity, smothering, or alteration of the mud/sand substrate.

Construction works can impact directly on fish populations through the direct mortality of adult cohorts and/or juvenile fish in addition to killing eggs on/or within river substrata should chemicals such as hydrocarbons or concrete be introduced into the water column. Indirect impacts can occur as a result of the smothering of spawning substrata with suspended solids making them unviable for spawning and thus reducing the longer-term prospects of survival for fish populations. Significant repair works such flood defence wall installation or reparation works may give rise to the release of suspended solids downstream.

The integrity of the SAC would be affected by reduction in quality of the habitats as well as impacts on the species that rely on them. It is likely that pollutants would be diluted as they moved within the estuary, and effects would not reach beyond 2km

The effect of a reduction in water quality during construction will be temporary, however any runoff or pollutants entering the water column could result in a significant impact at an International level.

8.5.6 Operation Phase Impacts

The key operation phase impacts assessed are:

- Disturbance to habitats
- Species loss (Flora)
- Disturbance to species
- Reduction in water quality

Potential impacts are discussed in detail below. Where potentially significant adverse impacts are identified, avoidance and mitigation measures are proposed to offset these impacts.

8.5.7 Operation impacts 1: Disturbance to Habitats

Marsh

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

The proposed flood defence scheme involves the construction of new embankments on the north of King's Island. Upon completion the new embankments will not encroach within the boundary of the Lower River Shannon SAC. During operation any disturbed area of marsh at the boundary of the SAC and the widened and deepened drains will be left to revert to marsh habitat.

Characterisation of unmitigated impact on the feature

The disturbed area of marsh habitat along the boundary of the embankment and within the area of disturbed drains will revegetate naturally after flood events and revert to typical marsh flora.

Rationale for prediction of effect

The extent of the marsh habitat is dependent on hydrography and flood events. Hydrology for this area will remain the same as before the proposed works, with one outflow to the Abbey River. Runoff from the new eastern embankment will feed through filter drains into the drainage ditches on the floodplain. It is not expected that there will be any change to the hydrography of this area.

Effects without mitigation

There will therefore be a neutral impact on the designated site in terms of disturbance to habitat.

Ditch/New Channel/Swale

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

The proposed permanent channel /swale excavated inside the proposed western embankment to replace the original ditch will be excavated to similar depth, but greater width. The slope of the sides of the new channel is of a shallower angle than the original ditch. The location of the new channel is about 35m to the east of the original ditch, allowing for equivalent surface and groundwater inputs to the water course. The proposed channel will be allowed to revegetate naturally.

Characterisation of unmitigated impact on the feature

The channel, though wider and shorter than the original ditch, offers compensatory habitat. Once revegetated the habitat should succeed in supporting similar species to what was there previously.

Rationale for prediction of effect

Both watercourses are artificial and constructed in approximately the same location by similar methodology.

Effects without mitigation

The proposed channel should have a neutral to positive impact at a local level.

8.5.8 Operation Impacts 2: Species Loss (Protected Flora)

Opposite-leaved Pondweed

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

The permanent construction of a new channel/swale adjacent to the western embankment is planned as habitat for the translocated population of Opposite-leaved Pondweed to lead to successful re-establishment of this species.

Characterisation of unmitigated impact on the feature

A newly excavated channel in freshly dug, uncompacted soil and similar conditions of surface and ground fed water, with translocated population of Opposite-leaved Pondweed, may not necessarily lead to successful reestablishment of this species.

Rationale for prediction of effect

Hydrological and biological conditions may not match that of original ditch. The reestablishment of translocated populations of Opposite-leaved Pondweed is not always successful (Denyer, 2018)[105]. If left unmanaged, vegetation growth of other species within the new channel may obscure and create conditions unsuitable for the pondweed.

Effects without mitigation

Without mitigation the population of Opposite-leaved Pondweed may not succeed, leading to a significant impact at national and local level.

105 *Denyer, J* (2017) King's Island *Groenlandia densa Survey, June 2017. Unpublished report.*

8.5.9 Operation impacts 3: Disturbance to Species

Bats

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

The proposed permanent lighting scheme along the top of the new embankments will have an impact on local bat population commuting routes and foraging areas. Any reduction in bat activity could impact on success of local populations.

Characterisation of unmitigated impact on the feature

The pathway on the embankment around King's Island was not previously lit at night. The proposed lighting plan is designed to improve use and security of people using the path. This may interfere with bats using the river for commuting and foraging.

Rationale for prediction of effect

Increased urbanisation and light pollution can reduce the activity level of bats and can negatively impact on selection of flight routes. The river area provides a suitable habitat in terms of foraging value. Lighting during the hours of darkness will reduce the quality of foraging for locally based bats.

Effects without mitigation

The unmitigated effect of the proposed lighting plan will result in long-term impacts to species of high local sensitivity and importance. All bat species are protected under the Irish Wildlife Acts (1976 – 2012) and they are also listed on the EU Habitats Directive. As such, there is an identified potential for a breach of relevant legislation.

Wintering Waterbirds

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

Embankment maintenance operations on the eastern embankment and the presence of a new and potentially popular walkway, with consequent increase in public usage of the facility (e.g. walking/running, dog walking, birdwatching), will result in disturbance to wintering birds that utilise the flood plain area of King's Island to the north east of the Island. Disturbance can cause sensitive species to deviate from their normal, preferred behaviour, resulting in stress, increased energy expenditure and, in some cases, species mortality.

Characterisation of unmitigated impact on the feature

Wintering wetland birds use the marsh area of King's Island during periods of high water and flooding of the marsh habitat. The marsh floods gradually with water accumulating over periods of high tides and/or heavy rains resulting in a shallow water body suitable mainly for foraging for waterfowl. Protected birds such as Whooper Swans and also a number of Red and Amber Listed birds have been recorded when the marsh is flooded for long periods during winter.

At present the embankment and pathway runs along the eastern side of the floodplain, with trees blocking the view in places. The proposed works will result in the flood plain being completely enclosed by embankments, with public paths on top and easier public access to the marsh area.

Rationale for prediction of effect

Increased public usage of pathways and access to flood plain will result in greater disturbance to wintering waterbirds during flood events.

Effects without mitigation

Without mitigation waterbirds will be exposed to greater disturbance than experienced at present. Disturbance will be ameliorated to some extent by waterbird occurrence in winter coinciding with wet weather and flood events. However, impacts are assessed as significant at an International level.

Fish

Atlantic Salmon

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

The proposed permanent lighting scheme on King's island will have an impact on Salmon populations. Any light impinging on the water will attract fish and may cause them to delay passing through the area, impacting on normal migrations routes.

Characterisation of unmitigated impact on the feature

These sections of the Shannon and Abbey Rivers are resting areas for Salmon. Additional lighting may interfere with natural movement of Salmon and their migration and increase illegal fishing opportunities.

Rationale for prediction of effect

Studies have shown artificial light can impact on timing and path of migration of Atlantic Salmon (Stitch et al. 2015[106], Mueller and Simmons, 2008[107]).

Effects without mitigation

Long term significant impact at a local, national and international level.

8.5.10 Operation Impacts 4: Water Quality

Proposed activity and its duration, biophysical change and relevance to the feature in terms of ecosystem structure and function

Periodic maintenance of embankments or drainage scheme (i.e. clearing of build-up of silt) will contribute additional particulate matter to sensitive water courses.

Characterisation of unmitigated impact on the feature

Once embankments and open areas are revegetated there is less opportunity for silt runoff. However, over time, vegetation debris or silt may block drains and outflows. Maintenance work may result in silt being released to the Shannon or Abbey Rivers.

Rationale for prediction of effect

Drainage and maintenance requirements for the new embankments connect these areas to sensitive water courses within the SAC. Any silt/polluted runoff will end up in the local drains or channels within King's Island and will eventually reach the rivers via the filter drains and outfalls.

Effects without mitigation

Without mitigation there could be long term impact from runoff to sensitive water courses within King's Island (channel with Opposite-leaved Pondweed) and within the SAC (Shannon and Abbey rivers). These are assessed as a significant impact at local and national level and at International level respectively.

Non-native Invasive Species

The proposed flood relief scheme will involve movement of machinery and large volumes of soil and material on King's Island over a two-year period. Machinery contaminated with fragments of invasive non-native species brought in from outside of King's Island, or movement of machinery or soil from locations within the site that already have invasive species growing there, will result in the spread of invasive species within King's Island. This will result in additional impacts on the sensitive Annex 1 habitat Alluvial forest and other habitats such as marsh and wet grassland. Seeds of Giant Hogweed or small fragments of Japanese Knotweed can spread rapidly and be viable for a number of years resulting in an impact on the vegetation composition. The large leaves of Giant Hogweed shade out less vigorous native plants in its immediate vicinity, which results in decrease in the

[106] Stich, D.S., G.B. Zydlewski, J.F. Kocik, and J.D. Zydlewski. 2015. Linking behavior, physiology, and survival of Atlantic salmon smolts during estuary migration. Marine and Coastal Fisheries 7 (1): 68–86.
[107] Mueller, R.P., and M.A. Simmons. 2008. Characterization of gatewell orifice lighting at the Bonneville Dam second powerhouse and compendium of research on light guidance with juvenile salmonids, 1–55. Richland: Pacific Northwest National Laboratory.

biodiversity of the surrounding area. As a consequence of out-competing native riverside plants, river banks can be left bare in the winter and susceptible to erosion during spates and floods (Hüls, Otte, and Eckstein, 2007)[108].

8.6 Mitigation Measures

8.6.1 Construction Phase

Design Mitigation

This section describes the mitigation measures that have been incorporated at the design stage. A number of measures which follow generic best practice are proposed to mitigate the impacts of the proposed works on the ecological environment at the Site:

General

- All Site construction will be undertaken in accordance with the CIRIA (2015) Environmental Good Practice on Site (Charles and Edwards 2015);
- Mitigation described in this report will be followed during site construction and operation phases;
- There shall be no water abstraction from or discharges to Shannon River or Abbey River from the construction activities on the site;
- A site specific CEMP)will be written by the contractor prior to site works commencing. This CEMP will incorporate the mitigation measures listed here.

Site Compound

The site compound shall be located within the site boundary

- The compound will be sited as far from any water course (>50m) as possible in order to minimise any potential impacts.
- Only plant and materials necessary for the construction of the works will be permitted to be stored at the compound location.
- Site establishment by the Contractor will include the following:
    - i. Offices;
    - ii. Site facilities (canteen, toilets, drying rooms, etc.);
    - iii. Office for construction management team;
    - iv. Secure compound for the storage of all on-site machinery and materials;
    - v. Temporary car parking facilities;
    - vi. Temporary fencing;
    - vii. Site security to restrict unauthorized entry;
    - viii. Bunded storage of fuels and refuelling area. Bunds shall be 110% capacity of the largest vessel contained within the bunded area;
    - ix. A separate container will be located in the Contractors compound to store absorbents used to contain spillages of hazardous materials. The container will be clearly labelled, and the contents of the container will be disposed of by a licenced waste contractor at a licenced site. Records will be maintained of material taken off site for disposal;
    - x. A maintenance programme for the bunded areas will be managed by the site environmental manager. The removal of rainwater from the bunded areas will be their responsibility. Records will be maintained of materials taken off site for disposal;
    - xi. The site environmental manger will be responsible for maintaining all training records;
    - xii. The contents of any tank will be clearly marked on the tank, and a notice displayed requiring that valves and trigger guns be locked when not in use;

[108] Hüls, J., Otte, A. & Eckstein, R.L. Population life-cycle and stand structure in dense and open stands of the introduced tall herb *Heracleum mantegazzianum*. *Biological Invasions* (2007) 9: 799

xiii. Drainage collection system for washing area to prevent run-off into surface water system;

xiv. All refuelling of vehicles will be carried out at the fuel stores within the main site compound and only ADR trained personnel will be permitted to operate fuel bowsers.

Specific Design Mitigation

Alluvial Woodland

- Design mitigation will ensure location of new outfall at north west of site is not located within Alluvial forest habitat.

Opposite-leaved Pondweed

Conservation of Opposite-leaved Pondweed *Groenlandia densa* on King's Island has been discussed with NPWS (see Section 5.5.3 and Appendix C3-2). A licence for the translocation of the pondweed has been applied for (Appendix C3-3) and approved (Appendix C3-4) and the following mitigation applies:

- To conserve the population of Opposite-leaved Pondweed *G. densa* design mitigation includes the relocation of plant specimens to suitable watercourse habitats. This involves removal of pondweed plants from ditch habitat to a holding area and then translocation into a newly excavated channel and two other locations. Mitigation will follow the Methods statement in the Section 21 Licence Application (Floral Protection Order) for *G. densa* (Denyer, 2019)[109] (Appendix C3-3) and any additional agreements with NPWS. A licence has been granted by NPWS (see Appendix C4).
- All conservation work connected with *G. densa* and its habitat to follow and implement the strategies, methods and actions described in the report "Section 21 Application. *G. densa* Methods Statement. March 2019. Unpublished report to NPWS, in support of Section 21 Licence application prepared by Denyer Ecology", its two appendices A&B and the finalised detailed translocation plan (see below) and any subsequent modifications to these as may be proposed and agreed with the NPWS.
- The detailed translocation plan noted in sections 2.3.1 and 2.3.3 of the above report to be finalised in agreement with NPWS and incorporated with a finalised Methods Statement Report into a Conservation Management Plan for the species at the site, in advance of commencement of any of the works – this plan to include finalised details of actions to be undertaken and the order and timeline for these.
- Translocation of *G. densa* with storage should remain the prime method; although direct translocation should also be attempted if feasible.
- Translocation/enhancement of two other sites in or as near to King's Island as possible, as per NPWS instructions under licence. The option of using the upper parts of the drains on the east side of Kings Island will be considered for habitat translocation of some plants, if suitable habitat can be created there, as a first choice in habitat enhancement, rather than sites distant from King's Island. Sites outside of King's Island will have to be owned by LC&CC. Sites where Opposite-leaved Pondweed occur in Limerick are outlined in Reynolds (2013), *Flora of Limerick.* Five potential sites have been chosen by licence holder Jo Denyer. These are described below in Table 8-14 with their ranking (1 being the highest) and are also seen in Figure 8-14. There are two sites with a ranking of 1, Rossbrien ditch/ Ballynaclogh River and Ballynaclough River, east of Dooradoyle, which are the most likely sites for enhancement. If, after surveying, none of the five sites listed in Table 8-14 are feasible NPWS will be contacted for further advice on other suitable sites.
- The enhancement of two chosen sites for *G. densa* will be developed and monitored over three years. This will be carried out as a research project for scientific and educational purposes, and a report will be published after completion.

[109] Denyer J. (2019) Section 21 Application *Groenlandia densa* Methods Statement.

Table 8-14. Potential *G. densa* enhancement sites and ranking (1 being highest)

Site name	Limerick CC ownership	Grid reference	Date last recorded*	Notes	Rank
Rossbrien ditch/ Ballynaclogh River	Part of site	R571546	2010	In situ populations recovered after dredging (under licence) in 2009, but subsequently declined due to lack of ditch management. Current condition unknown.	1
Ballynaclough River, east of Dooradoyle	Part of site	R566546	2009	In situ populations recovered after dredging (under licence) in 2009, but subsequently declined due to lack of ditch management. Current condition unknown.	1
Abbey River	Possibly, depending on exact location	R581574	1998	Unknown if *Groenlandia densa* has been recorded recently or if suitable habitat still present within LCC owned lands.	2
Near Sarsfield Bridge	Yes	R5757	1993	Unknown if *Groenlandia densa* has been recorded recently or if suitable habitat still present within LCC owned lands.	3
Loughmore Canal	Part of site	R5453	2006 (NPWS), possibly more recent records	Translocation plan created for proposed dredging but this may not have yet been undertaken. Not clear if *Groenlandia densa* is present in LCC owned part of the canal.	4

Otter

Lighting

- Any new lighting required as part of the project will be of as low a wattage as possible and will be directed away from river bankside and the surface of the water (see Section 4.2.3. Lighting Design). The original eastern embankment will not have any lighting on it.

Bats

Planting

- Additional planting of treelines will benefit bats foraging in the area and act as dark buffer zones to illuminated areas. Treelines can act as physical light screening to attenuate light spill. Newly planted vegetation will take time to contribute to light attenuation.

Lighting

- New lighting required adjacent to the proposed footpath along the embankment will be of as low a wattage as possible and will be directed away from the surface of the water (see Section 4.2.3 Lighting Design).
- The specification and colour temperature of light treatments will be chosen based on their tolerability by bats. LED luminaires are ideal due to their sharp cut-off, lower intensity, and dimming capability. A warm white spectrum (ideally less than 2700K) will be used to reduce the blue light component.
- Where lighting along the public pathway is required, dimmable lights will be installed so that during peak dusk activity, the lowest light level is apparent, and the light levels are increased slowly to full output as the natural light decreases. The light fittings will be mounted at 6m or less. The original eastern embankment will not have any lighting on it.

Fish

- Any new lighting required as part of the project will be of as low a wattage as possible and will be directed away from the surface of the water (see Section 4.2.3 Lighting Design).

Construction Mitigation 1: Habitat Disturbance/Loss

All of the works and mitigation measures will be monitored by a suitably qualified ecologist during the construction period, with findings reported to the competent authority. The ecologist should have at least 5 years' experience in riverine infrastructural works and should have a high-level knowledge of fisheries and fish conservation. This knowledge base and onsite construction experience is required given the sensitivity of the Lower River Shannon as an internationally important habitat for fish.

Riparian/alluvial woodland

- Access to riparian/alluvial woodland will be prevented by sensitively located fencing and signage. Ecologist to advise on location and be present during positioning.

Marsh

In order to mitigate identified construction impacts on the Lower River Shannon SAC marsh habitat;

- The footprint of the construction works on the eastern embankment will be minimised to limit encroachment into Lower River Shannon SAC;
- The boundary of the SAC on the flood plain will be fenced off throughout the period of works;
- Runoff from works on the proposed eastern embankments will be controlled so that no water or sediment discharge reaches the marsh/floodplain habitat;
- Works on cutting sheet piling will take place from the embankment only and will not take place from the marsh side of the SAC; and
- Extension of drains in marsh to connect with filter drains from the proposed eastern embankment will be carried out prior to construction of embankment. Excavations will be minimised by marking out allowed tracking route of machinery. Ecologist to advise on location and be present during positioning.

Wet grassland

Suitable gradation of slope of earth is designed to allow for natural recolonisation of wet grassland adjacent to relocated channel. This will allow development of a natural buffer beside the new channel and progression of habitats from watercourse to wet grassland to meadow or amenity grassland.

Ditches

After completion of excavations for relocated channel, in-channel sediment and hydrology features will be reinstated as per the Methods statement in the Section 21 Licence Application (Floral Protection Order) for *Groenlandia densa* (Denyer, 2019)[110]. Slope angle of new channel to be agreed with NPWS.

Treeline

Trees will be planted to compensate for loss of willow treelines along ditches during construction of western and eastern embankment. Additional trees will be planted as screening for houses from raised embankment paths (see Section 4.3.4).

Construction Mitigation 2: Disturbance to Species

Badger

The presence of an outlier Badger sett in the bank beside the southern ditch of the flood plain will require mitigation, as the ditch is adjacent to the location of construction works for the new embankment beside the football pitches. Permanent closure of the outlier set is required, and a letter of permission has been sought (Appendix C5) and granted (see Appendix C6) by NPWS[111].

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[110] Denyer J. (2019) Section 21 Application *Groenlandia densa* Methods Statement.

[111] Until recently derogations were issued for disturbance or destruction of badger setts, but as badgers are protected under the Wildlife Acts, and not under EU Annex IV, 1976-2018, this no longer applies. Until the Wildlife Acts are amended, licences to destroy or disturb badger setts cannot be issued, but it is possible for the Department of Culture, Heritage and the Gaeltacht to issue a letter stating that it and NPWS do not oppose the works provided the report mitigation and TII's guidelines, plus any variant specified by regional staff, if any, are followed.

On completion of construction the proposed embankment will be revegetated with native hedgerow species to expand and further enhance habitat suitable for Badger.

Otter

A survey for Otter will be carried out within 10 months prior to construction. This should be supplemented by inspection of development area immediately prior to site clearance, to ensure no holts have been created in the intervening period. If any holts are found appropriate steps will be taken and a derogation licence will be applied for from NPWS.

In order to mitigate identified construction impacts on Otter the following mitigation measures will be implemented:

- Trenching works shall not create confined areas where Otter may get trapped. However, if such areas are created, the area will be fitted with an escape ramp (no more than 45º) to allow trapped animals to escape when the area is not in operation. These areas must be made safe before leaving site each day;
- Design mitigation will ensure lighting will be minimised during hours of darkness and will not illuminate areas near the riverbank and the area of the flood plain, to ensure no adverse effects on Otter.

Bats

During construction lighting will be minimised during hours of darkness and will not illuminate peripheral mature trees and vegetation to ensure no adverse effects on bats and other nocturnal animals.

Wintering Waterbirds

In order to prevent disturbance impacts to important overwintering waterbird populations within the flood plain area all works on the eastern embankment will be conducted between April and September inclusive for the duration of the project.

Breeding Birds

In order to mitigate identified construction and operational impacts on birds, not including the overwintering waterbird populations in the SPA detailed above, the following mitigation measures will be implemented:

- All vegetation clearance works, and site preparatory works will be conducted outside of the bird nesting season (31 March to 31 August inclusive). If this is not possible, a breeding bird survey will be undertaken by a suitably qualified ecologist in advance of the works to ensure that there will be no impacts on nesting birds. If nests are found, they will be safeguarded, with an appropriate buffer, until the chicks have successfully fledged.
- Tree planting, using native, locally sourced species appropriate to the locality, will replace the length of treeline lost to accommodate the new flood embankment.
- Planting of trees/scrub lost to the project should take place as soon as possible after the clearance works to ensure continuity and availability of habitat on the site.
- Any areas of scrub will be replaced with a similar or greater area of revegetated habitat. This will ensure that areas previously used for breeding bird habitat will be replaced and thus the site may maintain a similar or improved level of biodiversity and habitat potential

Mining Bees

In order to mitigate disturbance to solitary bee nests, sandbags on the western embankment will be moved only after bees emerge from hibernation in the spring and before new nests have been excavated. Provision of a suitable replacement bank with sandy substrate suitable for aggregations of solitary bees will be made. Discussion of timing and supervision of works by Ecologist.

Fish

Juvenile Lamprey

In order to mitigate identified construction and operational impacts on fish, the following mitigation measures will be implemented:

- In-channel working will be minimised, wherever possible.
- In-channel working during the salmonid spawning season will not occur (November to March inclusive).
- Pre-construction targeted removal for translocation of juvenile lamprey will take place at Areas A9 and B3. Electro-fishing is possible between July 1st and September 30th. An electro-fishing licence has been applied for and granted from IFI (see Appendix C7).
- Ecologist to oversee deployment and movements of jack-up rig.
- IFI Biosecurity Protocol for Field Survey Work (see Appendix C8) to be adhered to for any instream works: i.e. jack-up rigs and electro-fishing.

Methodology and Reasoning Behind Use of Jack-up Rigs

It is proposed that a jack-up barge will be introduced into the Abbey River (north of Abbey Bridge) and the River Shannon (at the Court House) in order to carry out construction works to the parapet wall (taking down sections of the existing parapet wall and replacing it with a new wall and re-pointing of the existing Quay Wall in order to maintain the existing wall and protect its integrity into the future). The use of jack-up rigs reduces the impact on the riverbed to just the area beneath the 4 supporting legs. Jack-up rig locations are shown in Figure 8-12, Volume 3.

The jack-up rig has 4 supporting legs, each with a 1.5m x 1.5m base plate, which is placed on the river bed in order to provide support to the barge. The barge itself will be approximately 12m wide x 20m long. A netting apron will be suspended off the side of the barge, to catch any debris, in order to prevent material falling into the river

As the works progress the rig will be moved along the defence walls, requiring the legs to be repositioned. The length of walls affected are 37m at Area A9 and 300m at Area A3. Works at A9 on the Abbey River in front of the Absolute Hotel requires 2x setups with duration of works of 2-3 months, resulting in approximately 18m² area of substrate being affected (see Plate 8-20). Works at B3 on the Shannon River in front of the Court House requires 3x setups, with duration of works 5-6 months, resulting in approximately 27m² area of substrate being affected.

Given the small area of the feet this will ensure that any impacts to lamprey habitat will be temporary, localised and not significant.

No introduction of rock infill is required as part of the set-up or operation of the jack-up rig.

Areas to be Electro-fished

Abbey River Area A9

It is proposed to carry out electro-fishing of the near bank platform feet areas in the Abbey River and exclude the outer areas by virtue of higher flows, lower aggradation rates (due to higher energy) and therefore low probability of lamprey presence in those areas. Areas of fine sediment are characteristically in the river margins and pool slacks and this is where invariably most lamprey ammocoetes are in large rivers. The jack-up rig feet positioning in the centre of the channel are less likely to encounter areas of soft sediment due to erosional forces 12m out in the fast flowing Abbey River. The 9 m² area of legs close to the walls at low tide will be electro-fished thereby removing any localised ammocoete populations. Electro-fishing and translocation under licence of juvenile lampreys will take place in pre-construction phase. Electro-fishing can only take place between 1 July and 30 September inclusive. Instream works can take place after translocation but only within the summer fishery season ending 30 September.

Shannon River Area B3

The area (27 m²) beneath proposed jack-up rig locations in Area B3 will be electro-fished.

Electro-fishing and Efficiency of Removal

The footprint of the platform feet overlapping soft sediment areas would be marked with posts. This would form the electro-fishing boundary area. A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) will be used to electro-fish soft sediment areas during base flow conditions. Settings for lamprey follow those recommended and used by Harvey & Cowx (2003)[112], APEM (2004)[113] and Niven & McAuley (2013)[114]. Using this approach, the anode is placed under the water surface, approx. 10–15 cm above the sediment, to prevent immobilising lamprey ammocoetes within the sediment. The anode will be energised with 100V of pulsed DC for 15-20 seconds and then turned off for approximately five seconds to allow ammocoetes to emerge from their burrows. The anode will be switched on and off in this way for approximately two minutes. Immobilised ammocoetes will be collected using a fine-mesh hand net as they emerge from silt and sand and transferred to 100l oxygenated bankside water tanks. The process is repeated several times until all lamprey are drawn from the footprint of the platform feet. Electro-fishing efficiency can be established using a depletion curve. Efficiency of removal is typically extremely high and is unlikely that any ammocoetes would remain behind. Lamprey would be released into soft sediment areas upstream and away from the works areas following electro-fishing. These are very well distributed at King's Island and numerous suitable receptor habitat areas exist.

Translocation

Lamprey ammocoetes from the Abbey River would be translocated near the confluence of the Park Canal where abundant soft sediment beds exist for larval lamprey settlement (ITM 0558168, 0657461). For the Shannon River ammocoetes a number of soft sediment littorals also exist locally between Thomond Bridge and the railway bridge upstream on the east bank of the River Shannon. Some areas are larger in size than others. One specific area includes the river adjoining Verdant Place (ITM 0557579, 0658115).

Regeneration of Habitat

After winter flows which are typically significant in the lower River Shannon, un-compacted silt habitat will rapidly regenerate in the works areas. The footprint of the feet in the working platforms covers a small area and in the context of temporary impingement on soft sediment there will be no long term changes to the structure and composition of the bed. As such the river substrata will, after removal of the working platforms, revert to a condition very close to that pre-works.

Launch of Jack-up Rigs

Ensure launch of jack-up rig will not entail disturbance to riverbank or riverbed substrate. Proposals for the jack-up rig launch locations are provided in Figure 8-13, Volume 3. Two cranage points are required to lift the jack-up barge into the river at two points, as well as separate boat access points. It is proposed to lift the jack-up rig into the Abbey River at the hatched location with the note "Area A9 launch location option 1 (preferred)". For craning the barge into the River Shannon, a location beside the Curragower Boat Club is proposed. In addition to a cranage point for the jack-up barge, two boat access locations are required. The contractor would be able to use the existing pontoon on George's Quay, or the slipway near O'Dwyer's Bridge.

Follow pollution prevention measures as detailed below and overleaf.

Construction Mitigation 3: Management Measures for Surface Water

Relevant legislation and best practice guidance that have been considered includes but not limited to the following:

- NetRegs - 'Guidance for Pollution Prevention: Works and maintenance in or near water' GPP 5 (NetRegs, 2018)[115];

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[112] Harvey, J. & Cowx, I. (2003) Monitoring the River, Sea and Brook Lamprey, Lampetra fluviatilis, L. planeri and Petromyzon marinus. Conserving Natura 2000 Rivers Monitoring Series No. 5, English Nature, Peterborough.
[113] APEM (2004). Assessment of sea lamprey distribution and abundance in the River Spey: Phase II. Scottish Natural Heritage Commissioned Report No. 027 (ROAME No. F01AC608).
[114] Niven, A.J. & McCauley, M. (2013) Lamprey Baseline Survey No2: River Faughan and Tributaries SAC. Loughs Agency, 22, Victoria Road, Derry.
[115] Netregs (2018) Guidance for Pollution Prevention Works and maintenance in or near water: GPP 5. Available at: http://www.netregs.org.uk/media/1418/gpp-5-works-and-maintenance-in-or-near-water.pdf?utm_source=website&utm_medium=social&utm_campaign=GPP5%2027112017]

- CIRIA Guidance C532 (2001): 'Control of water pollution from construction sites. Guidance for consultants and contractors[116];
- CIRIA Guidance C750D (2016): 'Groundwater control: design and practice' (Preene et al., 2016)[117];
- Inland Fisheries Ireland (2016) 'Guidance on Protection of Fisheries During Construction Works In and Adjacent to Waters'.[118]
- Inland Fisheries Ireland (2010) 'Biosecurity Protocol for Field Survey Work: Appendix 8 '

Best practice mitigation will be adhered to which will alleviate the risk associated with accidental spills and runoff events. In particular, the following measures will be implemented:

- Adoption of surface water controls including appropriate erosion and silt controls (e.g. trenches, settling ponds/tanks, silt fence) to prevent any flow of surface water from the site into the SAC marsh, water courses within the site, or the Shannon or Abbey Rivers. Contents of any sediment tanks will be removed off site by a licenced waste contractor. The details of the control of site drainage will be shown in the developed CEMP;
- The delineation of trench works by a fence, outside of which no access shall be permitted;
- At no point should there be storage of material or vehicles/machinery at east of the site near the flood plain area within the SAC or near newly excavated channel at north of site;
- The excavation through embankments with open trench for connection of filter drain to Shannon River and to drains across flood plain need to be carried out during a period of dry weather. Rainfall needs to be monitored and works carried out during consecutive dry days;
- Works on excavation and removal of existing sandbags, footpath, and concrete along the length (approx. 1km) of the western embankment Place to include appropriate erosion and silt controls to prevent surface water flow and accidental spillages onto riverbank and into Shannon River. Discussion at detailed design/construction phase on benefits of retention of concrete plinth;
- Reseeding of embankments will take place immediately after construction;
- Works on pilings and new concrete wall at Verdant Place to include appropriate erosion and silt controls to prevent surface water flow and accidental spillages onto riverbank and into Shannon River;
- Works on cutting of sheet piling and excavation and laying of new Bitmac path to north of sheet piling will take place during a period of dry weather. Rainfall needs to be monitored and works carried out during consecutive dry days. Appropriate erosion and silt controls will be required to prevent surface water flow, sediment mobilization and accidental spillages onto riverbank and into Abbey River;
- Oil booms and oil soakage pads should be maintained on-site to enable a rapid and effective response to any accidental spillage or discharge. These shall be disposed of correctly and records will be maintained by the environmental manager of the used booms and pads taken off site for disposal;
- Do not attempt to hose the spillage down or clean up with detergents or emulsifiers, as these will increase the risk of harming the environment.
- Fail-safe site drainage and bunding through drip trays on plant and machinery will be provided to prevent discharge of chemical spillage from the sites to surface water;
- No excavation shall take place below the water-table on the Application Site except for excavation of channel for Opposite-leaved Pondweed;

[116] PUB C532 Control of water pollution from construction sites: guidance for consultants and contractors. Available at: https://www.thenbs.com/PublicationIndex/documents/details?Pub=CIRIA&DocID=252367]

[117] Preene, M., Roberts, T. O. L. and Powrie, W. (2016) PUB C750 *Groundwater control - design and practice*. Available at: https://www.thenbs.com/PublicationIndex/documents/details?Pub=CIRIA&DocID=314073]

[118] IFI (2016) *Guidance on Protection of Fisheries During Construction Works In and Adjacent to Waters*. Available at: https://www.fisheriesireland.ie/documents/624-guidelines-on-protection-of-fisheries-during-construction-works-in-and-adjacent-to-waters/file.html

- Jack-up rig and plant are clean and are in good working order (no leaks) before entering the estuarine environment for work on defence walls in Area A9 and B3.
- All working platforms within or adjoining watercourses should have spill kits available to prevent egress of chemicals include concrete, lubricants, fuels, setting compounds or other from entering the River Shannon
- Launch of jack-up rig will be carried out by crane and will not disturb bank habitats or bottom sediment at launch sites
- Emergency repair tools and/or towing equipment is to be made available in case of damage to jack-up rig
- All soil stockpiles shall be covered (i.e. vegetated) to minimise the risk of rain / wind erosion;
- Mobile plant will refuel over a drip tray with an absorbent mat; and
- Follow pollution prevention measures as detailed in Chapter 9.

Pollution Control and Spill Prevention

Spill kits containing absorbent pads, granules and booms will be stored in the site compound with easy access for delivery to site in the case of an emergency. Absorbent material will be used with pumps and generators at all times and used material disposed of in accordance with the Waste Management Plan. All used spill materials e.g. Absorbent pads will be placed in a bunded container in the contractor's compound. The material will be disposed of by a licenced waste contractor at a licenced facility. Records will be maintained by the environmental site manager.

Regular inspections and maintenance of plant and machinery checking for leaks, damage or vandalism will be made on all plant and equipment.

In the event of a spill the Contractor will ensure that the following procedure are in place:

- Emergency response awareness training for all Project personnel on-site works;
- Appropriate and sufficient spill control materials will be installed at strategic locations within the site. Spills kits for immediate use will be kept in the cab of mobile equipment;
- Spill kits will be stored in the site compound with easy access for delivery to site in the case of an emergency. A minimum stock of spill kits will be maintained at all times and site vehicles will carry spill kits at all times. Spill kits must include suitable spill control materials to deal with the type of spillage that may occur and where it may occur. Typical contents of an on-site spill kit will include the following as a minimum;
- Absorbent granules;
    - Absorbent mats/cushions;
    - Absorbent booms.
- Spill kits will contain gloves to handle contaminated materials and sealable disposal sacks;
- Track mats, drain covers and geotextile material;
- All potentially polluting substances such as oils and chemicals used during construction will be stored in containers clearly labelled and stored with suitable precautionary measures such as bunding within the site compound;
- All tank and drum storage areas on the site will, as a minimum, be bunded to a volume not less than the following;
- 110% of the capacity of the largest tank or drum within the bunded area;
- 25% of the total volume of substances which could be stored within the bunded area;
- The site compound fuel storage areas and cleaning areas will be rendered impervious and will be constructed to ensure no discharges will cause pollution to surface or ground waters;
- Designated locations for refuelling are within Site Compound;
- Potentially contaminated run off from plant and machinery maintenance areas will be managed within the site compound surface water collection system; and
- Damaged or leaking containers will be removed from use and replaced immediately.

Non-native Invasive Species

In order to mitigate the potential spread of non-native invasive species listed in the Third Schedule (Part 1) of the European Communities (Birds and Natural Habitats) Regulations 2011, the mitigation measures listed in Section 4 of the King's Island Invasives Species Management Plan (JBA, 2019)[119] will be implemented during construction.

Measures to Prevent the spread of Non-native Invasive Species

In order to mitigate the possible spread of non-native invasive species, the following mitigation measures will be incorporated into a site-specific Invasive Species Management Plan:

- All works shall be conducted according to the NRA Guidelines 'The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads';
- Avoid working in areas where Japanese Knotweed is present; all areas within 7m of visible above-ground growth will be avoided, where possible and clearly demarcated;
- If work is required in areas infested with Japanese Knotweed (including any area within 7m of visible above-ground growth) an appropriate Japanese Knotweed Mitigation Strategy will need to be devised and implemented to prevent spread; and
- Where the new eastern embankment meets the Japanese Knotweed bund, part of the bund will be relocated. This will be incorporated into the new embankment further south and outside of the SAC.

8.6.2 Operation Phase Mitigation

Habitats

Marsh

Any disturbed marsh habitat at the SAC boundary and where drains were widened and deepened will be allowed to revegetate naturally.

Protected Flora

To ensure the successful translocation of Opposite-leaved Pondweed to the new channel monitoring of Opposite-leaved Pondweed in the new channel on King's Island will take place according to Section 21 Licence application for *Groenlandia densa* (Denyer, 2019)[120], conditions outlined in Licence No. FL08/2019 (Licence to take Protected Flora, alter or otherwise interfere with the habitat or environment of a species of Protected Flora) seen in Appendices C3 and C4, and advice from NPWS,

Management of vegetation growth in new channel will follow guidance in final Conservation Management Plan for Opposite-leaved Pondweed as agreed with NPWS.

The enhancement of two additional sites for *G. densa* will be developed and monitored over three years. This will be carried out as a research project for scientific and educational purposes, and a report will be published after completion.

Species

Badger

Landscape plans and long-term management will encourage planting of native tree and plant species to expand and further enhance wildlife corridors on King's Island as suitable habitat for Badger.

Badgers require a range of resources to thrive, including sett-building habitat, connectivity and a range of foraging habitats to reflect the seasonal variation in the availability of different food resources.

[119] JBA (2019) *King's Island Flood Relief Scheme- Invasive Species Management Plan.* Unpublished report.
120 Denyer J. (2019) Section 21 Application *Groenlandia densa* Methods Statement

Wintering Birds

Planting

The steepness (1:3) of the embankment in the northern third of the proposed eastern embankment and the southern embankment area north of Star Rovers should discourage public access to the floodplain in these areas. Planting a natural barrier using whips of low-growing native species such as Hawthorn/Blackthorn on or near base of eastern embankment where it is less steep and where there is space between SAC boundary and base of embankment should also discourage access to the flood plain. Allow minimal meadow grassland management (e.g. one cut / year) on the embankment, with unmanaged areas where scrub and natural succession are allowed. Public access of the paths and use of marsh is likely to be less during the winter months when flooding occurs.

Public Participation

A local awareness campaign could highlight the biodiversity of King's Island. Bird counts by local Limerick nature groups (e.g. Irish Wildlife Trust, Birdwatch Ireland) could potentially monitor wintering bird numbers and rates of disturbance from pubic use of new paths. As an example, Booterstown Marsh in Dublin has a train line and main road close by. Wintering birds appear undisturbed by human activity and it is a regular location for bird watching[121]. However, there is little direct access by the public onto Booterstown Marsh, unlike King's Island.

Salmon

Any new lighting required as part of the project will be of as low a wattage as possible and will be directed away from river bankside, flood plain and the water surface. This should be as per the requirements of and in consultation with Inland Fisheries Ireland. Illumination should be "cowled" or designed to ensure that the pool of light falls only on the footpath and not on the water (see Appendix B and Section 4.2.3 Lighting Design).

Water quality

Regular maintenance of drainage network will ensure good water quality. This will include regular operation and review of drainage maintenance requirements. Maintenance procedures will follow those recommended in CIRIA SUDS Manual (2015), Part E C753, Chapter 32 Operation and Maintenance.

8.7 Residual Impact

8.7.1 Do Nothing Scenario

The site in its present form is an island in a city surrounded by flood defence walls with distinct urban areas to the south, with embankments to the north surrounding an urban estate, open amenity grassland, marsh habitat, ditches and low treelines. The marsh and grassland areas are grazed by horses. Under its current use, there is a neutral effect on the general ecology of the area.

8.7.2 Construction Phase

Construction phase requires clearing of vegetation, infilling of ditches, construction of embankments, a new surface water drainage scheme, and upgrading of flood defence walls.

Implementation of mitigation measures during the construction phase, such as fencing off of SAC boundary, the replanting and enhancement of embankment vegetation, translocation of Opposite-leaved Pondweed, electro-fishing and translocation of juvenile lamprey, suitable lighting plan (taking Otter and bats into account), along with pollution and surface water control, good site management and construction practices, will help to minimise any significant and/or permanent impact on the environment.

The residual impact during the construction phase is assessed to be of temporary negative impact on account of the disturbance to treelines, marsh and ditch habitat and Opposite-leaved Pondweed, as well as temporary impact on breeding birds, Badger, juvenile lamprey and solitary bees.

121 Dún Laoghaire-Rathdown County Council (2013) Booterstown Marsh and Beach. Biodiversity Education Programme. Available at: https://www.dlrcoco.ie/sites/default/files/atoms/files/biodiversitybooterstown.pdf]

8.7.3 Operational Phase

The proposed mitigation and enhancement measures for the operational phase should act to provide suitable conditions for Opposite-leaved Pondweed, and suitable habitat for Otter, bats, wintering birds, solitary bees, juvenile lamprey as well as good water quality. Provided the translocation of Opposite-leaved pond-weed is successful, the lighting design and post-installation review for light spill are satisfactory and ongoing maintenance reviews take place, this eliminates all significant negative impacts on the environment. Table 8-15 summarises in tabular form the conclusions of sections 8.6.1 and 8.6.2 and identifies what the residual impact of the proposed King's Island FRS will be on ecological receptors.

Table 8-15. Summary of impacts of proposed King's Island FRS on ecological receptors

Impacts	Characterisation of unmitigated impact on the feature	Effect without mitigation	Mitigation	Significance of effects of residual impacts after mitigation
Construction impacts				
Habitat loss/disturbance	Riparian/alluvial woodland Damage to riparian/alluvial woodland during construction of north west outfall pipe, and upgrading of flood defence walls	Physical damage to riparian/alluvial woodland leading to significant impact at international level	The footprint of the construction works will not encroach within the boundaries of the Annex 1 Alluvial forest habitat Fencing/signage will be used to demarcate SAC boundary. Bankside trees on Shannon and Abbey Rivers will not be disturbed	Not significant
	Marsh habitat Loss and physical damage to marsh habitat within the SAC boundary due to embankment construction and extension of drains	Physical damage to marsh habitat due to machinery and fill materials Material from construction works altering soil levels and raising flood plain level thereby interfering with flooding regime Surface runoff from bare soil/fill material bringing additional particulate matter into marsh habitat and contributing to change of species composition The marsh is supporting habitat to Estuaries habitat and impact is significant at international level	The footprint of the embankment construction works will be limited to that agreed with NPWS. Fencing will be used to demarcate marsh habitat and SAC boundary. Extension of drains in marsh to connect with filter drains from eastern embankment will be carried out prior to construction of embankment. Excavations will be minimised by marking out allowed tracking route of machinery. Ecologist to advise on location and be present during positioning. Cutting of sheet piling will take place from embankment and will not take place inside the marsh habitat. Surface water flow from works will be prevented from reaching marsh habitat. Allow natural revegetation of marsh habitat upon completion of works.	Temporary negative- Not significant
	Ditch and wet grassland Construction of embankments will	The loss of north west ditch is assessed as significant at a national level due to	Relocation of ditch and reinstate with similar hydrology and	Temporary negative- Not significant

Impacts	Characterisation of unmitigated impact on the feature	Effect without mitigation	Mitigation	Significance of effects of residual impacts after mitigation
	result in direct loss of ditches and wet grassland	presence of protected species Opposite-leaved Pondweed.	sediment features to original; adequate sloping of ground to allow revegetation and succession of wet grassland. Mitigation will follow the Methods statement in the Section 21 Licence Application (Floral Protection Order) for Groenlandia densa (Denyer, 2019) and any subsequent modifications to these as may be proposed and agreed with the NPWS. NPWS have requested enhancement of two further sites where Opposite-Leaved Pondweed is located in the environs of Limerick city. The enhancement of these sites for *G. densa* will be developed and monitored over three years. This will be carried out as a research project for scientific and educational purposes, and a report will be published after completion.	
	Ditch, treeline/scrub Construction of embankments will result in direct loss of treeline/scrub habitats	The loss of south east ditch, wet grassland and treeline/scrub arising from this project is considered of moderate significance at a local level	All vegetation clearance works and site preparatory works will be conducted outside of the bird nesting season (31 March to 31 August inclusive). Compensatory planting of treeline and allow succession of scrub vegetation.	Temporary negative- Not significant
(Protected Flora) Species loss	Infilling of ditch will result in loss of population of Opposite-leaved Pondweed	Without mitigation population of Opposite-Leaved Pondweed will be lost to King's Island, leading to significant impact at a National and local level.	Removal of pondweed plants from ditch habitat to a holding area and then translocation into a newly excavated channel. Mitigation will follow the Methods statement in the Section 21 Licence Application (Floral Protection Order) for Groenlandia densa (Denyer, 2019) and any subsequent modifications to these as may be proposed and	Temporary negative - Not significant

Impacts	Characterisation of unmitigated impact on the feature	Effect without mitigation	Mitigation	Significance of effects of residual impacts after mitigation
			agreed with the NPWS. Methodology will include sequencing of construction allowing the excavation of new ditch and drainage connection to the Shannon River prior to that of the embankment. Pondweed must stay in original ditch as long as possible but may go into suitable storage for a period prior to translocation. It must not be moved to new ditch before suitable hydrological and water chemistry conditions are in place. The Section 21 licence for the translocation of the pondweed will be contingent on final method statement approved by NPWS. NPWS have requested enhancement of two further sites where Opposite-Leaved Pondweed is located in the environs of Limerick city. These are seen in Figure 8-14. The enhancement of these sites for *G. densa* will be developed and monitored over three years. This will be carried out as a research project for scientific and educational purposes, and a report will be published after completion.	
Disturbance to species	Otter Additional lighting required for construction phase will inhibit Otter activity	Increased urbanisation and light pollution can discourage Otter activity and reduce success of foraging Significant at national level	Surveying for Otter holts within 10 months prior to commencement of works No additional lighting systems set up. Night-time working will not be permitted.	Not significant

Impacts	Characterisation of unmitigated impact on the feature	Effect without mitigation	Mitigation	Significance of effects of residual impacts after mitigation
	Badger Disturbance / destruction of sett south of marsh during embankment construction	Disturbance / destruction of sett will cause significant impact on local Badger population	Permanent closure of mammal holes (outlier sett) with written permission from NPWS under prescribed conditions between July- November inclusive. Revegetation with native hedgerow /tree species Allow natural succession to scrub	Temporary negative - Not significant
	Bats Additional lighting required for construction phase will inhibit Otter activity	Increased urbanisation and light pollution will reduce activity level of bats and will negatively impact on selection of flight routes and foraging success	No additional lighting systems set up. Night-time working will not be permitted.	Not significant
	Waterbirds Machinery operation and workforce movement will cause disturbance to wintering birds in the flood plain area	Disturbance to wintering birds results in increased stress and additional energy expenditure, compromising success	Avoidance of works on the eastern embankment and cutting of sheet piles during wintering bird season (October to March) throughout construction period Should works extend through the winter period (i.e. October - February) the following measures should be undertaken, although they may be adopted as best practice: a) Daily monitoring of average daytime temperatures will be undertaken. When average daytime temperatures fall below 0ºC for five consecutive days, works will temporarily cease. Works can proceed again when temperatures become milder. b) Night-time working will not be permitted. c) All machinery used on the eastern embankment will be fitted with noise reduction measures.	Not significant
Disturbance to species	Breeding Birds The construction of the new western	Destruction of treeline/scrub results in short-term impact to species of local	All vegetation clearance works and site preparatory works will be	Temporary negative and then Positive

Impacts	Characterisation of unmitigated impact on the feature	Effect without mitigation	Mitigation	Significance of effects of residual impacts after mitigation
	embankment will require the removal of the treeline and scrub adjacent to the path along the north of Kind's Island with potential discrete loss of available nesting habitat	sensitivity and importance	conducted outside of the bird nesting season (31 March to 31 August inclusive). Compensatory planting of native trees, with some unmanaged areas where scrub and natural succession are allowed.	Revegetation with trees, scrub and unmanaged areas of vegetation will increase nesting and pollinator habitat and overall biodiversity
	Bees Movement of sandbags on walls surrounding embankment will disturb nests of bees. However the plastic material of the bags is deteriorating and is a of cause pollution	Short-term impact on local level	Removal of sandbags to take place within 6-8 weeks of bee larvae hatching (Spring) and before new nests have been excavated. Provision of replacement bee nesting habitat Discussion of timing and supervision of works by Ecologist	Not significant
	Fish			
Disturbance to species (compaction and physical damage)	Juvenile lamprey- Whilst the launch site and jack-up rigs will be temporary, they will result in compaction and physical damage to substrate and the loss/damage of juvenile lamprey living in the sediment.	Compression of sediment beneath rig leg pads, though relatively small in size, will damage lamprey habitat and destroy any juvenile lamprey present, potentially several cohorts, resulting in a significant impact at an International level.	Pre-construction targeted removal for translocation of juvenile lamprey will take place at Areas A9 and B3. Electro-fishing is possible between July 1st and September 30th. An electro-fishing licence has been applied for and granted from IFI (see Appendix C7). Ecologist to oversee deployment and movement of jack-up rig. IFI Biosecurity Protocol for Field Survey Work (see Appendix C8) to be adhered to for any instream works: i.e. jack-up rigs and electro-fishing. Electro-fishing and translocation under licence of juvenile lampreys in pre-construction phase- Electro fishing to take place during July and September inclusive.	Temporary negative - Not significant
Protected species loss	European Eel Infilling of two ditches will result in loss of population of any extant Eel	Without mitigation any extant population of Eel in the ditch will be lost leading to significant impact at a local and national	Electro-fishing under licence and translocation of any Eels to the Shannon/Abbey River	Not significant

Impacts	Characterisation of unmitigated impact on the feature	Effect without mitigation	Mitigation	Significance of effects of residual impacts after mitigation
		level.		
	Sticklebacks, coarse species Infilling of two ditches will result in loss of population of these fish	Without mitigation population of fish will be lost with reduction in local biodiversity	Electro-fishing under licence and translocation of any fish to the Shannon/Abbey River	Not significant
Reduction in Water quality	Salmon and lamprey, Eel, Brown Trout and Smelt	Reduction in estuarine water quality, from silt mobilisation and pollution incidents can contribute to eutrophication, decreased water clarity, silt deposition in redds, increased algal blooms and sedimentation of substrates. This can have additional impacts on aquatic fish such as Salmon and lamprey, Eel, Brown Trout and Smelt and by impacting on breeding habitat degradation (e.g. Smelt- silt deposition on redds).	In-channel working will be minimised, wherever possible. In-channel working during the salmonid spawning season will not occur (November to March inclusive). Follow Management measures for surface water and pollution prevention measures (see Section 8.6.1- Construction Mitigation 3).	Not significant
Reduction in Water quality	Tidal rivers and Mudflats and sandflats habitat Surface water runoff will impact on the water quality of the Shannon and Abbey Rivers. Pollution from works on constructing new concrete walls and upgrading existing flood defence walls (e.g. concrete washings, dust or spills)	Mudflats and sandflats habitat, can be impacted by silt runoff and pollutants, reducing quality of the habitats as well as impacts on the flora and macro-invertebrate fauna. There may be further indirect impacts on predators such as Otter and waterbirds in the area.	Follow Management measures for surface water and pollution prevention measures (see Section 8.6.1- Construction Mitigation 3)	Not significant
Operational Impacts				
(Protected) Species loss	Opposite-leaved Pondweed A new channel with translocated population of Opposite-leaved Pondweed may not lead to successful reestablishment of this species.	Without monitoring and a management plan population may not succeed, leading to significant impact at a National and local level.	Management of channel vegetation, Monitoring of Opposite-leaved Pondweed according to Section 21 Licence application for Groenlandia densa (Denyer, 2019) and any subsequent modifications to these as may be proposed and agreed with the NPWS. Monitoring of two further enhancement sites as agreed with NPWS	**Not significant to Positive** **If successful, enhancement of other sites in Limerick for Opposite-leaved Pondweed will have a positive impact on population of this species**

Impacts	Characterisation of unmitigated impact on the feature	Effect without mitigation	Mitigation	Significance of effects of residual impacts after mitigation
Disturbance to species	Otter and Bats The pathway on the embankment around King's Island was not previously lit at night. A new lighting plan is designed to improve use and security of people using the path. Unless correctly designed this will interfere with Otter and bats using the river for commuting and foraging.	Additional lighting will result in long-term impacts to species of high local sensitivity and importance	Lighting plan will abide by specifications for Otter and bats in Chapter 4.	Not significant
	Badger Vegetation management	Excessive management of vegetation (grass cutting, cutting of scrub) could disturb Badger population and limit habitat suitable for foraging and commuting. Habitat suitable for sett building will be reduced resulting from nature of new embankment substrate	Landscape plans and long-term management will involve planting of native trees and plants, including some unmanaged areas which will provide undisturbed habitat for Badger foraging, commuting and sett building	**Slight negative**
	Salmon	Additional lighting scheme will result in long-term impacts to species of high local sensitivity and importance	Suitable lighting plan on paths with no light falling on surface of water	Not significant
Disturbance to species	Waterbirds The proposed works will result in the flood plain being completely enclosed by embankments, with public paths on top and easier public access to the marsh area.	Increased public usage of lit pathways and access to flood plain could result in greater disturbance to wintering waterbirds during flood events	Planting a natural barrier using low-growing native species such as Hawthorn at base of eastern embankment to discourage access. Allow minimal meadow grassland management (e.g. one cut / year), with some unmanaged areas where scrub and natural succession are allowed.	Not significant
Reduction in water quality	Periodic maintenance works such as clearing filter drains and outfalls will contribute silt or pollutants to water courses	Silt runoff into ditch with Opposite-leaved Pondweed, and Shannon and Abbey Rivers will lead to significant impact at local and national level and at an International level respectively.	Regular review of maintenance requirements as per recommended guidance documents	Not significant

8.8 Monitoring

Opposite-leaved Pondweed

Post-construction Monitoring for Opposite-leaved Pondweed within King's Island and at two other sites will take place under the licensing agreement for relocation of this species.

Lighting

Lighting checks post-installation will be carried out to ensure functionality of light spill cut-offs and that the boundary areas remain occluded for nocturnal species.

8.9 Interactions with other Environmental Effects

The excavation and construction of earth embankments could potentially increase the sediment loading to the groundwater and surface water environments. Adequate mitigation measures for sediment control relating to the construction phase are addressed above in Management Measures for surface water and in Chapter 9 (Surface and Groundwater).

8.10 Potential Cumulative Impacts

The site is situated in an island location surrounded by watercourses and connected by bridges to Limerick city. The area is zoned for nature, amenity, residential and commercial use with existing facilities located within the housing estates to the north and commercial/historic areas to the south. There are likely to be many applications for development within and adjacent to Limerick city in the near future. There is the possibility that cumulative interactions as a result of increasing development in the area may result in time, and habitat loss for some species (birds and mammals) incurred as a potential future impact.

A number of projects have the potential for cumulative impacts with the King's Island Flood Relief Scheme. These are described in detail in Chapter 16 Cumulative Impacts and none indicate significant cumulative impacts. Some of these projects have not yet gone to planning stage. All these projects will have to consider cumulative impacts from this EIAR.

The potential cumulative impacts of these schemes from a biodiversity point of view is summarised below. If the construction periods of these developments are to overlap, there is potential to impact on biodiversity through reduced surface water quality. These effects will be temporary.

Killaloe Bypass/Shannon Bridge Crossing and R494 Improvement Scheme

This scheme has received planning permission and is located approximately 16.5km north-east of the King's Island Flood Relief Scheme site.

The impact of the proposed scheme on the ecological environment along the proposed route will be locally significant for the River Shannon and associated habitats where the new Shannon Bridge crossing will be located. With mitigation, the ecological integrity of the Lower River Shannon SAC will not be adversely affected[122].

However, due to the temporary nature of the works, the mitigation measures included in the development, the distance from the present project and the dilution effect of the Shannon River, no cumulative impacts on biodiversity are expected.

Limerick Northern Distributor Road

Phase 1 of this scheme has commenced, with Phase 2 currently in design stages. Phase 1 (Coonagh-Knockalisheen) is under construction, and as this section of the project is not located near the River Shannon, it is therefore anticipated that it will not have any cumulative impacts with the King's Island Flood Relief Scheme from a biodiversity point of view. Phase 2 is in the design stage but has not received planning permission and is therefore not a committed scheme. As it is not possible to state in known detail whether Phase 2 will present cumulative impacts in combination with the King's Island Flood Relief Scheme at this stage, no detailed assessment of likely cumulative impacts can be assessed as part of the EIAR for this project.

122 Roughan & O'Donovan Consulting Engineers, Clare County Council/North Tipperary County Council (2012) Killaloe Bypass/Shannon Bridge Crossing and R494 Improvement Scheme, Environmental Impact Statement Volume 2- Main Text. Available at: https://www.clarecoco.ie/services/roads-and-transport/publications/killaloe-bypass-shannon-bridge-crossing-and-r494-improvement-volume-2-environmental-impact-statement-11300.pdf

Limerick City and Environs Flood Relief Scheme (FRS)

The proposed Limerick City and Environs FRS upgrade is currently at the 'Further Information' stage of its planning application. As it is not possible to state in known detail whether the Castletroy FRS upgrade will present cumulative impacts in combination with the King's Island Flood Relief Scheme at this stage, no detailed assessment of likely cumulative impacts can be assessed as part of the EIAR for this project.

Castleconnell Flood Relief Scheme (FRS)

The proposed Castleconnell Flood Relief Scheme, Co. Limerick is in the early stages of its planning development. As it is not possible to state in known detail whether the Castleconnell FRS will present cumulative impacts in combination with the King's Island Flood Relief Scheme at this stage, no detailed assessment of likely cumulative impacts can be assessed as part of the EIAR for this project.

Opera Site, Limerick City

The proposed regeneration of the Opera Site includes a mixed-use development, comprising offices, retail, culture, licenced premises and other ancillary uses. The Opera Site is located on the opposite side of the Abbey River and south of the R445, approximately 50m south of the King's Island site boundary. The site occupies the majority of a city block and is bound by streets all around. The project is expected to take 4 years and 6 months, and it is anticipated that construction will overlap with the present project should both projects receive statutory consent.

In the absence of mitigation the main impacts from the Opera project during construction that could be considered significant with regards to cumulative effects with King's Island FRS are;

- The installation of a new outfall to the Abbey River (in Charlotte's Quay, adjacent the Lower River Shannon SAC) to service a new surface water sewer. During construction, there is potential for dust, silt, oils, fluids, paints, and/or concrete washings, etc. to temporarily enter the Abbey River and impact water quality and aquatic species

The Construction Methodology and Phasing Management Plan (CMPP) for the Opera site includes pollution and spill control measures which will mitigate against any of these potential impacts.

During operation no cumulative impacts are predicted, taking into account the following design mitigation:

- The SUDS system included in the design of the new surface water sewer which will remove silt from roof and pedestrianised hardstanding run-off, prior to run-off entering the Abbey River within the Lower River Shannon SAC; and ·
- The proposed diversion of surface water from basement carparking areas (which will be contaminated with elevated levels of detergents in contrast to roof and pedestrianised hardstanding run-off) into an existing combined sewer, which will carry this contaminated surface water to the existing licensed Bunlicky Waste Water Treatment Plant (WwTP) for treatment prior to discharge to the Lower River Shannon SAC.
- Confirmation from Irish Water that the load generated by the proposed FRS can be catered for. Potential pollution impacts from the discharge of treated effluent in the River Shannon, following treatment at Bunlicky WwTP are therefore considered non-significant.
- (AECOM, 2019)[123].

Although the Opera Site has not received planning permission and is therefore not a committed scheme, given the above, no likely significant cumulative impact on biodiversity is expected should it be granted planning permission.

Limerick Urban Centre Revitalisation - O'Connell Street

The Limerick Urban Centre Revitalisation - O'Connell Street, otherwise known as the LUCROC project, is a commitment to the revitalisation of O'Connell Street. The project is located between the junctions of Denmark Street and the Crescent, with Phase I between Denmark Street and Cecil Street, approximately 400 metres in length. This proposed revitalisation projected is located

[123] AECOM, (2019) Environmental Impact Assessment Report- Mixed Use Development - Opera Site, Limerick. Limerick City and County Council. Unpublished Report.

approximately 330m south-west of the King's Island FRS site, and the River Shannon (Lower) is located approximately 200m from the development area.

A planning application for Phase I of this project has recently been submitted under the Part 8 planning process. It is anticipated that, should the LUCROC project be granted planning permission, it would be constructed over the following two years, i.e. the construction period may overlap with the King's Island Flood Relief Scheme.

There will be no direct discharges to surface water during the construction phase of the LUCROC development. The likelihood that the release of contaminated surface water could cause a significant effect to the River Shannon is considered highly unlikely given the existing drainage network in place and given the nature of the activities proposed.

Surface water run-off which is collected on site will be released via the existing network to a closed wastewater collection network which is treated in the Bunlicky WwTP prior to discharge to the Shannon estuary, in accordance with the EPA waste water discharge licence. As such, the construction phase of the proposed FRS is not predicted to result in a significant negative effect on hydrology or surface water quality.

During the operational phase surface water run-off, will be released to the existing closed network which is treated in the Bunlicky WwTP prior to discharge to the Shannon estuary, in accordance with the EPA waste water discharge licence. As such, no significant negative effects on hydrology or surface water quality are envisaged during the operational phase of the proposed FRS [124].

Similar to the Opera site, LUCROC has not received planning permission and is therefore not a committed scheme. However, given the above factors, no likely significant cumulative impact on biodiversity is expected should it be granted planning permission.

Mungret Local Infrastructure Housing

The Mungret Local Infrastructure Housing includes the upgrading of roads to allow for the development of 450 homes by 2021, with a potential estimate of 2,700 homes to be provided on the lands. The infrastructure will also ensure the delivery of a post primary school in the area within the next 3 years.

The development is currently in the Master planning stage, with a planning permission to follow. As it is not possible to state in known detail whether the Mungret Local Infrastructure Housing development will present cumulative impacts in combination with the King's Island Flood Relief Scheme at this stage, no detailed assessment of likely cumulative impacts can be assessed as part of the EIAR for this project.

International Rugby Experience Building, O'Connell Street

The International Rugby Experience Building on O'Connell Street involves works at No. 42 O'Connell St/No.1 Cecil Street to create a rugby museum and cultural site. The site is located approximately 670m south-west of the proposed King's Island FRS site on the other side of the Abbey River. The International Rugby Experience Building received Conditional Permission on 14th of February 2018, with an amendment granted Conditional Permission on 2nd of April 2019.

Due to the nature and location of the International Rugby Experience Building development in Limerick City, 225m away from the Shannon River, no likely significant cumulative impact on biodiversity is expected.

Corbally Housing Development, Corbally Road

The housing development proposed within the Corbally area is located adjacent to the Corbally Road to the east and the railway lines to the north and north-east. This proposed FRS is located approximately 215m east of the proposed King's Island FRS site.

The development is currently in the planning stage. As it is not possible to state in known detail whether the Corbally Housing Development Housing will present cumulative impacts in combination with the King's Island FRS at this stage, no detailed assessment of likely cumulative impacts can be assessed as part of the EIAR for this project.

[124] ARUP (2019) Limerick City and County Council Limerick Urban Centre Revitalisation - O'Connell Street Report for EIA Screening. Available at: https://www.limerick.ie/sites/default/files/media/documents/2019-09/05b%2804%29%20O%20Connell%20Street%2020190725%20EIA%20Screening.pdf]

8.11 Difficulties Encountered in Compiling this Information

There were no difficulties encountered in compiling this information.

9 Surface and Groundwater

9.1 Introduction

This chapter assesses and evaluates the surface and groundwater aspects of the proposed FRS. This chapter should be read in conjunction with Chapter 8 (Biodiversity) and Chapter 10 (Soils and Geology) due to overlapping impacts and mitigation measures.

The following legislation was consulted during the preparation of this chapter:

- The Water Framework Directive (WFD) (2000/60/EC) that established a framework for the protection of groundwater, surface water and transitional waters;
- The European Communities Environmental Objective (Surface Water) Regulations 2009 as amended (S.I. No. 792 of 2009);
- The River Basin Management Plan for the Shannon River Basin;
- The Foreshore Act;
- The European Communities (Water Policy) Regulations (S.I. No. 722 of 2003);
- The EU Floods Directive 2007/60 EC;
- Groundwater Directive (2006/118/EC); and
- The European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010).

9.2 Assessment Methodology

The methodology for rating impacts for the EIAR is completed in accordance with:

- The EPA 'Guidelines on the Information to be contained in Environmental Impact Statements' (EPA, 2002);
- The EPA document entitled 'Advice Notes on Current Practice in the Preparation of Environmental Impact Statements' (EPA, 2015);
- The 'Guidelines on the Information to be Contained in Environmental Assessment Report' (EPA, 2017) are also followed in this geological assessment and classification of environmental impacts; and
- National Road Authority (NRA) 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes' by the National Roads Authority (2009).

The rating of potential environmental impacts on the surface and groundwater environment is based on the matrix presented in Table 9-1 overleaf which takes account of the quality, significance, duration and type of impact characteristic identified.

The NRA criteria for estimation of the importance of surface water and hydrogeological attributes at the site during the EIAR Stage are summarised in Table 9-2.

In assessing likely potential and predicted impacts, account is taken of:

- The importance of the attributes; and
- The predicted scale and duration of the likely impacts

The quality, magnitude and duration of potential impacts defined in accordance with the criteria provided in the EPA Guidelines.

Table 9-1. Criteria for Rating Impact Significance of Hydrological Attributes (NRA)

Importance	Criteria	Typical Examples
Extremely High	Attribute has a high quality or value on an international scale	River, wetland or surface water body ecosystem protected by EU legislation e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988.
Very High	Attribute has a high quality or value on a regional or national scale	River, wetland or surface water body ecosystem protected by national legislation – NHA status Regionally important potable water source supplying >2500 homes Quality Class A (Biotic Index Q4, Q5) Flood plain protecting more than 50 residential or commercial properties from flooding Nationally important amenity site for wide range of leisure activities
High	Attribute has a high quality or value on a local scale	Salmon fishery Locally important potable water source supplying >1000 homes Quality Class B (Biotic Index Q3-4) Flood plain protecting between 5 and 50 residential or commercial properties from flooding Locally important amenity site for wide range of leisure activities
Medium	Attribute has a medium quality or value on a local scale	Coarse fishery Local potable water source supplying >50 homes Quality Class C (Biotic Index Q3, Q2-3) Flood plain protecting between 1 and 5 residential or commercial properties from flooding
Low	Attribute has a low quality or value on a local scale	Locally important amenity site for small range of leisure activities Local potable water source supplying <50 homes Quality Class D (Biotic Index Q2, Q1) Flood plain protecting 1 residential or commercial property from flooding Amenity site used by small numbers of local people

The NRA criteria for estimation of the importance of hydrogeological attributes at the site during the EIAR stage are summarised in Table 9-2 below.

Table 9-2. Criteria for Rating Impact Significance of Hydrogeological Attributes (NRA)

Importance	Criteria	Typical Examples
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status
Very High	Attribute has a high quality or value on a regional or national scale	Regionally Important Aquifer with multiple well fields Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source
High	Attribute has a high quality or value	Regionally Important Aquifer

	on a local scale	Groundwater provides large proportion of baseflow to local rivers Locally important potable water source supplying >1000 homes Outer source protection area for regionally important water source Inner source protection area for locally important water source
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer Potable water source supplying >50 homes Outer source protection area for locally important water source
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer Potable water source supplying <50 homes

9.3 Existing Environment

9.3.1 Baseline Desktop Assessment

This assessment was considered in the context of the available baseline information, potential impacts, consultations with statutory bodies and other parties, and other available relevant information. In collating this information, the following sources of information and references were consulted:

- Latest EPA Envision water quality monitoring data for watercourses in the area;
- EPA Catchment website (www.Catchment.ie);
- The Limerick City & County Development Plan;
- The Strategic Environmental Impact Assessment for the Limerick Regeneration Framework Implementation Plan prepared by HRA Planning and Limerick City & County Council, October 2013;
- The Planning System and Flood Risk Management, Guidelines for Planning Authorities (Department of the Environment, Heritage and Local Government (DoEHLG) and the Office of Public Works (OPW));
- CIRIA (2011). Environmental good practice on site: Construction Industry Research Industry and Information Association publication C692 (3rd edition- an update of C650 (2005). (I. Audus, P. Charles and S. Evans), 2011;
- CIRIA, (2012). Environmental good practice on site –pocket book; Construction Industry Research and Information Association publication C715 (P. Charles, and G. Wadams), 2012.
- Office of Public Works flood mapping data (www.floodmaps.ie);
- Environmental Protection Agency; [Available on-line at: http://gis.epa.ie], accessed 10/06/2019;
- Classification (regionally important, locally important) and extent of aquifers underlying the site perimeter area (www.gsi.ie);
- Natural hydrogeological/karst features in the area and potential for increased risk presented by the activities at the site (www.gsi.ie);
- National Parks and Wildlife Services (NPSW) www.npws.ie on-line database; Protected Register; and
- River Basin Management Plan 2018-2021.

Relevant documentation consulted as part of this assessment included the following:

- Technical note: Kings Island FRA: Updated hydrogeological summary (Arup, 2016);
- King's Island Flood Relief Scheme - Site investigation Contract, Phase 2 Factual Report (PGL, 2016);
- King's Island Options Report (JBA and Arup, 2018); and

- King's Island Surface Water Drainage Report (JBA, 2019).

9.3.2 Hydrological Environment (Surface Water)

Surface water bodies described in this section are shown in Figure 9-4, Volume 3 of this EIAR. This figure shows the hydrological environment within the Study Area.

River Shannon

The River Shannon is the largest river in Ireland, with a total catchment area covering approximately 17,000 km^2. The river rises in the Cuilcagh Mountains, at Shannon Pot, in Co. Cavan/Fermanagh. The river flows in a southwesterly direction, discharging into the Shannon Estuary. All of the River Shannon's flow drains to Limerick City, specifically around King's Island. King's Island is located at a large meander in the River Shannon, which splits into the Shannon and the Abbey River, a secondary channel of the Shannon. Around King's Island the river flows south toward Limerick City Centre before bending again and flowing west out to the Atlantic Ocean.

Approximately 1km upstream of King's Island, the main River Shannon meets the Ardnacrusha tailwaters at Parteen. This is an artificial channel constructed for use by the Ardnacrusha Hydroelectric station which is a further 2km upstream of the confluence. This artificial channel is over 13km long and extends from the Parteen weir to the confluence north of King's Island, which diverts water at controlled rates through to Ardnacrusha. The station and canal were built in 1925 to service the hydroelectric station. Ardnacrusha currently accepts flow at its maximum flow rate of 400m3/s.

Abbey River

At the north of King's Island, the Shannon splits into two distinct waterbodies; the Shannon and the Abbey River. The Abbey River is a smaller watercourse that flows south along the eastern and southern boundaries of the island before intercepting the Park Canal waters (artificial canal historically used for navigation to bypass Curraghgour Falls and Corbally rapids) and re-joining the Shannon adjacent to Merchant's Quay and the Courthouse.

It is believed that King's Island formed from the distributary of the River Shannon (Abbey River). The Abbey River is part of the Limerick Docks transitional waterbody of the Shannon Estuary.

The River Shannon and Abbey River are the main hydrological features that interact with the site.

Limerick Docks

The study area is in the Shannon River Basin District and surrounded by the Limerick Docks Transitional Waterbody. Limerick Docks is part of the Shannon Estuary, which extends from the Atlantic Ocean up to Limerick and has a length of 97 kilometres. The Shannon Estuary is divided into various transitional waterbodies: Lower Shannon Estuary, Fergus Estuary, Upper Shannon Estuary and Limerick Docks.

Both the Shannon and Abbey Rivers are within Limerick Docks Transitional Waterbody that extends across 3.03 km^2. Figure 9-4, Volume 3 outlines the water features within the study area. The estuarial waterbody encapsulates the River Shannon and Abbey River waterbodies in the vicinity of the site and extends to Athlunkard Bridge, approximately 2.8 km upstream of the development.

Upstream Tributaries

There are a few tributaries upstream of the study area, along the Shannon that may be affected by the introduction of flood relief infrastructure. The Shannon (Lower) and its tributaries, as well as, North Ballycannan River. The change in water levels or flow rates could have an effect upstream, therefore it is important to consider these waterbodies. These are shown in Figure 9-4, Volume 3.

Drainage ditches in St. Mary's Park

There are existing drainage ditches along the northwest of King's Island bordering St. Mary's Park and along northeast within the SAC, which attenuate much of the surface water that flows toward the River Shannon. These are detailed in Figure 9-1, Volume 3.

Flooding

Both the Abbey and Shannon rivers are tidal making King's Island susceptible to both fluvial and coastal flood risk. There is a history of flooding in King's Island, the most recent events recorded in

1999, 2002, 2009, and 2014. Prolonged rainfall, spring tides, and storm surges have been the source of severe flooding.

During the most recent severe flood event in Limerick City in February 2014, King's Island was one of the most affected areas due to the failure of existing local defences resulting in overtopping and breaching of water onto the island and surrounding areas. The result was displacement of residents and extensive property damage.

As King's Island is vulnerable to both tidal and fluvial flooding, the probability of flood extent was assessed for both event types and the greatest extent used to determine the geographical flood zones. King's Island is most vulnerable to tidal flood events in comparison to fluvial events, and so tidal event probability is used to determine geographical flood zones.

There are three types of flood zones defined for planning purposes in Ireland:

- Flood Zone A: where the probability of flooding from rivers and the sea is highest (greater than 1% AEP (1 in 100 year) for fluvial flooding, or 0.5% AEP (1 in 200 year) for tidal flooding);
- Flood Zone B: where the probability of flooding from rivers and the sea is moderate (between 0.1% and 1% (1 in 1000 to 100 year) for fluvial flooding, and between 0.1% and 0.5% (1 in 1000 to 200 year) for tidal flooding); and
- Flood Zone C: where the probability of flooding from rivers and the sea is low (less than 0.1% for both fluvial and tidal flooding). Flood Zone C covers all areas not covered by Zone A or B.

Much of King's Island is located within Flood Zone A, meaning that it has a High (1 in 200 year) probability of flooding. The extent of flooding during the 0.5% AEP (1 in 200 year) event in shown in Figure 9-5 in Volume 3. In terms of traditional planning implications, most types of development are considered inappropriate for this zone of flooding. OPW Guidelines for Planning Authorities (2009)[125] recommend that development in this zone should be avoided or only considered in exceptional circumstances, such as in city and town centres.

In the development of the CFRAM and the King's Island FRS, the island was divided into flood cells which informed the type of flood defence proposed. The upper, more residential part of the island is considered Flood Zone A, while the lower, more commercial part of the island is considered Flood Zone B.

Recreation and Landscape Value

The River Shannon runs through the heart of Limerick City and provides valuable recreation and landscape amenities. The River is popular for anglers, kayakers, boaters, and the banks of the River have many walkways which are used extensively by the public.

The use of the island and surrounding waterways by the local population is discussed in more detail in Chapter 6 - Population and Human Health.

The landscape value of the River Shannon and the Abbey River are further explained in Chapter 13 - Landscape and Visual.

Overall evaluation of Hydrological Features

Following NRA (2009) guidelines on the evaluation of hydrological features, the surface water bodies around King's Island are of Extremely High Importance, i.e. attribute has a high quality or value on a regional or national scale. This is due to the designation of the Lower Shannon SAC and the significance of the Shannon Estuary/Limerick Docks as both a commercial and recreational amenity which has great significance to both human beings and wildlife.

9.3.3 Hydrogeological Environment (Groundwater)

Groundwater can be defined as water that is stored in, or moves through, pores and cracks in subsoils. The potential of rock to store and transport water is governed by permeability of which there are two types, intergranular and fissure permeability.

There are two Groundwater bodies (GWB) within the study area that are of significant importance to the study: Limerick City North (IE_SH_G_139) and Limerick City East (IE_SH_G_138) (See Figure 10-2). They belong to the hydrometric area local authority of Shannon Estuary (25), Co.

[125] OPW. (2009). *Guideline 20: The Planning System and Flood Risk Management: Guidelines for Planning Authorities*.

Limerick. The GWB is low-lying, with elevations ranging from <10mAOD to about <40mAOD. Groundwater recharge occurs over most of the groundwater via rainfall, soaking though the subsoil and directly to the aquifer via outcrop. Urban and paved areas inhibit groundwater recharge. These GWB (Limerick City North and East) sustain flows into the surrounding rivers and streams the flow through the GWB (Shannon and Abbey River). The following reports were referenced in the preparation of this chapter:

- King's Island Flood Relief Scheme - Site investigation Contract, Phase 2 Factual Report (PGL, 2016); and
- Technical note: Kings Island FRA: Updated hydrogeological summary (Arup, 2016)

Aquifer Classification

Aquifers are generally classified as rocks or other matrices that contain sufficient void spaces and which are permeable enough to allow either significant flow of groundwater or the abstraction of significant quantities of groundwater. The GSI has classified the Limerick City North aquifer as primarily 'Locally important aquifer, bedrock which is generally moderately productive'. The same has been classified for the Limerick City East Aquifer, however in the south of the GWB there is a small area (2.5 km^2) of locally important aquifer which is moderately productive only in local zones. The groundwater bodies around King's Island are shown in Figure 9-2, Volume 3.

Aquifer vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristic that determine the ease with which groundwater may be contaminated generally by human activities. Due to nature of the flow of groundwater through bedrock in Ireland, which is almost completely through fissures, the main feature that protects groundwater from contamination and therefore the most important feature in protection of groundwater, is the subsoil (which can consist solely/ or of mixtures of peat, sand, gravel, glacial till, clays, or silts). Aquifer Vulnerability is shown in Figure 9-3, Volume 3.

The GSI groundwater vulnerability classification for Limerick City East GWB is classified as Extreme and High. Extreme vulnerability occurs in more extensive areas over the Volcanic rock aquifers in the north and south of the GWB, and only in small isolated areas over the limestone aquifers. The aquifers in the remainder of the GWB are Highly vulnerable. Groundwater vulnerability for the Limerick City North GWB is predominantly High. Extreme vulnerability occurs in small areas near Parteen, along the western boundary of the GWB, and in the SE. There are isolated small areas of Moderate vulnerability in the centre of the GWB.

Groundwater Testing (Site Investigation)

A site investigation completed by PGL (2016)[126] noted groundwater during boring and trial excavations at a depth ranging from 0.3m to 10.8m bgl. Deeper groundwater levels were observed on the eastern side of the island close to the banks of the Abbey River (5.8m to 10.8m bgl). In general, shallower strikes (3.1m to 4.4m bgl) were observed in the southern part of the island along Sir Harry's Mall and George's Quay.

The site investigation report also included water testing of groundwater at 7 boreholes, which tested for a range of parameters relevant to the European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010). A comparison of threshold values was made to determine the quality of groundwater within King's Island. According to Schedule 5 of these regulations:

“Threshold values” have been established for pollutants that are causing a risk to groundwater bodies. Exceedance of a relevant threshold value at a representative monitoring point triggers further investigation to confirm whether the criteria for poor groundwater chemical status are being met. If the criteria for poor chemical status are being met by one or more of the test procedures in Schedule 7, then a body or a group of bodies of groundwater is classified as being at poor chemical status.

The results identified that none of the parameters measured exceeded the thresholds for pollutants.

A hydrogeological investigation by Arup (2016)[127] (Appendix D[1] of this Volume) determined that groundwater in the limestone beneath the site is locally confined beneath the clay and highest in

[126] PGL. (2016). King's Island Flood Relief Scheme - Site investigation Contract, Phase 2 Factual Report
[127] Technical note: Kings Island FRA: Updated hydrogeological summary (Arup, 2016)

the centre of the site. The available data indicate that groundwater flow is likely to be radial from the centre outwards with surging effect close to the river reflecting tidal cycles.

Results of the Site Investigation, including groundwater strikes and groundwater testing are provided in Appendix D2, with accompanying figure provided in Figure 9-6 of Volume 3.

Water Framework Directive GWB Status and Risk

The WFD Risk Score for both Limerick City East and West GWB are 1a At Risk (See Table 9-3 overleaf). This means that the GWBs are at high risk of not achieving good status.

A review of the Geological Survey of Irelands data base (www.spatial.dcenr.gov.ie/) identified that there is a range of groundwater vulnerable areas within King's Island alone. Most of the island has a vulnerability level of moderate, however it has pockets of high vulnerability and X vulnerability (Rock at or near surface, though this was determined to be inaccurate as a result of the site investigation). The areas surrounding King's Island (Limerick City) are variable as well, being dominated by moderate and high levels of groundwater vulnerability.

According to the GSI characterisation, both GWBs are unconfined with the rivers and streams in hydraulic continuity with the aquifer, which means that if GWBs become contaminated, the rivers will also be affected.

There are various groundwater pressures present. Groundwater is vulnerable to seepage though the gravel layer underneath, due to the fissured bedrock. The analysis in the northern part of the island at BH105 indicates the seepage beneath the embankment would be circa 2 l/hr per m section127. Point source pollution poses the greatest threat to groundwater through septic tank effluent, sinking streams, leakages, and leachate from waste disposal sites. There were some illegal dumping sites on Islands Fields, St. Mary's Park in King's Island. Though this has been removed by Limerick City Council, some contaminants may still remain in the area.

Water Supplies

Limerick City North and East GWBs are used for drinking water and feed into the Limerick City Public Water Supply (PWS). (They both extend throughout Shannon District and have been described to have productive fissured bedrock. The existence of boreholes imply that the ground conditions are usually circa 2-7 metres depth of soft to very soft clays (SPT<10) over gravel. (See Chapter 10 Soils and Geology).

Groundwater Extractions

There are no known groundwater extractions on King's Island. Groundwater is not used as potable water on the island, rather, potable water on King's Island is obtained from the Limerick PWS.

Overall evaluation of Hydrogeological Features

Limerick City North and East GWBs are both classified as locally important aquifers which are generally moderately productive. Following NRA (2009) guidelines, these hydrogeological features are considered to be of Medium significance, i.e., the attributes have a medium quality or value on a local scale.

9.3.4 Discharges, IPPC/IE licenced companies and WWTP

Details on existing discharges to the foul sewer network, licensed discharges/extractions, and urban waste water treatment plants (WWTP) are discussed in Chapter 7 Material Assets.

9.3.5 Surface/Groundwater Interaction

Part of the Lower Shannon Special Area of Conservation (SAC) lies within the site boundaries. A hydrogeological investigation by Arup[127] was completed to determine whether the SAC is influenced by groundwater, and the finding of this investigation is summarised here.

Near the SAC, the site investigation illustrates that the peat / soil material is underlain by silt and clay. These in turn overlie sand / gravel and cobbles which overlie the bedrock.

Made ground in the SAC is described as having ‘tar inclusions’ indicating that there may be minor contamination due to the presence of Made ground.

Groundwater monitoring wells were installed in the limestone and the overburden to determine the interaction between these units. Available data indicates that one well (BH105, located in the northeast corner of the island), shown in Figure 9-6, Volume 3, with a response zone beneath the clay (in limestone) is artesian or at ground indicating that the clay is acting as a confining unit. Shallower wells show water levels at or below ground level further illustrating this.

The SAC is receiving recharge from rainfall which in inhibited from infiltrating into the underlying gravels due to the low permeability clay covering the site. Surface water runoff flows towards drains which flow towards the eastern boundary of the site. The river is not contributing flow to the SAC.

During flooding events, the rate at which the groundwater levels in all the geological units will rise will be determined by the level of the flooding, the position in the tidal cycle, how saturated the deposits are and the permeability of the material.

9.3.6 Environmental Status

WFD Status and Risk

The Environmental Protection Agency (EPA) is the body tasked with sampling and reporting on the various aspects of the WFD in Ireland. The EPA has published continuous monitoring of waterbodies around Ireland from 2007-2015. All surface waters were monitored, assessed, and classified in these publications. Ongoing monitoring still exists but has yet to be published for more recent years.

Limerick Dock is considered a heavily modified transitional waterbody (HMWB) for uses such as navigation. According to the WFD (2000/60/EC), transitional waters are described as the following:

"Bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal water but which are substantially influenced by freshwater flow."

The current objective for Limerick Docks transitional waterbody is to restore water quality to 'good status' by 2021.

The remaining waterbodies within the study area are classified as either "river" or "groundwater" under the WFD. The classification for each water body in the area is provided in Table 9-3.

Table 9-3. WFD Status for waterbodies in the study area

Water body Name	Status	Risk Value	Objective
River			
North Ballycannon River (North Ballycannan_010)	Moderate	At Risk	Protect
Lower Shannon (SHANNON (LOWER)_060)	High	Not At Risk	Restore_2021*
Transitional			
Limerick Dock	Moderate	At Risk	Restore_2021*
Groundwater			
Limerick City North	Good	At Risk	Restore_2021*
Limerick City East	Poor	At Risk	Restore_2021*

* Restore to "Good" status by 2021

The factor that put the quality of Limerick Dock as "At Risk" were primarily due to one point risk source which was identified as CSO (combined sewer overflow) discharges.

The Shannon River Basin District Transitional and Coastal Action Plan (2008) carried out a Pressure Based Risk Assessment and determined that Limerick Dock is at risk of land-based point source pressures such as combined sewer overflows, treatment plant overflows and direct licensed discharges. These risks are heightened by the potential fluvial and tidal floods that are probable in the area. Various mechanisms have been identified and recommended in order to restore Good Status of Limerick Dock waterbody, these include:

- Better monitoring and management of point source pollution (Licensed discharge, WWTPs and nutrient inputs);
- Flow amelioration work in the Abbey River;
- Flood relief measure and infrastructure;
- Control of urban waste discharges; and

- Control of unsewered wastewater discharges.

Surface Water Quality (Q-Rating)

The WFD status was used to determine the Q-value for Limerick Docks using the EPA's Q-Rating system. The EPA uses the Q-Rating system for the biological classification of water systems by using macro-invertebrate sensitivity, abundance, and diversity as indicators of water quality. The Q Rating system condenses the biological information into a simple 5-point biotic index (the Q value). Table 10-4 below illustrates the rating system and water quality.

Table 9-4. EPA Q-Rating System

Q Value	WFD Status	Pollution Status	Condition
Q5, Q4-5	High	Unpolluted	Satisfactory
Q4	Good	Unpolluted	Satisfactory
Q3-4	Moderate	Slightly Polluted	Unsatisfactory
Q3, Q2-3	Poor	Moderately Polluted	Unsatisfactory
Q2, Q1-2, Q1	Bad	Seriously Polluted	Unsatisfactory

The most recent status update on the Limerick Dock transitional waterbody Water Quality (WQ) was December 2014, where it received a status of "Unpolluted waterbody" making its condition Satisfactory.

The EU has identified priority hazard substances which include certain metals, pesticides, hydrocarbons, volatiles and hormone-disrupting compounds. In the assessment of the Shannon River Basin water quality status, Limerick Dock failed in relation to certain Specific Pollutants and Chemicals. Although the Limerick Dock water quality status has been classified as Unpolluted, under the EPA water quality assessment, the transitional waterbody failed the chemical status due to the breach of levels of brominated diphenlyethers, antracence, chloroalkenes and polyaromatic hydrocarbons. Assessments are underway to determine the sources of pollution and determine suitable strategies to lower the chemical pollution.

The closest water quality monitoring gauge on the River Shannon is located approximately 13km upstream of King's Island near Castleconnell (Station ID: RS25S012500). The most recent status update for this Castleconnell station was in 2015 and returned a Q value of 3-4, which is considered unsatisfactory.

No further Q-ratings were assigned to surface water bodies within the study area.

Lower River Shannon SAC

The Limerick Docks and the surface water bodies surrounding King's Island are part of the Lower River Shannon SAC [002165]. The River Shannon as it flows around King's Island and the eastern portion of King's Island is included within the SAC designation. The site contains many Annexed habitats, including the most extensive area of estuarine habitat in Ireland. The Lower River Shannon SAC contains internally and nationally important habitat for species of dolphin, lamprey, salmon, and waterfowl. The SAC is described further in Chapter 9 Biodiversity.

9.4 Predicted Impacts

For ease of discussion we have assessed the predicted impacts under the 'do nothing' scenario, during construction of the scheme, during operation of the scheme and decommissioning of the scheme. Tables 9-1, 9-2 and 9-3 in this chapter provide the reader with the criteria for significance testing.

9.4.1 Do Nothing Scenario

Much of King's Island, specifically the lands around St. Mary's Park, are within Flood Zone A, meaning that they are at a high probability of flooding where homes and businesses are currently located. In the event of a flood without adequate standard of protection, contamination to existing surface and groundwater environments is extremely likely. This will take the form of mainly suspended materials from the Shannon and Abbey Rivers. The current embankments and surface water drainage have the potential to worsen the water quality around King's Island over time if not adapted to improve the flood protection scheme. The drains within the island that currently assist in drainage, would, over time become overgrown and the effectives and functions of the drains would deteriorate. This would lead to further localised flooding and ponding of surface water.

9.4.2 Construction Phase

Construction will take place close to the Abbey River and the River Shannon in some areas of the scheme. In other areas, construction will require the excavation of soil and consequently the removal of the soil layer which protects the groundwater bodies. As such, pollution of surface water and groundwater is a great concern during the construction phase. The engineering works which will have the greatest potential to impact on the surface and groundwater environments include the following:

- Site preparation including the construction of the construction compound, temporary fencing and hoarding, and the erection of signage and traffic diversion signs throughout the island;
- Health Risks: As the work progresses, any remaining contaminated material in the old landfill has the potential to become exposed to rainfall and surface water runoff;
- The presence of the Japanese Knotweed Bund has the potential to release legumes or pieces of Japanese Knotweed into the surface water or onto human clothing, thus potentially spreading this material downstream;
- Import and placement of approximately 143,600m^3 of earth fill for construction of the embankments around the north side of the island;
- Demolition of old, and construction of new flood walls on the banks of the Shannon and Abbey Rivers;
- Excavations of hardstanding and topsoil during the construction of walls and embankments beside the River Shannon and along the rear of the houses on St. Munchin's Street, which will exposure the Rivers to contaminants and suspended solids;
- Use of jack-up rigs on the bed of the River Shannon and Abbey River to be used as a work platform for machinery operating at Merchant's Quay and the Absolute Hotel;
- Construction of access roads and foot paths;
- Groundwater pumping as a result of excavation works; and
- The removal of some existing drainage infrastructure and the installation of the upgraded drainage network to depths of 1.5m bgl.

The ways in which these works may impact on the surface water environment are through the following:

- Impacts from excavation and infilling;
- Accidental spills and leaks;
- Surface water runoff from the construction site;
- Groundwater contamination;
- Changes to the surface water drainage network; and
- Instream works / works near water.

These potential impacts are expanded below.

Excavation and Infilling

Excavation and import of soil will be required for construction of the embankments. It is estimated that approximately 143,600 m^3 of soil will be required for the construction of the 2,200 linear metres of embankment at different locations around the island. This will allow exposure of a significant area of bare ground around the north side of the island while construction work is ongoing, by providing a direct pathway to the underlying groundwater body. The excavation of material and import of fill material will increase the availability of suspended solids in surface water runoff from the site. The runoff may impact on the water quality in the River Shannon and Abbey River by increasing suspended solids level in the water. Increased suspended sediment concentrations in the water can be detrimental to wildlife and to the Lower River Shannon SAC. It is anticipated that these operations will have a moderate significant temporary impact on water quality in the rivers.

Accidental Spills and leaks

During construction of the development, there is a risk of localised accidental pollution incidences from the following sources:

- Spillages or leakage of temporary oils and fuels stored on site;
- Spillages or leakage of oils and fuels from construction machinery or site vehicles;
- Spillage of oil or fuel from refuelling machinery on site; and
- Run-off from concrete and cement during the foundation construction.

Accidental spillages may result in localised contamination of surface and groundwater underlying the site should contaminants migrate through the subsoils and impact underlying groundwater.

Any soil stripping and foundation construction will further reduce the thickness of subsoils and the natural protection they provide to the underlying aquifer. Concrete (specifically, the cement component) is highly alkaline and any spillages which migrate through subsoil can be detrimental to groundwater quality. The changes in pH of the waterbody will have a potential impact on water dependant species using the rivers on both sides of the island.

Machinery on site during the construction phase may result in contamination of the surface water. The potential impacts could derive from accidental spillage of fuels, oils, paints and solvents, which could impact surface water and groundwater quality if allowed to infiltrate to runoff to surface water systems and/or receiving watercourses. In addition, the compaction of the soils and subsoils by construction machinery will impact on the drainage function of the soil and hence render surface water runoff more probable. The compacted soil will create a pathway for a source, in this case oil/contaminated soil, to enter into a watercourse (receptor).

Surface Water Run-off and Groundwater Pumping

Surface water run-off during the construction phase will contain increased silt levels as a result of the exposure of bare ground and import of fill materials onto the site. If excavated and imported soils were to contaminate surface water runoff, the impact to the existing surface water bodies could be detrimental, affecting the downstream reaches of the Lower Shannon River and Estuary for the duration of the runoff.

Run-off containing large amounts of silt can cause damage to groundwater underlying the site. Silt-laden water can arise from exposed ground and soil stockpiles (prior to reinstatement). Excessive quantities of suspended material entering and depositing in the watercourses may impact on the hydromorphology of the Abbey and Shannon rivers.

Groundwater pumping will be required where the water table is encountered during excavations, most likely around the quay walls (George's Quay and Sir Harry's Mall). Appropriate mitigation will be required to ensure that groundwater discharged via pumping is not contaminated with suspended solids.

Groundwater Contamination

The excavation of overburden on the site for the placement of embankments and foundations for hard defences will reduce the overburden that reduces the vulnerability of groundwater. Pumping will be required where groundwater is encountered during excavations. Groundwater is likely to be contaminated with soil and silt materials and will require settling and/or filtration before being discharged.

Changes to the Surface Water Drainage Network

Proposed changes to the surface water drainage network are described in detail in Section 4.3 of this EIAR. Drawings showing the proposed upgrades to the drainage network are provided as part of the planning submission. Works will generally consist of:

- New outfalls fitted with non-return valves at various locations around the island;
- Decommissioning of selected existing outfalls;
- Installation of new non-return valves on selected existing outfalls;
- Widening of selected existing outfalls;
- New open drains;

- Filter drains at the toe of embankments;
- Provision of underground concrete intertidal and surface water storage tanks;
- Diversion of one area of foul sewer network into the Limerick Main Drainage sewer; and
- New manholes and raising of selected existing manholes.

Changes to the surface water drainage network have the potential to impact on the surface and groundwater environments primarily through increased suspended silt levels during the construction phase. Improved surface water drainage will increase runoff, and decrease groundwater infiltration within King's Island. This will have a slight negative impact on groundwater recharge.

Instream Works and Works Near Water

Works at Merchant's Quay and the Absolute Hotel are constrained by the available space for machinery to operate from the banks, and so will require the use of jack up rigs on the bed of the River Shannon and Abbey River to be used as work platforms. There will be two areas of instream works on the Shannon and Abbey Rivers:

(1) At the south east corner of the Absolute Hotel, instream work on the Abbey River is proposed. This is necessary for construction of a section of reinforced concrete wall to replace the existing parapet wall which is below the design flood defence level. Instream works will comprise the construction of a temporary, enclosed working platform on stilts (jack up rig) adjacent to the wall to allow part of the construction works to occur from the river side.

(2) At the south west of the Courthouse, instream work on the Shannon River is proposed. This is necessary for construction of a section of board walk around the Courthouse and would include sealing of existing joints, tanking of walls, removal of vents on walls adjacent to the river prior to the construction of the boardwalk and glass panels. Instream works will comprise the construction of a jack up rig to allow part of the construction works to occur from the river side.

These working platforms will be moved respective of the needs during each phase of construction including demolition of existing walls, excavation, and installation of new walls. Installation of the rigs will involve dropping legs onto the bed of the river and bolting into the side of the quay walls. These operations will impact on the surface water quality due to riverbed disturbance/silt mobilization, and dust, debris, oil, or contaminated runoff falling from the barge into the river. The impacts will be localised, and it is expected that currents will disperse any suspended materials. The heavier solids that may be suspended during the placement of the jack-up rig will settle out quickly.

Summary

Based on the points stated above in relation to the construction phase, the potential impact on the surface and groundwater environments (following EPA, 2002) has the potential to have a Short-term, Significant impact with a Negative impact on quality, i.e. an effect which by its character, magnitude, duration, or intensity alters a sensitive part of the environment. These effects would be reduced to Short-term, Slight effects if properly mitigated (as described in Section 9.5).

9.4.3 Operation Phase

Once the scheme is built and operational, assuming that the scheme functions as intended, the following impacts were identified:

- Contaminated surface and stormwater runoff entering the River Shannon and Abbey Rivers;
- Raised walls and embankments have the potential to increase the water level and velocity in the river during flood events, having secondary impacts on hydromorphology;
- Impacts to the physical riverine habitat as a result of changes to hydromorphology;
- Alkaline runoff from stone and concrete walls entering the watercourses or groundwater;
- Potential ground hardening/leakages as a result of the creation of access tracks for maintenance vehicles; and
- Increased drainage on the island, compacted surfaces, and increased hard standing have the potential to reduce infiltration and groundwater recharge.

Flood protection measures deepen the active channel through raising of bank levels and reduced floodplain storage, both effects which have the potential to increase stream power and shear stress on the bed of the river. Increased shear stress on the bed (a function of water depth) impacts sediment transport, erosion, and deposition. Impact to water levels as a result of the scheme was investigated through a glass wall modelling exercise completed during the options assessment stage of the scheme which determined that the scheme will not have an impact on water levels in the River Shannon. Additionally, most of the defences of the scheme are set back from the riverbank and into the floodplain, meaning that they will only interact with the active river body during flood events. Therefore, there is little interaction and influence on water level/bed shear stress.

Modelling was completed for the post-scheme scenario to investigate water levels in surrounding areas such as Corbally and Shannonbanks. The modelling results show no net increase in water level in the post-scheme scenario. This means the change in situation between the pre- and post-scheme design is minimal in terms of defence elevation, but clearly provides a significantly improved standard of protection when integrity of the defence is considered.

The impacts resulting from the creation of access tracks would be minimal, as vehicles would be travelling very infrequently on these tracks. Leaching from stone and concrete will also be minimal, as the stone will be finished, and concrete will be mostly buried underground, minimising exposure to runoff and erosive materials

With regards to impacts on groundwater, increased drainage on the island, compacted surfaces, and increased hard standing will reduce infiltration and groundwater recharge. However, this impact on recharge will be very localised and therefore has the potential to have only minimal impact in the long term. The foundations for defence wall will not significantly impact on the flow of groundwater in the overburden aquifers at the site. This will not measurably reduce the wetness of the ground in the SAC.

Based on the points stated above in relation to the operation phase, the potential impact on the surface and groundwater environments during the operation phase (following EPA, 2002) is considered to have a Long term, Not Significant impact with a Neutral impact on quality, i.e. an effect which alters the character of the environment without affecting its sensitivities.

9.5 Mitigation Measures

9.5.1 Do Nothing Scenario

In the do-nothing scenario, no mitigation measures will be required.

9.5.2 Construction Phase

To reduce the impacts to surface water as a result of excavation and infilling, accidental spills and leaks, and surface water runoff during the construction phase of the scheme, the following mitigation measures are proposed.

Best Practice Construction Methods

The following Guidelines will be used, as a minimum, by the contractor to prepare their Method Statements and Environmental Management Plan:

- Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters. Inland Fisheries Ireland, 2016;
- Fishery guidelines for Local Authority works. Department of Marine and Natural Resources 1998;
- CIRCA – Guideline Document C532 – Control of Water Pollution from Construction Sites; and
- CIRIA – Guideline Document C642 – Development and Flood Risk – Guidance for the Construction Industry.

Surface Water Run-off and Groundwater Pumping

The Main Contractor and sub-contractors shall be responsible for ensuring the following measures are implemented if with regards to surface water run-off and discharge of groundwater during pumping activities:

- If surface water or groundwater ingress into excavations is encountered, then the Main Contractor should ensure that the groundwater is not exposed to hazardous materials. If removal of the groundwater is required then this should be stored, treated if necessary and disposed of appropriately. If disposal of groundwater to the public sewer is required, then the necessary approval and license should be sought from Irish Water;
- Contractors will ensure that spill kits will be accessible to construction personnel at all times and all spills will be reported to the Main Contractor;
- All works undertaken near the banks will be fully consolidated to prevent scour and run-off of silt. Consolidation may include use of protective and biodegradable matting or geotextiles on the banks and the sowing of grass seed on bare soil. A silt fence should be included around the site perimeter in the vicinity of earth works, where possible, to retain silts onsite;
- If ponding occurs onsite during periods of heavy rainfall, water will pumped into a pond or sedimentation tank to allow settling of fine sediments prior to pumping to the local stormwater system;
- Stockpiles of soil will be remotely located from waterbodies;
- All concrete works will be carried out in dry conditions;
- All earthworks will aim to be carried out in periods of dry weather (from April to September inclusive) to avoid potential for suspended sediment runoff; and
- A site-specific CEMP will be prepared by the contractor prior to the commencement of any works in order to ensure all works are carried out in a manner designed to avoid and minimise any adverse impacts on the receiving environment.

Accidental Spills and Leaks

With regards to accidental spills and leaks, the Main Contractor and sub-contractors shall be responsible for ensuring the following measures are implemented:

- The Project Manager will take full ownership of the CEMP and will be responsible for storing all site records, including but not limited to, training records, incidents and emergencies, environmental quality monitoring records and updates to Method Statements. Sub-contractors will be made aware of the site-specific Construction and Environmental Management Plan for the work;
- Construction methods adopted by the contractors will be to minimise the requirement to disturb habitat in foreshore areas;
- An Emergency Plan for the site will be established by the Main Contractor prior to work commencing at the site. As a minimum the Emergency Plan should contain contact details for statutory bodies such as the NPWS and IFI. All site workers should be made aware of the plan and its location in the site offices;
- There will be no refuelling of machinery within or near the river channel. Refuelling will take place at designated locations at distances of greater than 30 metres from the watercourse;
- No vehicles will be left unattended when refuelling and a spill kit including an oil containment boom and absorbent pads will be on site at all times;
- Any fuel that is stored on the site will stored appropriately and at a location that is set back from the river. All other construction materials will be stored in this compound. The compound will also house the site offices and portable toilets. This compound will either be located on ground that is not prone to flooding or will be surrounded by a protective earth bund to prevent inundation;
- All vehicles will be regularly maintained and checked for fuel and oil leaks;
- All liquids, solids and powder containers will be clearly labelled and stored appropriately in sealable containers. Storage of fuels and oils will be in the main contractor's compound only;
- If a spillage does occur, it will be contained with adsorbent pig bags. These will be placed in a hazardous waste bin for ultimate disposal. The contractor will replenish the adsorbent pig bags immediately;
- Where a contractor is responsible for materials stored in a bunded area, that contractor shall implement measures for the regular inspection of bunds and emptying of rainwater (when uncontaminated). Bunding must have a minimum capacity of 110% of the volume of

the largest tank or 25% of the total storage capacity, whichever is the greater. Bunding shall be impermeable to the substance that is being stored in the tank;

- The use of settling lagoons, settling tanks, or equivalent, with outflow control measures may be used for the interception of surface water or groundwater pumped from an active working area;
- Concrete and mortar washout will take place in an impermeable bunded/lined area. The concrete will be allowed go off and broken up and used as blinding for site roads/haul roads etc;
- If a spillage of a hazardous material to groundwater does occur, the groundwater will be contained and pumped to a tank or holding vessel prior to shipment off site for disposal. The contractor will maintain disposal records. The contractor will identify the cause of the spillage and mitigation measures and controls will be put in place to prevent a repeat. The CEMP for the site will be updated and contractors and sub-contractors will be made aware of the amendments;
- Where possible, excavated soils should be re-used on site. Stockpiles of material should be located away from waterbodies;
- In the event of contaminated ground or hazardous waste been uncovered e.g. asbestos, work will stop and an investigation into the extent and characteristics of the material will be undertaken. The waste material will be removed by a licenced haulier and disposed of at a licenced/permitted facility. Waste disposal records will be kept by the Project Manager. Sandbags/ silt fences should be placed on the surface water drainages channels in this event;
- A water quality monitoring regime will be established and agreed with the NPWS and IFI in advance of works commencing; and
- All wastes generated within the canteen will be segregated and handled separately (further addressed in Chapter 7 - Material Assets including Waste).

Instream Works

With regards to instream works and the use of the moveable working platforms/jack up rigs, the following mitigation is proposed:

- The platform will be impermeable with raised sides to ensure that any spillages or debris caught by the barge is trapped before entering the surface water;
- Netting or similar should be used in the space between the jack up rig and the walls to trap any falling debris which would otherwise fall into the River Shannon or Abbey Rivers;
- Construction should be phased appropriately to avoid multiple movements of the jack-up rig, therefore limiting disturbance to the riverbed; and
- Reference Chapter 8 Biodiversity to mitigate impacts to any fauna or flora which may be impacted as a result of instream works.

Flooding during construction

There is a possibility that a flood will occur during the construction phase. To ensure that King's Island does not become more vulnerable to flooding during construction, the old flood embankments around the north of the island will be left in situ until the new embankments are finished.

To ensure that the south side of the island does not become vulnerable to floods during construction (particularly areas A9 south of the Absolute Hotel, Area 10 Abbey Bridge to Baal's Bridge, and area Area B2 at the pontoon access), the contractor will be required to monitor storm and high tide conditions that may cause inundation. In the event of a high tide or storm event, temporary concrete flood barriers can be erected at the exposed locations.

All works undertaken near the banks will be fully consolidated to prevent scour and run-off of silt. Consolidation may include use of protective and biodegradable matting or geotextiles on the banks and the sowing of grass seed on bare soil.

Earth works will be aimed to take place during the driest season to ensure that any flooding during the wet season does not result in mobilisation of significant quantities of unconsolidated material.

9.5.3 Operation Phase

Impacts to surface and groundwater during the operation phase of the scheme have been accounted for in the design of the scheme and require no mitigation once the scheme is constructed. Design adaptations included the following:

- Improved surface water drainage across the island, including filter drains at the base of all embankments, which are designed to filter sediment, organic material, and oil from runoff before entering the watercourses;
- Erosion mitigation will be put in place at the sheetpiling in area A4 to prevent further erosion on the river side of the piling;
- Design of a swale feature at the north east corner of the island (inside of the embankments); and
- New embankments are to be set back from the existing lower embankments to avoid close contact with the River Shannon and the Lower Shannon SAC.

9.6 Residual Impact

Following the implementation of the recommended mitigation measures and the final design and layout of the scheme, the magnitude and significance of the residual impacts is discussed in the following sections.

9.6.1 Do Nothing Scenario

In the do-nothing scenario, the surface and groundwater bodies around King's Island will experience Moderate effects with a Long-term, Negative impact on quality, i.e., effects which alter the character of the environment in a manner that is consistent with existing and emerging baseline trends.

9.6.2 Construction Phase

Provided that mitigation measures are followed closely during the construction phase of the scheme, the residual impact to surface and groundwater water bodies (following EPA, 2002) is considered to be a Short-term, Slight impact with a Negative impact on quality, i.e. an effect which causes noticeable changes the character of the environment without affecting its sensitivities.

9.6.3 Operation Phase

During the operation phase of the project, taking into account the design considerations benefitting surface and groundwater bodies, the residual impact will be Long-term and Slight effect, with a Neutral impact on quality, i.e. an effect which causes noticeable changes the character of the environment without affecting its sensitivities.

9.6.4 Monitoring

The site-specific CEMP will set out the monitoring requirements for the scheme during the construction stages. The monitoring programme should work on the if/when protocol i.e. if the total petroleum hydrocarbon levels in the groundwater exceed the recommended threshold, then the mitigation measures for groundwater protection will be reviewed and revised by the environmental manager acting on behalf of the contractor.

As a minimum the following parameters should be recorded in surface waters: pH, conductivity, chemical oxygen demand, suspended solids and total dissolved solids. Parameters for groundwater should include as a minimum, total petroleum hydrocarbons, pH, conductivity, suspended solids and total dissolved solids. The frequency and reporting procedures should be agreed with the NPWS and IFI before commencement of the work. All monitoring records should be maintained by the Project Manager or his nominated assistant.

9.6.5 Interactions with other Environmental Effects

Impacts to surface and groundwater have the potential to interact with the following environmental factors:

- Chapter 8 - Biodiversity: The waterbodies surrounding around King's Island are part of the Lower Shannon SAC, which is valuable habitat for a number of significant and protected species;

- Chapter 10 - Soil and Geology: Groundwater and aquifer characteristics and activity are largely dictated by geology and overlying soils. Impacts such as soil compaction, water infiltration into soil, and groundwater flow are directly related to both soil and geology, and surface and groundwater; and
- Chapter 13 - Climate Change: Surface water bodies around King's Island will be directly affected by climate change through sea level rise and changes to precipitation patterns, which is projected to cause increased water levels, and higher frequency of intense storms.

9.6.6 Potential Cumulative Impacts

Of the nearby projects identified in Chapter 16 as having the potential to have cumulative impacts with the proposed project, the following were found to have the potential to interact with the surface and groundwater environment of King's Island:

- Killaloe Bypass / Shannon Bridge Crossing and R494 Improvement Scheme;
- Limerick City and Environs Flood Relief Scheme (FRS);
- Castleconnell Flood Relief Scheme (FRS); and
- Springfield Flood Relief Scheme (FRS).

The Killaloe Bypass /Shannon Bridge Crossing and R494 Improvement scheme will involve a new bridge crossing over the River Shannon approximately 16.5 km northeast of King's Island. The proposed bridge will cross the River Shannon approximately 1km to the south of the existing Killaloe Bridge and will cross the Kilmastulla River (a tributary of the River Shannon and part of the Lower River Shannon SAC). As of March 2019, the design and land acquisition were still ongoing. Any impacts to surface water quality as a result of the bridge construction (i.e., suspended solids entering the Shannon through surface water runoff) would have the potential to add cumulatively to the impacts of the King's Island FRS.

The remaining FRS projects are not prepared in sufficient detail yet to determine cumulative impacts on surface water environment to any certainty. The construction of the schemes is not likely to overlap, therefore impacts to the surface and groundwater during construction are not likely to have cumulative effects. If construction phases do overlap, then there are likely to be cumulative impacts as a result of contaminated surface water runoff entering the rivers. There is unlikely to be cumulative impacts on hydromorphology of the River Shannon, as the river around King's Island is primarily tidally influenced. Cumulative impacts to the groundwater environment are unlikely. Cumulatively, these schemes are likely to have a positive impact in the long term due to management of overland flow.

9.7 Difficulties Encountered in Compiling this Information

There were no difficulties encountered in compiling this information.

10 Soils and Geology

10.1 Introduction

This chapter assesses and evaluates the impacts of the proposed FRS soil and geology. This chapter is also linked with Chapter 9 Surface and Groundwater.

10.2 Relevant Legislation

The legislation pertaining to groundwater and the Water Framework Directive are applicable for this portion of the EIAR and the reader is referred to Chapter 10 for more information.

The 1996 Waste Management Act (as amended) is also relevant to this section of the EIAR. In summary the act implements the EU Council Directive 99/31/EC (the Landfill Directive) on the landfilling of waste.

Classification of waste material that may be taken off-site for disposal is based on the Commission Decision of 18th December 2014, amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC of the European parliament and Council (2014/955/EEC) [the List of Waste (LoW)]. These enable waste to be classified as either hazardous, non-hazardous or minor (either hazardous or non-hazardous).

10.3 Assessment Methodology

The methodology for rating impacts for the EIARs is completed in accordance with the guidance framework outlined in Chapter 1.

Due consideration is also given to the guidelines provided by the Institute of Geologists of Ireland (IGI) in the document entitled ‘Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements’ (IGI 2013). In addition, the document entitled ‘Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes’ by the National Roads Authority (NRA, 2009) is referenced where the methodology for assessment of impact is appropriate.

In the EIARs assessment, consideration is given to both the importance of an attribute and the magnitude of the potential environmental impacts of the proposed activities on that cited attribute. The impact ratings presented in Table 1.1 of Chapter 1 are in accordance with impact assessment criteria provided in the EPA (2002) publication.

The NRA (2009)[128] criteria for estimation of the importance of geological attributes at the site during the EIAR Stage are summarised in Table 10-2. These criteria, as they are specific to soil and geology attributes, are used alongside the impact ratings in Chapter 1 and together present a holistic evaluation of the geological environment and the impacts from this development.

Table 10-1. Criteria for Rating Site Attributes: Estimation of Importance of Soil and Geology Attributes (NRA, 2009)

Importance	Criteria	Typical Examples
Very High	Attribute has a high quality, significance or value on a regional or national scale Degree or extent of soil contamination is significant on a national or regional scale Volume of peat and/or soft organic soil underlying route is significant on a national or regional scale*	Geological feature rare on a regional or national scale (NHA) Large existing quarry or pit Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale Degree or extent of soil contamination is significant on a local scale Volume of peat and/or soft organic soil underlying route is significant on a local scale*	Contaminated soil on site with previous heavy industrial usage Large recent landfill site for mixed wastes Geological feature of high value on a local scale (County Geological Site) Well drained and/or highly fertility soils Moderately sized existing quarry or

128 National Road Authority (NRA) ‘Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes’ by the National Roads Authority (2009)

		pit Marginally economic extractable mineral resource
Medium	Attribute has a medium quality, significance or value on a local scale Degree or extent of soil contamination is moderate on a local scale Volume of peat and/or soft organic soil underlying route is moderate on a local scale*	Contaminated soil on site with previous light industrial usage Small recent landfill site for mixed wastes Moderately drained and/or moderate fertility soils Small existing quarry or pit Sub-economic extractable mineral resource
Low	Attribute has a low quality, significance or value on a local scale Degree or extent of soil contamination is minor on a local scale Volume of peat and/or soft organic soil underlying route is small on a local scale*	Large historical and/or recent site for construction and demolition wastes Small historical and/or recent landfill site for construction and demolition wastes Poorly drained and/or low fertility soils Uneconomically extractable mineral resource

* relative to the total volume of inert soil disposed of and/or recovered

Table 10-2. Criteria for Rating Impact Significance of Soil / Geology Attribute (NRA)

Importance	Criteria	Typical Examples
Large Adverse	Results in loss of attribute	Loss of high proportion of future quarry or pit reserves Irreversible loss of high proportion of local high fertility soils Removal of entirety of geological heritage feature Requirement to excavate / remediate entire waste site Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Loss of moderate proportion of future quarry or pit reserves Removal of part of geological heritage feature Irreversible loss of moderate proportion of local high fertility soils Requirement to excavate / remediate significant proportion of waste site Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils beneath alignment
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Loss of small proportion of future quarry or pit reserves Removal of small part of geological heritage feature Irreversible loss of small proportion of local high fertility soils and/or high proportion of local low fertility soils Requirement to excavate / remediate small proportion of waste site Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment

Importance	Criteria	Typical Examples
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	No measurable changes in attributes
Minor Beneficial	Results in minor improvement of attribute quality	Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate enhancement of geological heritage feature
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

10.4 Existing Environment

10.4.1 Desk Based Assessment

Desk-based information on the geological environment underlying the extent of the site was obtained through accessing publicly available databases and other activities where available data was sourced from the following:

- Geological Survey of Ireland (GSI) www.gsi.ie online mapping; and
- Environmental Protection Agency (EPA) www, EPA.ie on-line mapping and database information and the EPA's new website: www.catchments.ie

Relevant documentation consulted as part of this assessment included the following:

- Technical note: Kings Island FRA: Updated hydrogeological summary (Arup, 2016);
- Limerick City Development Plan 2010-2016 (as Extended); and
- King's Island Flood Relief Scheme - Site investigation Contract, Phase 2 Factual Report (PGL, 2016).

The methodology for the assessment and mitigation measures proposed has regard to the following guideline documents:

- CIRIA (2011). Environmental good practice on site: Construction Industry Research Industry and Information Association publication C692 (3rd edition- an update of C650 (2005). (I. Audus, P. Charles and S. Evans), 2011; and
- CIRIA, (2012). Environmental good practice on site –pocket book; Construction Industry Research and Information Association publication C715 (P. Charles, and G. Wadams), 2012.Baseline Environment

10.4.2 Land-Use

The Limerick City Development Plan specified the importance of an FRS for King's Island. King's Island is an area which contains a variety of land uses including residential, administrative, ecclesiastical, educational, retail, business and tourism.

LCCC have several land use zoning plans for the Island as part of the regeneration of King's Island and St. Mary's Park area (Figure 10-1, Volume 3). In St. Mary's Park, the land zones consist of mostly 2A Residential and 6A Public open area. Some of that public open area has received Area of Special Development Control designation. The southern part of the Island has been categorised into two land use zonings: Zone1 (B) City Centre Commercial Area (CCCA) and Zone1 (C) Inner City Residential Neighbourhood.

- The Zone1 (B) CCCA has been assigned as an area of opportunity, where retention and expansion of a wide range of commercial, cultural, leisure, and residential uses in the commercial core area; and
- The objectives of Zone 1 (C) Inner City Residential Neighbourhood is to reinforce the residential environment and character of the area while supporting and maintaining local services.

In terms of community facilities and amenities in the area, there is an upgraded community centre into the south-west of the island and two playing pitches (Star Rovers) to the east (on short term lease from Limerick City Council). Although there are extensive areas of open space to the west of St. Marys Park, it is generally low-lying and liable to flooding, and is part of the Shannon Estuary SAC. There is a river-side walkway on three sides of the island which has been upgraded from Verdant Place, along the western, northern and eastern shores of King's Island. Existing childcare and educational facilities include a creche near Verdant Place, a boys and girls primary school, and two Gael Scoileanna located to the south of the island. There is a Garda station in Mary Street that has restricted opening hours and is in poor physical condition.

The County Courthouse and District Court are located to the west of the island, in proximity to City Hall which houses the offices of Limerick City Council. In addition, the island has a significant architectural and archaeological heritage, containing the remains of the Limerick City Walls and a number of surviving buildings from the 12th and 13th Centuries including King John's Castle and St. Mary's Cathedral. The southern portion of King's Island is regarded as the historic core of Limerick.

10.4.3 Soils

A description of the subsoils and history of soil contamination on King's Island is presented below. The following sections should be read in reference to Figure 10-2, Volume 3.

Agricultural and Sub Soils

The overburden/subsoil geology is heavily influenced by the River Shannon and Abbey River. The agricultural/topsoils of the Site and the Study Area comprise Marine/Estuarine Silts to the east and northwest, poorly drained mineral soils and peaty mineral soils further inland to the northwest on the Site and made ground everywhere else.

The subsoils in the study area based on the information provided on the Teagasc Soil Map of Ireland, comprise estuarine/alluvial deposits of soft clays and silts to the north and east of the Study Area,

Landfills

There is an area that once contained an unlicensed landfill to the east of St Mary’s Park on the Site as detailed in Figure 10-2 Volume 3, which is currently being remediated. JBA understand that municipal waste and mixed construction and demolition waste had been removed off site for disposal. Contaminated soils are likely to be present in this landfill, but the level and extent of contamination is not known.

Soil Analysis

As part of a site investigation completed by PGL in 2016[129], soil samples were taken from various locations around King's Island and analysed for a full range of analytes. The location of the boreholes and summary of the results of the soil investigation have been included in Appendix E1, with accompanying figure provided in Figure 9-6 of Volume 3.

Discrete soil samples were taken from the boreholes and submitted to an analytical laboratory for a full suite of heavy metal, polyaromatic hydrocarbon (speciated), polychlorinated biphenyl analysis (7 congeners), Total Petroleum hydrocarbon (speciated aliphatic and aromatic), BTEX (benzene,

[129] PGL. (2016). King's Island Flood Relief Scheme - Site investigation Contract, Phase 2 Factual Report

toluene, ethyl benzene and xylene) analysis. No asbestos analysis was conducted on the samples. Waste Acceptance Criteria (WAC) analysis was also determined on the samples, and a summary of the results are provided in Appendix E2 of this Volume, with accompanying figure provided in Figure 9-6 of Volume 3.

In summary the results indicate:

- Elevated levels of lead in BH125 (460 mg/kg);
- Elevated levels of zinc in FIP111 (0.6 m) at 200 mg/kg and the deeper sample at the same location (1.0 m) of 210 mg/kg zinc. Zinc was also found in TP116 (0.5 m) at levels of 300 mg/kg and in TP117 (0.5 m) at levels of 270 mg/kg;
- Mercury was detected above the detection levels of 0.1 mg/kg in a number of borehole and trial pits including BH125 (both samples), FIP111 (all three samples), and FP109 (all three samples);
- Barium was detected in several boreholes above background levels including FIP111 (0.6 m) at 190 mg/kg and at 150 mg/kg in the same trial pit at 150 mg/kg. Elevated levels of Ba were also detected in BH113 (460 mg/kg at 1.0 m and 410 mg/kg at 1.5 m) and in BH116 (240 mg/kg at 0.5 m and 210 mg/kg at 1.2 m). BH109 had elevated levels of barium ranging from 190 mg/kg in BH109 at 0.5 m to 310 mg/kg in BH109a;
- There is evidence of diesel/petrol contamination of the soils. This is demonstrated by the elevated levels of total petroleum hydrocarbons, mineral oil and associated PAH's. Total petroleum hydrocarbon levels (TPH's) in FIP103 (1.5 m) was 690 mg/kg, in TP116, the levels detected were 300 mg/kg. TP117 (0.5 m) had TPH levels of 270 mg/kg;
- PCB 138 was detected in FIP 104 (1.0 m) at 0.048 mg/kg); and
- Mineral oil an indicator of anthropogenic sources of contamination was detected in TP116 (210 mg/kg), FIP103 (24 mg/kg) and BH125 (59 mg/kg).

The Waste Acceptance Criteria analysis carried out on the samples found that total organic carbon (TOC) was the main reason for exceedances with the inert landfill site criteria of 3%. TOC levels of 11% was detected in a sample taken from BH109 (1.0 m) and 5.1% from the same trial pit at 1.5 m). TOC levels in TP117 (0.5 m) was 5 % and in TP116 (0.5 m) was 4.0 %.

The review of the soil analysis results demonstrates that a number of sources of anthropogenic activities have contributed to the quality of the soil around the site. There is evidence of petrol/diesel contamination of the soil, metals or scrap metals has contributed to some of the elevated heavy metal results found in the soil analysis.

10.4.4 Geology

A description of the underlying bedrock geology and geological heritage relative to King's Island is presented below, and shown on Figure 10-3, Volume 3.

Overburden Geology

The overburden is primarily Limestone derived till to the north and northwest of the Island and made ground everywhere else. Bedrock outcrops are mapped in the north west of the Site and west and northwest of the island. These outcrops are labelled 'karstified bedrock outcrops' and are the only karst features mapped on the constraints area. The hydrogeological summary/ground investigation by Arup in Appendix D confirmed that the that rock is up to 8mbgl in this area.

Historic site investigation information indicates the presence of very soft to firm brown/grey sandy gravelly silt and clay. These are likely to be highly variable, interlayered and to contain organic material. The alluvial silts and clay are generally underlain by medium dense to very dense estuarine/alluvial very silty sand and gravel, although these coarser grained deposits may be interlayered with pockets or lenses of clay and silt.

Made ground is encountered in the urban/populated areas of the site and west of the study area. Site investigations completed in the area revealed that the made ground was made up of silty clay and clayey sand with loose ash, red brick, gravel, shells and occasional glass and wood. The thickness of the made ground on the site varies between 1.0m to 5.5m thick in places. The made ground is generally thickest in the south, along George's Quay and Sir Harry's Mall. Along the riverside walkway, the thickness of made ground is approximately 2.2m. Site investigation information for the eastern section of the constraints area suggests there is 0.40m to 4.0m of made ground, with the stratum generally thickening from north to south. Glacial till was encountered in a number of exploration holes overlying the bedrock in the south of the island and also in boreholes in the eastern section.

The overburden thickness varies across the Site from 3.0m and 11.0m, generally increasing in a south west to north east direction. In the north east of the Site, one rotary corehole indicated the presence of overburden to 22.2m below ground level (bgl). Site investigation information for the eastern section of the Study Area, reveals overburden thickness from 3.40m to 10m, fluctuating from north to south in depth in no particular pattern.

Bedrock Geology

The Kings Island study area is underlain by Visean Limestones (undifferentiated) (refer to Figure 10-3).

Rotary core information available for the study area reveals the solid bedrock is locally slightly weathered, strong to very strong, thick to thinly bedded fossiliferous light to dark grey limestone. Discontinuities are closely to widely spaced; sub horizontal to sub vertical, rough, planar, open, clean to sediment in filled. The depths to bedrock were varied across the site. Moderately weak to strong limestone was encountered from depths of 3.4m bgl to 14.9m bgl.

The GSI groundwater vulnerability mapping notes an area of extreme vulnerability along the western walkway in the north west of the site indicating that rock may be present at or near the surface in this area. However, the ground investigation indicated that rock is up to 8m bgl in this area.

Karst

A rock bedrock on surface is noted on the GSI maps in the north west of the Site. Figure 10-3 refers to the outcrop as ‘karstified bedrock outcrop’, however the GSI karst database indicates that there is no karst mapped features in the area. The ground investigation by Arup (Appendix D1) confirmed that rock is up to 8mbgl in this area.

Geological Heritage

There are no geological heritage sites on or in proximity to King's Island.

Areas of Conservation

King's Island is surrounded by the Lower River Shannon SAC which covers the Lower Shannon Estuary and the Abbey River. The north-eastern part of the island is part of the SAC. Further details on the conservation areas impacted in this development are provided in Chapter 9 Biodiversity.

10.4.5 Rating of Importance of Soil and Geological Attributes

Based on the NRA methodology (2009) - Criteria for rating site importance of geological features (Table 10-1), the importance of the bedrock and soil features at this site is rated as 'Low Importance' based on the assessment that the attribute has a low quality significance or value on a local scale. There are no extractable mineral localities or areas of geological heritage, and the site is predominantly hardstanding and residential area and therefore is unsuitable for agricultural use.

10.5 Predicted Impacts of the Development on Soils and Geology

The characteristics of the proposed FRS with regard to the soil and geological environments are outlined below. Due to the inter-relationship between Soils and Geology and Surface and Groundwater (Chapter 9), these chapters should be read in reference to each other.

In terms of predicted specific impacts the following points are of note:

- There is no likely impact on the geological heritage in the immediate vicinity of the proposed FRS site;
- There will be no direct discharge during operations to the underlying soil & geology environments; and
- The groundwater vulnerability for King's Island is classified as 'Moderate' and 'Low' for the majority of the island, with patches of 'High Vulnerability' in the southern part of the island (commercial area) and around St. Mary's Park.

10.5.1 Do Nothing' Scenario

Under the 'do nothing' scenario the site would remain in its current condition.

Currently, the site is vulnerable to secondary contamination as a result of natural rainfall causing seepage of contaminants through the soils layers. The island is also vulnerable to the 0.5% AEP flood event which increases the potential for contaminated water to flood King's Island. Surface waters trapped on the landscape as a result of natural rainfall, and less likely due to flooding, are likely to be contaminated as a result of encountering the contaminants within the local environment (sewage, residential properties, agricultural runoff, etc.). Contaminated waters will both run off the landscape through the surface water drainage network but will also seep into the soil layers which can potentially further contaminate the soil and geological environments. Additionally, as some soils are already contaminated as a result of illegal landfills on the site

Under the ‘Do Nothing Scenario, as no development will take place, the site will remain in its existing condition, where the soil and geological environments are vulnerable to contamination as a result of flooding.

10.5.2 Construction Phase

Alterations to the soil and geology environments during construction for each flood cell area through excavation and infilling will involve the following, as described in Chapter 4:

- Area A2: Removal of sandbags, footpath hardstanding, and concrete plinth, and installation of flood wall and piled foundations to bedrock (approximately 11m), requiring excavations;
- Area A3: Removal of sandbags, footpath hardstanding, and concrete plinth, excavation of topsoil along the entire footprint of embankments (and stockpile/reuse of material for embankment formation), addition of impervious clay materials for the construction of the embankments, excavation to approximately 1m depth for installation of the filter drain on the inside of embankments, excavation to construct open drain;
- Area A4: Excavation around existing sheet pile wall and installation of footpath requiring excavation of 350mm topsoil along 120m length and 2.5m width, fill of impervious clay materials for the construction of the embankments, excavation to approximately 1m depth for installation of the filter drain on the inside of embankments, excavation of contaminated soils on the site of the illegal landfill, excavation within the field to the north east of the island to connect the filter drain outlets to existing open drains, excavation and movement of part of the Japanese knotweed bund, excavation of peat soils (where present) in areas where embankments are to be constructed;
- Area A5: Excavation of topsoil along the entire footprint of embankments (and stockpile/reuse of material for embankment formation), fill of impervious clay materials for the construction of the embankments, excavation to approximately 1m depth for installation of the filter drain on the inside of embankments;
- Area A6: Installation of intertidal storage tank (approx. 2m depth x 10m width x 10m length) requiring excavation and infilling, installation of flood wall and foundations requiring excavations of 1-3m, installation of manhole (4m depth x 2m diameter) requiring excavation, and infilling to raise existing manholes by 1.5m;
- Area A7: Excavation of road and existing footpath, installation of flood wall requiring excavations to approximately 1.5m depth;
- Area A9: Excavation of existing footpath and wall, installation of new flood wall and foundations requiring excavations to approximately 1.2m depth;
- Area A10: Excavation of existing footpath and wall, installation of new flood wall and foundations requiring excavations to approximately 4-5m depth;
- Area B1/B2: Excavation of existing footpath, installation of new flood wall and foundations requiring excavations to an unknown depth; and
- Area B3: Excavation of Potato Market car park for installation of new storm sewer pipelines (approximately 1m depth), installation of foul sewer ranging from 1.2m depth to 1.5m depth; installation of intertidal storage tank (approx. 2m depth x 10m width x 10m length) requiring excavation and infilling, installation of glass wall panelling and foundations requiring excavation to approximately 4m depth.

The predicted impacts are expanded below.

Import of Soil

It is estimated that 93,900 m^3 of embankment fill (cohesive clay) will be imported onto the site for construction of the embankments, 43,000 m^3 of landscape fill (class 4), and 6,700 m^3 of top soil, totalling 143,600 m^3. The importation of infill material may introduce contamination to the site if sourced from inadequate facilities. Responsible sourcing will ensure this impact does not arise. Clean soil will be imported to the site, and the contractor will be required to source the soil from areas that are free of invasive species, i.e., containing no Japanese Knotweed seed or legumes.

The scheme will require significant excavation and infilling around the border of King's Island, resulting in the import of 143,600m^3 of fill material. An indirect impact of the soil import to the site during the construction phase will be the increase in truck movements to the site. This will have a subsequent impact on air quality (dust and VOCs), noise and nuisance. These impacts are further described in Chapters 11 and 12 on Noise and Air Quality.

Excavation

To summarize the extent of excavations, construction works will require removal of peat soil and top soil cover in certain areas where the embankments are to be constructed, to ensure the embankments are built on a solid foundation. Existing sandbags, concrete stub wall and walkways will also be removed where the existing embankments exist bordering St. Mary's Park and in the western part of the island near the Star Rovers fields. Excavation of hardstanding materials will also be required for installation of the flood walls, proposed sewer pipes and drainage system. Removal of hardstanding and soil cover will increase the vulnerability of the underlying bedrock; however the area will be infilled during construction, and these areas will be replaced by further hardstanding along the top of the embankments.

Excavations around the north side of the island (areas A2, A3, A4, A5) may increase the risk of contamination and vulnerability to the underlying soils and geology during the construction phase. The existing vulnerability for the section of the site to experience excavation is classified as ‘Low’ and infilling works will provide greater protection to the underlying soils and bedrock geology.

The soils excavated from the site will be removed and disposed to an appropriate facility. This will be subject to the limits of the license/permit for waste disposal.

Accidental Spills and Leaks

During construction of the development, there is a risk of localised accidental pollution incidences from the following sources:

- Spillage or leakage of temporary oils and fuels stored on site;
- Spillage or leakage of oils and fuels from construction machinery or site vehicles;
- Spillage of oil or fuel from refuelling machinery on site; and
- Run-off from concrete and cement during pad foundation construction.

Accidental spillages may result in localised contamination of soils and geology underlying the site, should contaminants migrate through the subsoils.

Bedrock exposure

During the construction phase, some excavations will cause exposure of the bedrock, increasing the risk to bedrock geology. These exposures (in Areas A2 and B1/2) will be localised and temporary, as infilling will occur once the appropriate foundations have been constructed.

Waste Management

The waste material that will be generated as a result of this development includes:

- Concrete and stone material from excavated material for the construction of the flood walls
- Soil, potentially some non-hazardous and some hazardous during the construction of the embankments.
- Blacktop and asphalt from the removal of roads and tarmacadam footpaths throughout the scheme.
- General canteen wastes generated from the construction compound.

Concrete and stone materials will be minimized in terms of materials taken offsite. This will be achieved through crushing and screening of the materials, and re-use for alternative purposes such as site access tracks. Any material that is not re-used will be brought offsite and disposed of at a licensed waste facility, as agreed with Limerick County Council and as written in the Contractor’s Waste Management Plan.

During the construction phase of the project fill material will be imported into the site for the construction of the embankment in the northern part of the scheme. Approximately 2,200 linear metres of embankment will be formed. The material will comprise 93,900m^3 of cohesive clay, 433,000m^3 of landscape fill (class 4) and 6,700m^3 of topsoil, totalling 143,600m^3. The EIAR has not specified the source of the fill material. Nationally there is a shortfall in licenced waste capacity[130] indicating a surplus of waste material including soil and Construction and Demolition (C&D) waste. It is therefore assumed that sourcing suitable material will not be problematic prior to commencement of construction process scheduled for Autumn 2020. Sourcing the fill material may be outside the Limerick area as only two licenced soil recovery facilities will be in operation in the Southern Region in 2020, these are located in Kilkenny and Cork. Consideration of Waste is reported in Chapter 7 - Material Assets.

10.5.3 Operation Phase

The potential impacts in relation to the soil & geological environments during the operation phase of the scheme have been assessed and are as follows:

- It is anticipated that there will be an initial flush of soil and suspended matter from the newly constructed earthen embankments. This will cause an increase in suspended solids in the surface water run-off from the site. This is likely to happen during a heavy rainfall event and the suspended solids will contribute to the overall solids loading in the Abbey and/or Shannon rivers. The impact of this on water quality will not be significant and will be short-term. As the embankments stabilise and grass cover becomes thicker, the problem of suspended solids run-off from the embankments will lessen. In the long-term no significant impacts on water quality are anticipated;
- The construction of the embankments requires import and construction using impermeable clay, which will ultimately change the soil environment in these areas to a hard-standing area, with the consequential change in rainwater soakage and storage;
- The import of clay and soil media for the surrounding earthen banks will offer 'protective' topsoil and subsoil cover in these areas. This will not change the vulnerability category as the current classification is Moderate to Low however it will afford greater protection to the underlying bedrock;
- There will be very minimal impact on the local recharge to the aquifer due to the increase in impermeable surfaces and hardstanding area;
- There will be no direct discharges of contaminated water to groundwater or soil environments during the operational phase. A surface water drainage plan has provisions for foul sewer discharge, and drainage features such as a filter drain system which will trap some contaminants such as oils and organic materials;
- Export of any contaminated soil off-site and import of clean fill will improve the overall quality of the soil in King's Island; and
- The impact of the foundation and defence wall on groundwater flow and groundwater flow patterns will not be significant.

10.6 Mitigation Measures

The design of the proposed FRS has taken account of the potential impacts on the soils and geology environments local to the area where construction will take place and containment of contaminant sources during operation. Measures have been incorporated into the design to mitigate the potential effects on the surrounding soils and geology. These are described in further detail below.

Due to the inter-relationship between Soils & Geology and Surface & Groundwater, the following mitigation measures discussed will be considered applicable to both elements.

[130] RPS (2015) Construction and Demolition Waste, Soil and Stone Recovery/Disposal Capacity Eastern Midlands Region / Connacht Ulster Region / Southern Region Waste Management Plans 2015 - 2021 Report (Figure 4-4 Capacity Shortfall Profile).Dublin City Council.

10.6.1 Construction Phase

Embankment Construction

Construction works will require removal of peat soil cover in certain areas where the embankments are to be constructed, which will increase the vulnerability of the underlying soils and geology. Removal of hardstanding and soil cover will increase the vulnerability of the underlying bedrock; however the area will be infilled during construction, and these areas will be replaced by further hardstanding along the top of the embankments.

Temporary storage of soil will be carefully managed in such a way as to prevent any potential negative impact on the receiving environment and the material will be stored away from any surface water drains. Movement of material will be minimised in order to reduce degradation of soil structure and generation of dust.

It is estimated that the volume of material being imported to the site will be approximately 93,900m^3 of inert engineering fill (cohesive clay), 43,000m^3 of landscape fill (class 4) and 6,700m^3 of topsoil, totalling 143,600m^3. The contractor will be required to import clean fill material to the site. The contractor will request a waste characterisation report from the supplier of the waste soil. The material will need to meet the inert criteria to be accepted onto the site.

Soil Import and Removal

The Contractor will be required to install a Soil Management Programme for the operations at the site. The construction programme will contain as a minimum, ways to minimise truck movements across the site to avoid soil compaction, re-use of suitable material on-site to minimise the quantities that need to be imported.

The contractor will be required to carry out a waste characterisation of the material that will be taken off site for disposal. A waste acceptance criteria (WAC) analysis and asbestos levels should be determined on any material that will be taken off site for disposal. All wastes in the European Waste Catalogue are classified by a unique 6-digit code. In this case (waste soil/stones), two List of Wastes (LoW) Codes are applicable to material that may be taken off site for disposal during the construction phase:

- 17 05 03* - Soil and stones containing hazardous substances
- 17 05 04 - Soils and stones other than those mentioned in 17 05 03.

Any soil samples that contains asbestos should be subjected to full quantification analysis.

Uncontaminated soil materials can be brought to a soil recovery facility. Soil recovery facilities are licensed to accept only uncontaminated natural soil and stone. Any materials exceeding soil trigger levels determined by Table 3.3 -Summary of Soil Trigger Levels for Soil recovery Facilities of the EPA Guidelines [131] or invasive species will be disposed at a hazardous landfill site. The Site Manager will ensure that a Waste Management Plan is in place to ensure that these criteria are followed. The acceptance of this material at a licenced soil recovery facility will be subject to the approval of the facility operator.

Fuel and Chemical Handling

To minimise any impact on the underlying subsurface strata from material spillages, all oils, solvents and paints used during construction will be stored within temporary bunded areas. Oil and fuel storage tanks shall be stored in designated areas, and these areas shall be bunded to a volume of 110% of the capacity of the largest tank/container within the bunded area(s) (plus an allowance of 30 mm for rainwater ingress). Drainage from the bunded area(s) shall be diverted for collection and safe disposal.

Re-fuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles, will take place in a designated area (or where possible off the site) which will be away from any existing surface water gulleys or drains. In the event of a machine requiring refuelling outside of this area, fuel will be transported in a mobile double skinned tank. An adequate supply of spill kits and hydrocarbon adsorbent packs will be stored in this area. All relevant personnel will be fully trained in the use of this equipment. Guidelines such as “Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors” (CIRIA 532, 2001) will be complied with. If a spillage does occur, the adsorbents will be treated as a hazardous waste and disposed of accordingly. The

[131] EPA. (2017). Waste acceptance criteria and development of soil trigger values for EPA-licensed soil recovery facilities.

site's Environmental Manager will maintain an inventory of spill kit for the site. Contracts to the main contractor, as part of their site Environmental Induction Training will be informed of the location and use of the spill adsorbents.

All ready-mixed concrete will be brought to site by truck. A suitable risk assessment for wet concreting will be completed prior to works being carried out which will include measures to prevent discharge of alkaline wastewaters or contaminated storm water to the underlying subsoil. The pouring of concrete will take place within a designated area using a geo-synthetic material to prevent concrete runoff into the soil/ groundwater media. Wash down and washout of concrete transporting vehicles will take place at an appropriate facility off site.

In the case of drummed fuel or other chemical which may be used during construction containers should be stored in a dedicated internally bunded chemical storage cabinet and labelled clearly to allow appropriate remedial action in the event of a spillage.

Surface Water Runoff

Water containing silt will be treated to ensure silt removal and then disposed of to the foul sewer; refer to Chapter 9 - Surface and Groundwater and the Drainage Design Drawings in Volume 3 for more detailed information.

Best Practice Construction Methods

During the construction phase, there will be consideration for the standard best international practice including but not limited to:

- CIRIA, (2001), Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors, (C532) Construction Industry Research and Information Association;
- CIRIA (2005), Environmental Good Practice on Site (C650); Construction Industry Research and Information Association;
- BPGCS005, Oil Storage Guidelines;
- CIRIA 697 (2007), The SUDS Manual; and
- UK Pollution Prevention Guidelines, (PPG) UK Environment Agency, 2004.

10.6.2 Operation Phase

As protection for the soil and geological environments of King's Island was incorporated into the design of the FRS on many levels, no mitigation will be required during the operational phase of the scheme.

10.7 Residual Impact

Do Nothing Scenario

Currently, the site is vulnerable to secondary contamination as a result of natural rainfall causing seepage of contaminants through the soils layers. Contaminated waters will both run off the landscape through the surface water drainage network but will also seep into the soil layers which can potentially further contaminate the soil and geological environments. Additionally, as some soils are already contaminated as a result of illegal landfills within King's Island.

Under the 'Do Nothing Scenario, as no development will take place, the site will remain in its existing condition, where the soil and geological environments are vulnerable to contamination and leaching as a secondary impact of natural rainfall and flooding. Therefore, the impact is classified as Moderate Negative, i.e., an effect that causes noticeable change in the environment without affecting its sensitivities, and with long-term effects.

Construction Phase

Shallow excavation works will be limited to areas around the north of the island where peat soils interfere with embankment creation (described further in Section 10.5.2). Deeper excavations will include areas where the flood wall foundations, stormwater system pipework and attenuation tanks are to be installed. Implementation of mitigation measures during the construction phase, along with good site management and construction practices will eliminate any significant impact on the environment.

The residual impact during the construction phase is the temporary exposure of the soils and geological environment, but with an overall improvement in the environmental condition.

The implementation of mitigation measures highlighted above will ensure that the predicted impacts on the soils and geological environments do not occur during the construction phase and that the predicted impact identified as being Short term, Slight Negative impact - on quality, i.e. an effect which causes noticeable changes in the character of the environment but without affecting its sensitivities.

Operation Phase

The design and installation of permanent mitigation measures for the operational phase eliminates all significant negative impacts on the soil and geological environment. The risk of contamination by run off is remote provided that the mitigation measures are installed and that all design, construction and other activities are carried out in accordance with all relevant standards and regulations.

The potential impact during operation (following EPA, 2002 assessment criteria) is considered to have a Slight, but Permanent impact, i.e. an effect which causes noticeable change in the character of the environment but without affecting its sensitivities. The overall impact on quality will be Positive, due to the excavation and export of contaminated soils and import of clean fill material.

10.8 Monitoring

Visual monitoring will be undertaken during the construction including the mitigation measures described in Section 10.6. Any potential contamination such as hydrocarbon and concrete spillages should be immediately investigated and remedied. There will be no direct discharge to the underlying geological environment during the operational phase.

10.9 Interactions with other Environmental Effect

The interactions between the Soils & Geology Chapter and the relevant EIAR topics are addressed below.

Chapter 9 Surface and Groundwater: A potential impact on the soils & geological environment includes the excavation and removal of made ground and overburden which could potentially increase the sediment loading to the surface water environment. Imported soil has the potential to run off during the construction phase and have negative impacts on surface and groundwater environments. Adequate mitigation measures relating to the construction phase and operational phase are addressed in Section 10.5 of the EIAR.

10.10 Potential Cumulative impacts

Of the projects described in Chapter 17 which were found to have the potential for cumulative impacts on the environment, none were identified as having significant cumulative impacts on the soil and geology environments of King's Island. There is a very slight potential for cumulative impacts if disposal of contaminated soils is required as part of this development and as part of the identified developments.

10.11 Difficulties Encountered in Compiling this Information

There were no difficulties in compiling this chapter.

11 Noise & Vibration

11.1 Introduction

This section of the EIAR comprises an evaluation of the noise and vibration impacts associated with the King's Island FRS. The assessment identifies any potential sensitive noise receptors and the current baseline noise levels at these locations. It also identifies the main noise and vibration impacts associated with the proposed scheme as relating to the construction and operational phases, proposes mitigation measures to reduce these impacts and states the residual impacts.

11.2 Existing Environment

11.2.1 Introduction

The EPA (2016) defines noise sensitive locations as "*any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels".*

The noise environment on King's Island varies from the north of the island to the south. To the north of the island, around St Mary's Park, noise levels are dominated by internal traffic, pedestrians, birdsong, the River Shannon and some ongoing construction activities (at the time of noise monitoring) and are in the range of 50 to 62 dBL_{Aeq}.

Toward the south, south west and south east of Kings Island, the noise environment is largely urban, and dominated by local and regional road traffic. All access roads to King's Island are in these areas. Sources include local traffic; car movements and pedestrians and noise levels are in the range of 57 to 58 dBL_{Aeq}.

11.2.2 Overview of the Surveys

The baseline noise environment was determined by conducting surveys on 7 May 2019 at sensitive receptors (residential properties) in the vicinity of the proposed FRS. The surveys were undertaken in accordance with ISO 1996-1:2016.

11.2.3 Survey Locations

Attended noise measurements were conducted around King's Island at eight locations. These eight locations are representative of the types of receptors encountered across the proposed FRS. The locations and descriptions of each of the survey locations are presented in Table 12-2 overleaf and illustrated in Figure 12-1, Volume 3.

11.2.4 Instrumentation

A Brüel & Kjær 2250 Light Class 1 Sound Level Meter was used to carry out the baseline noise surveys. This meter complies with applicable industry standards. The noise meter was calibrated before and after each measurement at each survey location using a Brüel & Kjær 4231 Acoustic Calibrator. A windshield was used to provide the microphone with effective wind protection to ensure that local meteorological conditions did not impact on the monitoring.

11.2.5 Meteorological Conditions

Meteorological conditions over the monitoring periods are set out in Table 11-11. Met data has been taken from Shannon Airport weather station data (the nearest weather station).

Table 11-1. Meteorological Data from Shannon Airport

Date	Rainfall (mm)	Max Temp (°C)8	Min Temp (°C)	Mean Wind Speed (m/s)
7/5/2019	0	14.8	9.8	4.1 to 5.6

11.2.6 Measurement Parameters

The following parameters were recorded and reported as part of the baseline surveys:

- L_{Aeq} – this is the continuous steady sound level during the sample period and effectively represents an average value;

- L_{A10} – this is the sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for traffic noise; and
- L_{A90} – this is the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.

The "A" suffix denotes the fact that the sound levels are "A-weighted" in order to account for the non-linear nature of human hearing.

11.2.7 Survey Periods

Measurements were conducted between 10am and 3pm on 7 May 2019. Surveys were carried out on a week-day and during time periods which were selected in order to provide a typical snapshot of the existing baseline noise environment in the vicinity of the sensitive receptors.

The results were initially noted onto a survey record sheet immediately following each sample and were also saved to the instrument memory for later analysis where appropriate. Survey personnel also noted all primary noise sources contributing to the baseline noise environment.

Baseline Noise Survey Table 11-2 below presents the results of the baseline noise survey. The results of the survey indicate that baseline noise levels at all locations assessed are dominated by passing traffic on the local and regional road network, pedestrians, birdsong and noise from the River Shannon. No sources of vibration were noted during the surveys. Construction activities from a nearby dwelling were observed during the measurement at S04 and S05.

Table 11-2. Baseline noise survey results

Survey Location	Location	LAeq (dB)	LAmax (dB)	LA10 (dB)	LA90 (dB)	Qualitative Description
S01	Sir Harvey's Mall, adjacent to River Shannon	58	74	60	53	The dominant source of noise was from local traffic. Minor noise sources included; noise from passing pedestrians, distant traffic and distant industry/construction noise.
S02	George's Quay, adjacent to River Shannon at Creagh Lane	57	81	59	53	The dominant source of noise was from local traffic. Minor noise sources included; noise from passing pedestrians, distant traffic and distant industry/construction noise.
S03	St John's Castle, adjacent to River Shannon at car park	52	74	54	49	The dominant source of noise was from distant traffic. Minor noise sources included; noise from birdsong and noise from the flow of the River Shannon.
S04	Beside King's Island Community Centre at Verdant Place.	57	73	61	43	The dominant source of noise was from passing traffic and nearby construction works. Minor noise sources included; noise from passing pedestrians and birdsong.
S05	Oliver Plunket Street (South)	59	79	62	44	The dominant source of noise was from nearby construction works. Construction works were ongoing at houses opposite the monitoring location during the monitoring period. Minor noise sources included; passing traffic and birdsong.
S06	St Munchin's Street (North)	50	75	49	41	The dominant source of noise was from birdsong. Minor noise sources included; passing traffic.
S07	St Munchin's Street (South)	62	90	62	43	The dominant source of noise is from passing local traffic and passing pedestrians. Minor noise sources include; birdsong and distant construction noise.

Survey Location	Location	LAeq (dB)	LAmax (dB)	LA10 (dB)	LA90 (dB)	Qualitative Description
S08	Rear of Abbey View Estate	50	73	51	44	The dominant source of noise was from birdsong. Minor noise sources included passing pedestrians.

11.3 Assessment Methodology

11.3.1 Introduction

This assessment considers the potential for significant noise and vibration impacts associated with the construction and operation of the proposed scheme phases, and the likely effects of noise and vibration on sensitive receptors. Noise and vibration has been considered during the construction phase only as there is not considered to be the potential for significant sources of noise or vibration during the operation of the proposed scheme.

The noise and vibration assessment has been undertaken in accordance with the EPA Impact Classification Terminology (EPA, 2017)[132] (Table 1-1 Chapter 1 of this report) and in accordance with:

- EPA (2016) Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)[133;]
- Transport Infrastructure Ireland (TII, formerly NRA) (2014) Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes[134;]
- TII (2004) Guidelines for the Treatment of Noise and Vibration in National Road Schemes[135;]
- British Standards Institution (BSI) (2014) 5228-1 and 2:2009+A1:2014. Code of practice for noise and vibration control on construction and open sites. Noise and Vibration[136;]
- Limerick City & County Council Noise Action Plan 2018-2023, Limerick City & County Councils[137]; and
- The TII guidance documents, along with British Standard guidance documents, have set out noise and vibration limits during construction which are generally applied by planning authorities to all construction projects in Ireland.

11.3.2 Noise Assessment Criteria

Construction Noise

BS 5228 136 outlines guidance for construction noise criteria with reference to the existing noise environment, as well as prediction methodologies to estimate the impact. This guidance is considered the most appropriate to apply in this instance as it has regard to the existing baseline noise environment. BS 5228 states that a potential significant effect is indicated if the LAeq, T noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level. Table 11-3 sets out the ABC method for establishing the impact criteria of construction noise as presented in BS5228.

[132] . Environmental Protection Agency (August 2017) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (Draft)
[133] EPA (2016) Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4). Available from: http://www.epa.ie/pubs/advice/noise/guidancenotefornoiseng4.html
[134] TII (2014) Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes. Available from: http://www.tii.ie/technicalservices/environment/planning/Good_Practice_Guidance_for_the_Treatment_of_Noise_during_the_Planning_of_National_Road_Schemes.pdf
[135] TII (2004) Guidelines for the Treatment of Noise and Vibration in National Road Schemes.
[136] British Standards Institution (BSI) (2014) 5228-1 and 2:2009+A1:2014. Code of practice for noise and vibration control on construction and open sites. Noise and Vibration.
[137] LCCC Noise Action Plan 2018-2023 https://www.limerick.ie/sites/default/files/media/documents/2018-12/LCCC%20Noise%20Action%20Plan%202018-2023.pdf

Table 11-3. BS5228 (Part 1) ABC assessment categories and thresholds at dwellings

Assessment Category and Threshold Value Period LAeq, 1 hour	Threshold Value in Decibels (dB)		
	AA)	**BB)**	**CC)**
Night (23:00-07:00hrs)	45	50	55
Evening and weekends D)	55	60	65
Day (07:00-19:00hrs) and Saturdays (08:00-14:00)	65	70	75

A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than category A values.
B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.
C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.
D) 19:00 – 23:00hrs weekdays, 14:00-23:00hrs Saturdays and 07:00-23:00hrs Sundays.

The construction noise criteria outlined in Table 11-4 will be applied at the nearest sensitive receptor to the construction works based on the BS5228136 criteria.

It should be noted that the noise criteria quoted in the table are specific to construction activities only (i.e. these levels are not cumulative with the existing noise environment from road traffic and other surrounding sources).

Table 11-4. Noise limits to be applied based on BS5228 criteria

Assessment Category and Threshold Value Period LAeq, 1 hour	Standard noise limits at sensitive receptors LAeq, 1 hour
Day (07:00-19:00hrs) and Saturdays (08:00-14:00)	65

Where an exceedance of the construction noise criteria, as outlined in Table 11-4, is predicted, the impact associated with the noise increase is rated in accordance with Table 11-5.

Table 11-5. Likely impact associated with exceedance of construction noise criteria

Extent of Noise impact (Exceedance of Assessment Criteria)	Noise impact Magnitude	Magnitude Rating
Less than 3dB	No significant change/Imperceptible	Neutral to Slight Impact
Increase of 3-5dB	Slight increase	Slight to Moderate Impact
Increase of 6-10dB	Moderate Increase	Moderate to Major Impact
Increase of more than 10dB	Substantial Increase	Significant Impact

Table 11-6 outlines the duration and frequency of effect based on EPA (2017) guidance[138].

Table 11-6. Duration and frequency of effects

Effect type	Duration
Momentary Effects	Effects lasting from seconds to minutes
Brief Effects	Effects lasting less than a day
Temporary Effects	Effects lasting less than a year

138 EPA (2017) Guidelines on the information to be contained in Environmental Impact Assessment Reports.

Short-term Effects	Effects lasting one to seven years
Medium-term Effects	Effects lasting seven to fifteen years
Long-term Effects	Effects lasting fifteen to sixty years
Permanent Effects	Effects lasting over sixty years

Traffic Volumes

The TII guidance135 states that routes should be considered for assessment where the flow of traffic volumes is likely to increase or decrease by 25% or more during construction and/or operation.

During the construction phase, there will be increases in traffic volumes due to construction vehicles. As outlined in Chapter 7- Material assets including Traffic, Section 7.1.5, the construction phase of the proposed scheme will not result in offsite traffic increases of greater than 25%, therefore a detailed assessment of noise and vibration associated with traffic is not required. The operational phase of the proposed scheme will not result in offsite traffic increases of greater than 25%, therefore a detailed assessment of noise and vibration associated with traffic is not required.

11.3.3 Vibration Assessment Criteria

Vibration standards come in two varieties: those dealing with human comfort, and those dealing with cosmetic or structural damage to buildings. For the surface construction works proposed here, vibration is expressed in terms of Peak Particle Velocity (PPV) in mm/s. There are no expected significant vibration sources associated with the proposed scheme once the facility becomes operational.

BS 7385-2[139], gives guidance regarding acceptable vibration in order to avoid damage to buildings. BS 5228-2136 reproduces these guidance values.

These standards differentiate between transient and continuous vibration. Surface construction activities are transient because they occur for a limited period of time at a given location. Risk of cosmetic damage to residential buildings starts at a Peak Particle Velocity (PPV) of 15mm/s at 4Hz. Below 12.5 mm/s PPV, the risk of damage tends to zero.

Important buildings that are difficult to repair might require special consideration on a case by case basis, but buildings of historical importance should not (unless they are structurally unsound) be assumed to be more sensitive. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground borne disturbance.

Potential sources of transient vibration during the construction phase of the proposed scheme may arise from the breaking of existing road surfaces during road works.

Table 11-7 summarises the vibration levels below which there is no risk of damage to buildings. These limits apply to vibration frequencies below 15Hz where the most conservative limits are required. For protected or potentially vulnerable buildings, the recommended construction vibration limit is reduced by 50%.

Table 11-7. Transient Vibration Impact Criteria for Buildings (conservative criteria below which there is no risk of cosmetic damage (BS 5228-2)

Category of Building	Threshold of potential significant effect (Peak Particle Velocity - PPV - at building foundation) for Transient Vibration
Structurally sound and non-protected buildings	12 mm/s
Protected and / or potentially vulnerable buildings	6 mm/s

[139] BS 7385-2 (1993) Evaluation and measurement for vibration in buildings – Guide to damage levels from groundborne vibration

11.3.4 Construction Assessment Methodology

The construction assessment has been undertaken in accordance with ISO 9613-2:1996[140] using sound power levels from BS 5228-1136. It is not possible at this stage to predict the exact equipment that will be chosen by the Contractor(s) and predicted calculations are indicative only and used for the purposes of comparison with the adopted criteria. Based on the indicative construction program available, a reasonable worst-case assessment has been undertaken. The calculations assume that plant items are operating simultaneously, as outlined in Table 11-8.

In reality, mitigation, in the form of a screen/hoarding of 2.4m will achieve a reduction up to 10dB(A). Mitigation has been applied to each of the modelling scenarios where required for the proposed concrete wall/barriers for compliance with the limit values (Construction Areas A2, A6, A7, A9, A10, B1 & B2, B3). Mitigation has not been applied for embankment construction as it is not practicable.

Typically, construction will be from 8am to 8pm, Monday to Friday and 8am to 4pm on Saturday. It is anticipated that the construction works would take approximately 18 months.

Table 11-8. Sound Power Levels for Construction Plant

Plant included in site preparation assessment	BS 5228 reference136	Sound Power Level (Lw) dB	Percentage time in operation (%)
Tracked Excavator	C.2.25	97	66
Concrete Pump + Cement Mixer Truck	C.4.24	95	66
Articulated Dump Truck	C2.32	102	66
Dozer	C.2.1	103	66
Mini Tracked Excavator	C.4.68	93	66

11.4 Predicted Impacts

11.4.1 Do Nothing Scenario

Under a “Do Nothing” scenario, it is assumed that the proposed scheme would not go ahead. Consequently, there would be no impact on the existing baseline noise environment identified in Table 11.2.

11.4.2 Construction Phase

Overview of Construction Works

Flood Defence and Retaining Walls

New concrete flood defence walls are proposed at a number of locations such as; Verdant Place Steps and Creche, Athlunkard Boat Club, South of Absolute Hotel Boardwalk to Abbey Bridge, Abbey Bridge to Baal’s Bridge, George’s Quay and Potato Market and Civic Buildings.

Retaining walls are proposed at a number of locations such as; North East Embankment (knotweed bund), Star Rovers to Athlunkard Boat Club (over the Lower River Shannon SAC).

There are many residential and commercial properties in close proximity to areas where flood defence walls require construction, which means there is potential for impacts on sensitive receptors in the vicinity of the proposed works.

Flood Defence Embankment

Earthen embankments are proposed at a number of locations such as; North West Embankment, North East Embankment, Star Rovers to Athlunkard Boat Club, Athlunkard Boat Club. Additional HVG movements will be required to deliver materials to the site.

[140] ISO (2016) Acoustics – Description, measurement and assessment of environmental noise (Part 1 & Part 2).

Works to Footpaths/Access Paths

Additional access pathways/footpaths are proposed across the proposed scheme. The nature of this work is not predicted to give rise to significant impacts.

Construction Stages and Impacts

For the purposes of this assessment, the following construction phases are considered for the proposed scheme. It is anticipated that the overall construction phase will be approximately 18 months. An approximate duration for each phase is outlined below.

- Area A1 - Thomond Place and Verdant Place (1 month);
- Area A2 - Verdant Place Steps and Creche (1 month);
- Area A3 - North West Embankment (2 months);
- Area A4 - North East Embankment (2 months);
- Area A5 - Star Rovers to Athlunkard Boat Club (2 months);
- Area A6 - Athlunkard Boat Club (1 month);
- Area A7 – Sir Harry's Mall (1 month);
- Area A8 – Absolute Hotel Boardwalk (1 month);
- Area A9 - South of Absolute Hotel Boardwalk to Abbey Bridge (1 month);
- Area A10 - Abbey Bridge to Baal's Bridge (1 month) ;
- Area B1 & B2 – George's Quay (3 months); and
- Area B3 – Potato Market and Civic Buildings (2 months)

It is anticipated that there may be times due to exceptional circumstances that construction works will be necessary outside of the standard hours. This will be agreed in advance with Limerick City and County Council and communicated to local residents with an estimation of the timing and duration.

Area A1 - Thomond Place and Verdant Place

Works proposed: painting of existing coping; removal of existing safety rail; installation of a new coping with rail.

The works associated with Area A1 are not predicted to generate any significant noise and therefore have not been assessed in detail. Noise limits outlined in Table 11-4 are predicted to be complied with at the nearest sensitive receptor with no significant impacts.

Area A2 - Verdant Place Steps and Creche

Works proposed: Replacement of temporary concrete barrier with new concrete wall matching the replacement wall; new flood defence wall between creche and start if embankment. Regrading and raising of existing footpath.

Table 11-9 outlines the number and type of equipment assumed to be in operation, along with the percentage time in operation, during this phase site of works. The results of the assessment at the nearest sensitive receptor are presented in the following sections.

Table 11-9. Predicted sound pressure levels at the nearest sensitive receptor for construction works in Area A2.

Plant in operation (Table 11-8)	Predicted Noise Level (LAeq, 1 hr) dB(A)	Limit Value (LAeq, 1 hr) dB(A)	Impact Rating (refer to Table 11-5)	Change in noise level over baseline dB(A)
Tracked Excavator **Concrete Pump + Cement Mixer Truck** **Articulated Dump Truck**	64	65	Not significant	7

The results of the assessment indicate that for construction phase in Area A2, the daytime noise limit of 65 dB LAeq is likely to be complied with during the construction works adjacent to the nearest receptor. The predicted effects associated with these works are temporary and negative. The impact is not significant.

Area A3 - North West Embankment

Works proposed: New engineered embankment approximately 16m wide, 4m high with side slopes of 1 in 3 (on the wet side) and 1 in 2 (on the dry side). Proposed access paths to the embankment walkway.

Table 11-10. Predicted sound pressure levels at the nearest sensitive receptor for construction works in Area A3.

Plant in operation (Table 11-8)	Predicted Noise Level (LAeq, 1 hr) dB(A)	Limit Value (LAeq, 1 hr) dB(A)	Impact Rating (refer to Table 11-5)	Change in noise level over baseline dB(A)
Tracked Excavator **Articulated Dump Truck, Dozer**	62	65	Not significant	3

The results of the assessment indicate that for construction phase in Area A3, the daytime noise limit of 65 dB LAeq is likely to be complied with during the construction works adjacent to the nearest receptor. The predicted effects associated with these works are temporary and negative. The impact is not significant.

Area A4 - North East Embankment

Works proposed: Engineered (or reprofiling of) embankment along the rear of houses on St. Munchin's Street. Possible retaining wall construction at bund encapsulating Japanese knotweed. Proposed access paths to the embankment walkway.

Table 11-11. Predicted sound pressure levels at the nearest sensitive receptor for construction works in Area A4.

Plant in operation (Table 11-8)	Predicted Noise Level (LAeq, 1 hr) dB(A)	Limit Value (LAeq, 1 hr) dB(A)	Impact Rating (refer to Table 11-5)	Change in noise level over baseline dB(A)
Embankment construction **Tracked Excavator, Articulated Dump Truck, Dozer**	65	65	Not significant	3
Wall Construction Concrete Pump + Cement Mixer Truck (Discharging), Tracked Excavator	63	65	Not significant	1

The results of the assessment indicate that for construction phase in Area A4, the daytime noise limit of 65 dB LAeq is likely to be complied with during the construction works adjacent to the nearest receptor. The predicted effects associated with these works are temporary and negative. The impact is not significant.

Area A5 - Star Rovers to Athlunkard Boat Club

Works proposed: Engineered embankment proposed to run along the north side of the Star Rovers FC ground before re-joining along the inside edge of existing footpath until Athlunkard Boat Club. Retaining walls and boardwalk over SAC to north of Star Rovers. Proposed pedestrian access paths to the embankment walkway and vehicular access to boat house.

Table 11-12. Predicted sound pressure levels at the nearest sensitive receptor for construction works in Area A5.

Plant in operation (Table 11-8)	Predicted Noise Level (LAeq, 1 hr) dB(A)	Limit Value (LAeq, 1 hr) dB(A)	Impact Rating (refer to Table 11-5)	Change in noise level over baseline dB(A)
Retaining walls and embankment **Concrete Pump + Cement Mixer Truck (Discharging), Tracked Excavator, Dozer, Articulated Dump Truck**	64	65	Not significant	15

The results of the assessment indicate that for construction phase in Area A5, the daytime noise limit of 65 dB LAeq is likely to be complied with during the construction works adjacent to the nearest receptor. The predicted effects associated with these works are temporary and negative. The impact is not significant.

Area A6 - Athlunkard Boat Club

Works proposed: Combination of wall, embankment and regrading ground. Proposed pedestrian access paths to the embankment walkway and vehicular access to boat house.

Table 11-13. Predicted sound pressure levels at the nearest sensitive receptor for construction works in Area A6.

Plant in operation (Table 11-8)	Predicted Noise Level (LAeq, 1 hr) dB(A)	Limit Value (LAeq, 1 hr) dB(A)	Impact Rating (refer to Table 11-5)	Change in noise level over baseline dB(A)
Embankment construction **Tracked Excavator, Articulated Dump Truck, Dozer**	62	65	Not significant	12
Wall Construction Concrete Pump + Cement Mixer Truck (Discharging), Tracked Excavator	61	65	Not significant	11

The results of the assessment indicate that for construction phase in Area A6, the daytime noise limit of 65 dB LAeq is likely to be complied with during embankment construction and wall construction the nearest receptor. The predicted effects associated with these works are not significant.

Area A7 – Sir Harry's Mall

Works proposed: Existing wall is to be raised and strengthened to 5.1m AOD. Widening of footpath / steps to 2m with graded steps.

Table 11-14. Predicted sound pressure levels at the nearest sensitive receptor for construction works in Area A7.

Plant in operation (Table 11-8)	Predicted Noise Level (LAeq, 1 hr) dB(A)	Limit Value (LAeq, 1 hr) dB(A)	Impact Rating (refer to Table 11-5)	Change in noise level over baseline dB(A)
Concrete Pump + Cement Mixer Truck (Discharging) **Mini Tracked Excavator**	59	65	Not significant	1

The results of the assessment indicate that for construction phase in Area A7, the daytime noise limit of 65 dB LAeq is likely to be complied with during the construction works adjacent to the nearest receptor. The predicted effects associated with these works are brief to temporary and negative. The impact is not significant.

Area A8 – Absolute Hotel Boardwalk

Works proposed: Existing wall is to be raised and strengthened from 5.1m to 5.2m AOD.

The works associated with Area A8 are considered minor and are not predicted to generate any significant noise and therefore have not been assessed in detail. Noise limits outlined in Table 11-4 are predicted to be complied with at the nearest sensitive receptor.

Area A9 - South of Absolute Hotel Boardwalk to Abbey Bridge

Works proposed: Parapet wall is to be replaced with a reinforced concrete wall. The maximum height of this new wall is 1.4m.

Table 11-15. Predicted sound pressure levels at the nearest sensitive receptor for construction works in Area A9.

Plant in operation (Table 11-8)	Predicted Noise Level (LAeq, 1 hr) dB(A)	Limit Value (LAeq, 1 hr) dB(A)	Impact Rating (refer to Table 11-5)	Change in noise level over baseline dB(A)
Mini Tracked Excavator **Concrete Pump + Cement Mixer Truck** **Articulated Dump Truck**	63	65	Not significant	5

The results of the assessment indicate that for construction phase in Area A9, the daytime noise limit of 65 dB LAeq is likely to be complied with during the construction works adjacent to the nearest receptor. The predicted effects associated with these works are temporary and negative. The impact is not significant.

Area A10 - Abbey Bridge to Baal's Bridge

Works proposed: Entire length of the wall is to be replaced with reinforced concrete wall. This new wall will be up to 1.6m above ground level at the eastern end.

Table 11-16. Predicted sound pressure levels at the nearest sensitive receptor for construction works in Area A10.

Plant in operation (Table 11-8)	Predicted Noise Level (LAeq, 1 hr) dB(A)	Limit Value (LAeq, 1 hr) dB(A)	Impact Rating (refer to Table 11-5)	Change in noise level over baseline dB(A)
Mini Tracked Excavator **Concrete Pump + Cement Mixer Truck** **Articulated Dump Truck**	63	65	Not significant	5

The results of the assessment indicate that for construction phase in Area A10, the daytime noise limit of 65 dB LAeq is likely to be complied with during the construction works adjacent to the nearest receptor. The predicted effects associated with these works are brief to temporary and negative. The impact is not significant.

Area B1 & B2 – George's Quay

Works proposed; The eastern stretch of the wall is to be raised to the required guarding height. The remainder of the wall is to be replaced with a new concrete wall, interspersed with stretches of glass flood defence panels. Removal of approximately 5 trees.

Table 11-17. Predicted sound pressure levels at the nearest sensitive receptor for construction works in Area A8.

Plant in operation (Table 11-8)	Predicted Noise Level (LAeq, 1 hr) dB(A)	Limit Value (LAeq, 1 hr) dB(A)	Impact Rating (refer to Table 11-5)	Change in noise level over baseline dB(A)
Mini Tracked Excavator **Concrete Pump + Cement Mixer Truck** **Articulated Dump Truck**	61	65	Not significant	4

The results of the assessment indicate that for construction phase in Areas B1 and B2, the daytime noise limit of 65 dB LAeq is likely to be complied with during the construction works adjacent to the nearest receptor. The predicted effects associated with these works are brief to temporary and negative. The impact is not significant.

Area B3 – Potato Market and Civic Buildings

Works proposed; The eastern stretch of the wall is to be raised to the required guarding height. The remainder of the wall is to be replaced with a new concrete wall, interspersed with stretches of glass flood defence panels.

Table 11-18. Predicted sound pressure levels at the nearest sensitive receptor for construction works in Area B3.

Plant in operation (Table 11-8)	Predicted Noise Level (LAeq, 1 hr) dB(A)	Limit Value (LAeq, 1 hr) dB(A)	Impact Rating (refer to Table 11-5)	Change in noise level over baseline dB(A)
Mini Tracked Excavator **Concrete Pump + Cement Mixer Truck** **Articulated Dump Truck**	63	65	Not significant	5

The results of the assessment indicate that for construction phase in Area B3, the daytime noise limit of 65 dB LAeq is likely to be complied with during the construction works adjacent to the nearest receptor. The predicted effects associated with these works are temporary and negative. The impact is not significant.

Construction Traffic

Additional traffic due to construction will generate noise, however, the impact of these additional movements is below the assessment threshold of 25%. As outlined in Chapter 7- Traffic and Transportation Section, the greatest increase is only 13% on Island Road North.

11.4.3 Operation Phase

There are no operational noise sources associated with the proposed scheme. Therefore, no impact is predicted.

11.5 Mitigation Measures

11.5.1 Construction Phase

Construction noise will be kept to a minimum. The contract documents will specify that the contractor, undertaking the construction of the works, will be obliged to take specific noise abatement measures and will comply with the best practice outlined in BS 5228 – 1136.

The following measures will also be employed:

- Selection of plant machinery with low inherent potential for generation of noise and/or vibration. All construction plant and equipment to be used at the site will be modern equipment and will comply with the relevant legislation and regulations;
- Regular maintenance of plant will be carried out in order to minimise noise produced by on-site operations. The regular and effective maintenance of plant can play an important role in reducing noise emissions. In particular, attention will be paid to the lubrication of bearings and the integrity of silencers. Silencers and engine covers will be maintained in good and effective working order;
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the construction phase;
- Any compressors used on-site will be of the 'sound reduced' models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers;
- Machines, which are used intermittently, will be shut down or throttled back to a minimum during those periods when they are not in use;
- Any plant, such as generators or pumps, which are required to work outside of normal working hours, will be surrounded by an acoustic enclosure;
- Training of drivers to ensure smooth machinery operation/driving, and to minimise unnecessary noise generation;
- A c.2.4m hoarding of density of at least 7kg/m^2 shall be provided around construction works for concrete walls/barriers outlined in Section 11.3.4; and
- A maximum speed limit of 30 km/hr will be imposed for HGVs and drivers will be instructed to maintain as far as possible the distances between vehicles.

In terms of minimising vibration levels, the Contractor will be required to select and utilise methods of working and items of plant so that the maximum measured ground vibrations do not exceed a peak particle velocity (PPV) as outlined in Table 11-7.

11.5.2 Operation Phase

As discussed in Section 11.4.3, there are no operational noise sources associated with the proposed scheme. Therefore, no mitigation measures are proposed.

11.6 Residual Impact

11.6.1 Construction Phase

The implementation of the mitigation measures outlined in Section 11.5 will assist in reducing the impact on nearby sensitive receptors with no significant impacts predicted.

11.6.2 Operation Phase

No residual impacts are predicted during the operation phase of the proposed scheme.

11.7 Monitoring

11.7.1 Construction Phase

Prior to the commencement of construction works, baseline noise monitoring will be carried out by the Contractor to determine the existing noise environment. During the works, noise monitoring will take place at the nearest sensitive receptors to the works. Eight noise sensitive locations will be monitored during construction, these are shown in Figure 11-1, Volume 3.

Monitoring will be carried out at worst-case receptors at these locations, at a minimum. Measured levels will be compared to the limits outlined in Table 11-4.

As discussed, given the nature of the works required and the proximity of receptors to the construction works site, there may be instances where on employing all mitigation measures outlined, these noise limits may be exceeded during a particular type of construction activity. If and when the noise limits are likely to be exceeded as a result of the proposed works, the Contractor will contact the affected residents/businesses through the Community Liaison Officer (CLO) as well as Limerick City and County Council. An agreement will be reached between the Contractor, Limerick City and County Council and affected residents/businesses which will allow the required works to proceed at a time which will minimise noise nuisance or disturbance of the affected residents/business.

Vibration measurements shall be taken at the base of buildings, on the side facing the source of vibration. Where feasible, the measurement should be taken on a hard surface on the ground outside the building. A pre-condition survey will also be undertaken of all properties potentially affected by the works (likely within a 10m radius of works areas). Crack monitoring will be installed on such affected properties and monitored throughout the works.

11.7.2 Operation Phase

No monitoring measures are proposed during the operational phase of the proposed scheme.

11.8 Interactions with other Environmental Effects

Interactions that may arise between noise and vibration and other sections of this EIAR include;

- Traffic and Transport- (noise impacts during construction and operational phase). An assessment of the impacts from the construction and operational phase of the proposed FRS shows that the increases in traffic during both phases will not give rise to significant impacts;
- Soil and Geology- (noise impacts from excavations impacts). An assessment of the impacts from the construction phase of the proposed FRS shows that the increases in noise from construction plant are considered brief to temporary, moderate to major negative impacts; and
- Population and Human Heath- -(noise and vibration impacts). An assessment of the overall impacts of the proposed FRS during construction and operation shows that the increases in noise from construction plant are brief to temporary, moderate to major negative impacts.

11.9 Cumulative Impacts

As outlined in Chapter 16, cumulative impacts are assessed by looking at all current developments for which planning has been approved within 10km of the proposed site location. Ten projects have been identified. It is not predicted that, cumulatively with the proposed FRS, any of these projects will result in significant noise or vibration impacts.

11.10 Difficulties Encountered in Compiling this Information

No significant difficulties were encountered in compiling this chapter.

12 Air Quality, Dust and Climate Change

12.1 General

This chapter is in two parts:

1- Air Quality and Dust

2- Climate Change

12.2 Air Quality and Dust - Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) assesses the potential impact on local air quality and potential dust deposition impacts due to the Kings Island Flood Relief Scheme (FRS) in Limerick City.

During the 'Construction Phase' there will be the potential for an air quality and dust impact due to the nature of the proposed construction activities. A construction dust assessment has been undertaken to determine whether air quality impacts are likely to arise from the construction of the proposed FRS., using the "Guidance on the assessment of dust from demolition and construction" (Version 1.1), published by The Institute of Air Quality Management in February 2014.

Given the nature of the proposed FRS, it is expected that there will be no air quality and dust impact during the 'Operation Phase'.

12.3 Existing Environment

12.3.1 Baseline Air Quality

No baseline air quality survey was undertaken. Reference has been made to EPA data to quantify the existing air quality in proximity to the proposed FRS site.

The background air quality in the area of the development is of very good quality and the site is located in 'Zone C' as denoted by the EPA. The EPA has divided the country into zones for the assessment and management of air quality. The zones adopted in Ireland are Zone A, the Dublin conurbation; Zone B, the Cork conurbation; Zone C, comprising 21 large towns in Ireland with a population >15,000; and Zone D, the remaining area of Ireland.

Figure 12-1 shows the Annual mean PM10 concentrations in the four zones in Ireland 2006 – 2016, referenced from 'Air Quality in Ireland 2017- Indicators of Air Quality' report. This indicates that the PM10 levels for Zone C in 2017 were approximately 17 µg/m³ and are well below the EU annual limit value of 40µg/m³ and WHO air quality guideline of 20µg/m³ respectively.

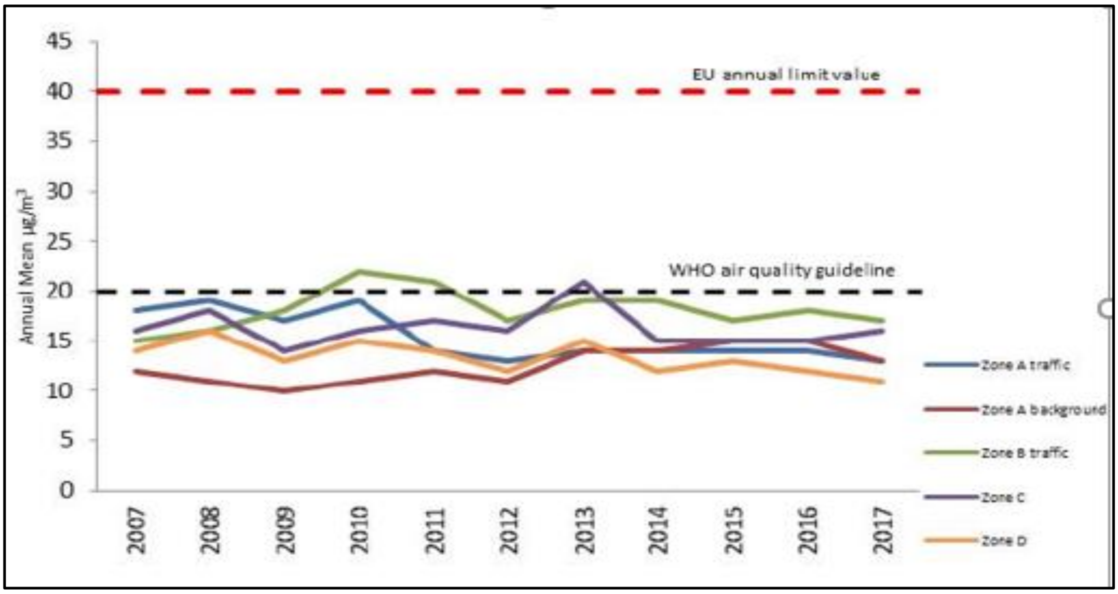

Figure 12-1. Annual mean PM10 concentrations in Zone A-D in Ireland 2007 – 2017

Limerick City and County Council has installed three air quality monitors in the metropolitan area of Limerick to provide live indicative air quality data to the public. These monitors are located in Limerick City (O'Connell Street), Mungret and Castletroy. These monitors measure particulate matter (measured since 10th May 2017) and gases (added to the monitoring suite on 24th January 2018), including nitrogen dioxide (NO2), sulphur dioxide (SO2), carbon monoxide (CO) and ozone. The most recent available report applicable for referencing is 'Air Quality Report for Limerick - November 2018'. The long term mean values for particulate matter and gases (NO_2, SO_2, CO and ozone) since the monitors were installed are shown in Table 12-1 below and compared with the annual mean limits and guidelines.

Table 12-1. Limerick County Council Air Quality monitoring station data (µg/m3)

Parameter	Location	Measured long term mean (µg/m3)	WHO annual mean guideline (µg/m3)	EU CAFÉ directive annual mean limit(µg/m3)
Total Particulates (Dec 17 – Nov 18)	O'Connell St	15 µg/m3	None specified	None specified
	Castletroy	11 µg/m3		
	Mungret	10 µg/m3		
PM10 (Dec 17 – Nov 18)	O'Connell St	10 µg/m3	20 µg/m3	40 µg/m3
	Castletroy	8 µg/m3		
	Mungret	7 µg/m3		
PM2.5 (Dec 17 – Nov 18)	O'Connell St	6 µg/m3	10 µg/m3	25 µg/m3
	Castletroy	6 µg/m3		
	Mungret	6 µg/m3		
PM1 (Dec 17 – Nov 18)	O'Connell St	3 µg/m3	None specified	None specified
	Castletroy	3 µg/m3		
	Mungret	3 µg/m3		
NO2 (Jan 18 – Nov 18)	O'Connell St	17 µg/m3	40 µg/m3	40 µg/m3
	Castletroy	11 µg/m3		
	Mungret	11 µg/m3		
SO2 (Jan 18 – Nov 18)	O'Connell St	7 µg/m3	None specified	20 µg/m3
	Castletroy	6 µg/m3		
	Mungret	5 µg/m3		
CO (Jan 18 – Nov 18)	O'Connell St	0.3 µg/m3	None specified	None specified
	Castletroy	0.1 µg/m3		
	Mungret	0.1 µg/m3		
Ozone (Jan 18 – Nov 18)	O'Connell St	37 µg/m3	None specified	None specified
	Castletroy	52 µg/m3		
	Mungret	54 µg/m3		

Nitrogen oxides (NOx, NO and NO_2) background concentrations in 2011 (final year of recorded monitoring) have been referenced from the Limerick EPA Air Quality monitoring station on Park Road which is <1km east of the development site.

Table 12-2. Limerick – Park Road EPA Air Quality monitoring station data (µg/m3)

Year	Annual Mean Concentration (µg/m3)		
	NOx	**NO**	**NO2**
2011	20.34	5.23	12.36
Limit Value	30 µg/m3	-	40 µg/m3

An EPA Air Quality Monitoring Station is located in the grounds of People's Park, Limerick City. Monitoring is carried out using continuous monitors for ozone, oxides of nitrogen and particulates (PM2.5 and PM10). The monitoring location is approximately 1 Km south of Kings Island.

The monitoring data for ozone, oxides of nitrogen, sulphur dioxide, carbon monoxide and particulates (PM2.5 and PM10) in Limerick City has consistently indicated compliance with the relevant ambient air quality standards.

The CAFE (Clean Air for Europe) Directive sets air quality standards for member states in Europe and has been transposed into Irish legislation by the Air Quality Standards Regulations. There were not any exceedances of these EU CAFÉ directive annual mean limits or WHO guideline values.

The Environmental Protection Agency's Air Quality Index for Health (AQIH) is a number from one to 10 that identifies the current air quality currently in a region and whether or not this might affect human health. A reading of 10 means the air quality is very poor and a reading of one to three inclusive means that the air quality is good. The AQIH readings are based on five air pollutants which can harm human health: Ozone gas, nitrogen dioxide gas, sulphur dioxide gas, PM2.5 particles and PM10 particles There are two monitoring stations in Limerick located in Park Road (monitoring finished) and Shannon Estuary (current monitoring site with real time data). Both monitoring facilities defined the AQIH in Zone C - Limerick as 2 - Good [index calculated at 10:28, Thursday Mary 29, 2019] (EPA, 2019).

Baseline dust deposition monitoring was not undertaken in proximity to the area of the Kings Island Flood Relief Scheme (FRS) as it can be assumed that existing baseline dust deposition rates are low and well in compliance with guideline limit values. Also, due to concerns for the security of the monitoring equipment before the installation of work areas and work compounds, etc. dust deposition monitoring equipment was not installed.

12.4 Assessment Methodology

The Institute of Air Quality Management (IAQM) Guidance on the assessment of dust from demolition and construction (Version 1.1) has been referenced to assess the potential impact of the construction of the proposed site. Good practice construction mitigation measures are recommended to be implemented to minimise emission quantities during construction.

12.4.1 Dust deposition Guidelines

Dust particles can be classified into those that are easily deposited and those that remain suspended in the air for long periods. This division is useful as deposited dust is usually the coarse fraction of particulates that causes dust annoyance, whereas suspended particulate matter is implicated more in exposure impacts. Airborne particles have a large range of diameters, from nano-particles and ultrafine particles (diameters less than 0.1μm) to the very large particles with diameters up towards 100μm. There is no clear dividing line between the sizes of suspended particulates and deposited particulates, although particles with diameters >50 μm tend to be deposited quickly and particles of diameter <10 μm (PM10) have an extremely low deposition rate in comparison. Therefore, the size of suspended and deposited dust particles affects their distribution and as such requires two very different approaches to sampling these fractions. PM10 is the fraction of airborne (suspended) particulates which contains particles of diameter less than 10μm. PM2.5 is the fraction of airborne (suspended) particulates which contains particles of diameter less than 2.5μm. PM10 and PM2.5 particles can penetrate deep into the respiratory system increasing the risk of respiratory and cardiovascular disorders. Total Suspended Particles (TSP) is the term used when referring to larger particles which do not have a specified size limit. It is common for TSP to be measured alongside PM10 and PM2.5 particularly at industrial sites when dust monitoring is undertaken.

Particulate matter can emanate from natural and anthropogenic sources. Natural sources include sea salt, forest fires, pollen and moulds. Natural sources are unregulated and harder to control. Anthropogenic sources can be regulated and understanding the sources of particulate matter is very important. PM10 is most commonly associated with road dust and construction activities. Wear and tear of brakes and tyres on vehicles and crushing activities at construction sites can all contribute to a rise in PM10. PM2.5 is associated with fuel burning, industrial combustion processes and vehicle emissions. Larger particles (100μm diameter) are likely to settle within 5-10m of their source under a typical mean wind speed of 4-5 m/s, and particles between 30-100 μm diameter are likely to settle within 100m of the source. Smaller particles, particularly those <10 μm in diameter, i.e. PM10, have a greater potential to have their settling rate impeded by atmospheric turbulence and to be transported further from their source. Dust emissions are exacerbated by dry weather and high wind speeds. The impact of dust therefore, also depends on the wind direction and the relative location of the dust source and receptor.

Currently no Irish statutory standards or limits exist for the assessment of dust deposition and its tendency for causing nuisance. Similarly, no official air quality criterion has been set at a European or World Health Organisation (WHO) level, although a range of national 'yardstick' criteria from other countries is found in literature.

The German TA Luft Regulations, "Technical Instructions on Air Quality Control" state that total dust deposition (soluble and insoluble, measured using Bergerhoff type dust deposit gauges as per German Standard Method for determination of dust deposition rate, VDI 2119) should not exceed a dust deposition rate of 350 mg/m2/day (when averaged over a 30+/-2 day period). The use of this limit value is appropriate to minimise the impact of airborne dust levels on the receiving environment beyond the site boundary. The German TA Luft criteria for 'possible nuisance' and 'very likely nuisance' are 350mg/m2/day and 650mg/m2/day, respectively.

In 2005, the UK Highways Agency released an Interim Advice Note 61/05 'Guidance for Undertaking Environmental Assessment of Air Quality for Sensitive Ecosystems in Internationally Designated Nature Conservation Sites and SSSIs' as a supplement to the Design Manual for Roads and Bridges (DMRB) Guidelines. This interim guidance states that dust or particles falling onto plants can physically smother the leaves affecting photosynthesis, respiration and transpiration. The literature suggests that the most sensitive species appear to be affected by dust deposition at levels above 1,000 mg/m2/day which is considerably greater than the level at which most dust deposition may start to cause a perceptible nuisance to humans. As such, once dust deposition rates are maintained within the guidelines for human nuisance the impact of dust deposition on sensitive ecosystems is considered negligible.

Therefore, the following dust limits have been recommended;

- Dust Deposition Rate limit = 350 mg/m2/day (averaged over a 30+/-2 day period using Bergerhoff Gauge Method).
- Dust Deposition Rate limit affecting sensitive ecological receptors = 1,000 mg/m2/day

12.5 Predicted Impacts

12.5.1 Do Nothing Scenario

The 'Do Nothing' scenario is defined as the option involving no future expenditure on flood defences or maintenance of existing defences/channels. There is no air quality and dust impact from the 'Do Nothing scenario'.

12.5.2 Construction Phase

Construction Dust Impact Assessment

Kings Island lies in the heart of Limerick City and is surrounded by the waters of the River Shannon and the Abbey River. Both rivers are tidal at this location and the island is historically susceptible to both tidal and fluvial flood risk. A major improvement on the existing temporary flood defences is required to reduce the frequency of extreme events which inundate the island. The Kings Island Flood Relief Scheme (the Scheme) will be designed to provide protection to properties in the study area from the 1 in 200-year tidal flood event (0.5% AEP event).

Generally described, it is a series of flood defences positioned around Kings Island comprising both new and upgraded flood walls (incorporating glass panels in the urban areas) and embankments plus associated townscape improvements. The length of river channel on which works are proposed is 3.7km.

STEP 1: Screening the Need for a Detailed Assessment

An assessment will normally be required where there is:

- a 'human receptor' within:
  - 350 m of the boundary of the site; or
  - 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s)
- an 'ecological receptor' within:
  - 50 m of the boundary of the site; or
  - 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

STEP 2: Assess the Risk of Dust Impacts

The risk of dust arising in sufficient quantities to cause annoyance and/or health and/or ecological impacts should be determined using four risk categories: negligible, low, medium and high risk. A site is allocated to a risk category based on two factors:

- the scale and nature of the works, which determines the potential dust emission magnitude as small, medium or large (STEP 2A); and
- the sensitivity of the area to dust impacts (STEP 2B), which is defined as low, medium or high sensitivity.

These two factors are combined in STEP 2C to determine the risk of dust impacts with no mitigation applied. The risk category assigned to the site can be different for each of the four potential activities (demolition, earthworks, construction and trackout). More than one of these activities may occur on a site at any one time. Where appropriate, the site can be divided into 'zones' for the dust risk assessment.

Step 2A: Define the Potential Dust Emission Magnitude

Earthworks, construction and track out will occur during the construction phase. There will be no demolition activities on the site. Table 12-3 describes the potential dust emission class criteria for each outlined construction activity.

Table 12-3. Criteria Used in the Determination of Dust Emission Class

Activity	Criteria used to Determine Dust Emission Class		
	Small	**Medium**	**Large**
Earthworks	Total site area <2,500m2 soil type with large grain size (e.g. sand), <5 heavy moving earth vehicles active at any one time formation of bunds <4 m in height Total material moved <20,000 tonnes	Total site area 2,500 – 10,000m2 Moderately dusty soil type (e.g. silt) 5-10 heavy moving earth moving vehicles active at any one time. formation of bunds 4 m - 8 m in height, Total material moved 20,000 – 100,000 tonnes	Total site area >10,000m2 potentially dusty soil type (e.g. clay) >10 heavy earth moving vehicles active at any one time formation of bunds >8 m in height Total material moved >100,000 tonnes
Construction	Total building volume <25,000m3 Construction material with low potential for dust release	Total building volume 25,000 – 100,000m3 Potentially dusty construction material (e.g. concrete) On-site concrete batching	Total building volume >100,000m3 On-site concrete batching Sandblasting
Trackout	<10 outward HDV trips in any one day surface material with low potential for dust release, Unpaved road length <50m	10 - 50 outward HDV trips in any one day moderately dusty surface material (e.g. high clay content), Unpaved road length 50-100m	>50 outward HDV trips in any one day potentially dusty surface material (e.g. high clay content Unpaved road length >100m

The potential dust emission magnitudes for the proposed FRS were estimated using information provided and determined using the criteria detailed in Table 1-1 as follows;

Earthworks:

The total site works area is approximately 3,500m^2. The length of river channel on which works are proposed is 3.7km. During the construction phase of the project fill material will be imported into the site for the construction of the embankment in the northern part of the scheme. Approximately 2,200 linear metres of embankment will be formed.

The site itself contains moderately dusty soil type / silty sand. The geology of Kings Island is composed of made ground and alluvial deposits (silt, clay, sand and gravel) overlying limestone. The clay and silt overlying the gravels is consistent across the site.

It is assumed that there will be >10 heavy moving earth moving vehicles active at any one time.

During the construction phase of the project fill material will be imported into the site for the construction of the embankment in the northern part of the scheme. The material will comprise 93,900m^3 of inert engineering fill, 43,000m^3 of landscape fill (class 4) and 6,700m^3 of topsoil, totalling 143,600m^3. Therefore > 100,000 tonnes of material will be imported into the site for the construction of the embankment.

The bunds will be 4-8 metres in height.

Therefore, the dust emission magnitude for Earthworks is defined as Medium - Large.

Construction:

The total building volume will be <25,000 m3.

Construction material with a low potential for dust release will be used e.g. fill material imported into the site, i.e. 93,900m^3 of inert engineering fill (cohesive clay), 43,000m^3 of landscape fill (class 4) and 6,700m^3 of topsoil, totalling 143,600m^3.

Therefore, the dust emission magnitude for construction is defined as Low.

Trackout:

Considering and the daily number of HGV movements over constriction period, there will be greater than 50 outward HGV movements in any one day. Table 12-4 outlines the predicted construction phase traffic volumes as provided by ARUP. The unpaved road length will be >100m.

Therefore, the dust emission magnitude for track out was defined as Large.

Table 12-4. Predicted Construction Phase Traffic Volumes

Link	2019 Base Year AADT	2021 Construction Year AADT	2021 + Devt AADT	Construction traffic
Verdant Place	276	282	282	0
Thomond Bridge	8970	9153	9173	20
Castle Street	8829	9008	9028	20
Island Road West	218	222	222	0
Island Road North	1245	1271	1448	177
Island Road Central	7968	8130	8287	157
Athlunkard St	3861	3939	3955	16
Island Road South	6393	6523	6640	17
R463 West (Bridge)	6978	7119	7143	24
Corbally Road R463	8627	8802	8818	16
Pa Healy Road	5877	5997	6005	8
R445 East	9874	10073	10186	113
Mary Street	1830	1866	1866	0
Broad Street	2759	2815	2819	4
Charlotte's Quay	4974	5074	5074	0
Bridge Street	5138	5241	5257	16

Step 2B: Define the Sensitivity of the Area

The sensitivity of the area takes account of a number of factors:

- the specific sensitivities of receptors in the area;
- the proximity and number of those receptors;
- in the case of PM10, the local background concentration; and
- site-specific factors, such as whether there are natural shelters, such as trees, to reduce the risk of wind-blown dust.

The criteria for determining the sensitivity of receptors is detailed in Table 12-5 for dust soiling effects and health effects of PM10.

Table 12-5. Criteria for Determining Sensitivity of Receptors

Receptor Sensitivity	Criteria for Determining Sensitivity	
	Dust Soiling Effects	Health Effects of PM10
High	Dwellings, museums and other culturally important collections, medium and long-term car parks and car showrooms	Residential properties, hospitals, schools and residential care homes
Medium	Parks, places of work	Office and shop workers not occupationally exposed to PM10
Low	Playing fields, farmland, footpaths, short-term car parks and roads	Public footpaths, playing fields, parks and shopping streets

The criteria detailed in Table 12-6, Table 12-7, and Table 12-8 were used to determine the sensitivity of the area to dust soiling effects and human health impacts.

Table 12-6. Sensitivity of the Area to Dust Soiling Effects on People and Property.

Receptor Sensitivity	Number of Receptors	Distance from Source (m)			
		<20m	<50m	<100m	<350m
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Table 12-7. Sensitivity of the Area to Human Health Impacts

Receptor Sensitivity	Annual Mean PM10 Conc	Number of Receptors	Distance from Source (m)				
			<20m	<50m	<100m	<200m	<350m
High	>32 µg/m3	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32 µg/m3	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28 µg/m3	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24 µg/m3	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>32 µg/m3	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	28-32 µg/m3	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low

	24-28 µg/m3	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<24 µg/m3	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Low		≥1	Low	Low	Low	Low	Low

Table 12-8. Sensitivity of the Area to Ecological Impacts

Receptor Sensitivity	Distance from the Source (m)	
	<20m	<50m
High	High	Medium
Medium	Medium	Low
Low	Low	Low

12.6 Sensitivity of Receptors

Kings Island is in the heart of Limerick and contains residential, administrative, ecclesiastical, educational, retail, business and tourism elements. Kings Island also contains some cultural heritage features such as remains of Limerick City Walls and various 12th and 13th century buildings including King John's Castle and St. Mary's Cathedral. The southern portion of Kings Island is regarded as the historic core of Limerick City and consequently has strong tourism potential. However, the northern portion of Kings Island is St. Mary's Park residential estate, an area of deprivation, in terms of health, education, employment, and housing conditions and standards. Built in 1995, of 464 houses, only 303 were occupied in 2014.

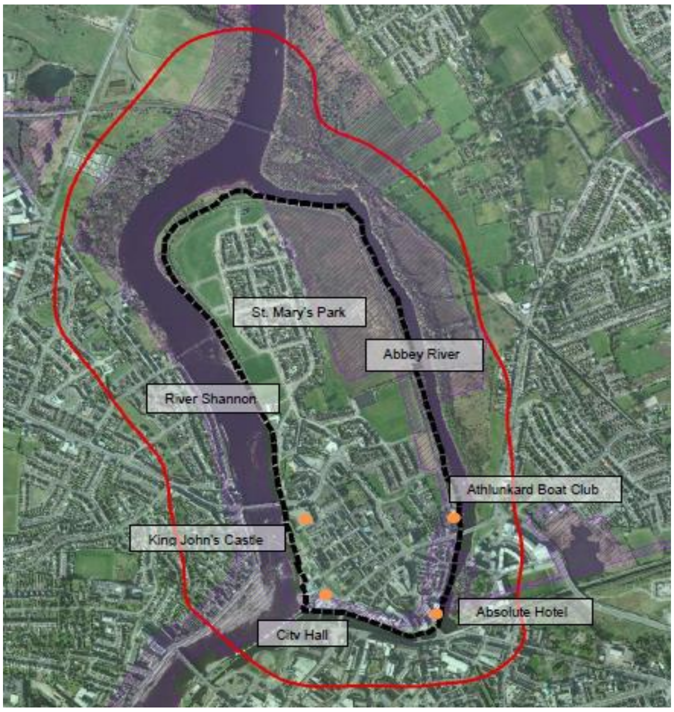

Figure 12-2. Location of sensitive receiver locations including areas sensitive to ecological Impacts

Table 12-9 outlines the range of numbers of properties within specific distance bands from the proposed construction activities on Kings Island, using the values provided in Table 12-6 to determine the receptor sensitivity of the area to Dust Soiling Effects on People and Property.

Table 12-9. Cumulative number of residential properties within 20m, 50m, 100m, 200m and 350m of the site

Parameter	Number of Receptors within Distance from Site (m)				
	<20m	<50m	<100m	<200m	<350m
No. of receptors in proximity to Site	10-100	10-100	>100	>100	>100
Receptor Sensitivity	High	Medium	Medium	Medium	Low

Sensitivity of the Area to Dust Soiling Effects on People and Property

There is an estimated 10-100 receptors within 20m of the proposed construction activities on Kings Island, considering, residential properties (particularly Munchin Street properties), and many other culturally important buildings and car parks located in close proximity to the proposed works. Therefore, the sensitivity of the Area to Dust Soiling Effects on People and Property is High; in terms of potential earthworks, construction and track out dust impacts.

Sensitivity of the Area to Human Health Impacts

Figure 13-1 (graph earlier in this chapter) shows the annual mean PM10 concentrations in the four zones in Ireland 2006 – 2016. This indicates that the PM10 levels for Zone C in 2017 were approximately 17 µg/m3 and are well below the EU annual limit value of 40µg/m3 and WHO air quality guideline of 20µg/m3 respectively. Table 12-2 displays PM10 monitoring levels at three locations by Limerick City and County Council. The PM10 concentration of 10 µg/m3 in O Connell street (closest location to Kings Island), is well below the EU annual limit value of 40µg/m3 and WHO air quality guideline of 20µg/m3 respectively.

Therefore, the sensitivity of the Area to Human Health Impacts is Low; in terms of potential earthworks, construction and track out dust impacts.

Sensitivity of the Area to Ecological Impacts

Dust deposition due to earthworks, construction and track out has the potential to affect sensitive habitats and plant communities. A portion of Kings Island is designated within the Lower River Shannon Special Area of Conservation (SAC) (Site Code: 02165). The proposed construction works will take place within the SAC. Therefore, the sensitivity of the Area to Ecological Impacts is High.

Step 2C: Define the Risk of Impacts

The dust emission magnitude and sensitivity of the area have been combined and the risk of impacts from earthworks, construction and track out, before mitigation is applied, was determined. The risk of dust soiling and impact on human health and ecological receivers before mitigation is summarised in Table 12-10 below.

Table 12-10. Summary Dust Risk Table to Define Site-specific Mitigation

Potential Impact	Risk		
	Earthworks	Construction	Trackout
Dust Soiling	High Risk	High Risk	High Risk
Human Health	Low Risk	Low Risk	Low Risk
Ecological	High Risk	High Risk	High Risk

12.6.1 Operation Phase

There will be no air quality and dust impact from the 'Operation Phase'.

12.7 Mitigation Measures

12.7.1 Do Nothing Scenario

There will be no air quality and dust mitigation measures required for the 'Do Nothing scenario'.

12.7.2 Construction Phase

Step 3: Site-Specific Mitigation

In accordance with the IAQM Guidance, for proposed mitigation measures, the highest risk category should be applied. Therefore, the mitigation measures applicable to a High Risk site should be applied. These are as follows:

General Measures

Dust Management

A Dust Management Plan (DMP) will be developed and implemented which will include the mitigation measures outlined below to control dust emissions. The DMP will include monitoring of dust deposition, and possibly real-time PM10 continuous monitoring as well as visual inspections.

Communications

- Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.
- Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.
- Display the head or regional office contact information

Site Management

- Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.
- Make the complaints log available to the local authority when asked;
- Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book; and
- Hold regular liaison meetings with other high risk construction sites within 500 m of the site boundary, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/deliveries which might be using the same strategic road network routes.

Preparing and maintaining the site

- Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible;
- Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site;
- Fully enclose site or specific operations where there is a high potential for dust production and the site is actives for an extensive period;
- Avoid site runoff of water or mud;
- Keep site fencing, barriers and scaffolding clean using wet methods;
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below; and
- Cover, seed or fence stockpiles to prevent wind whipping.

Operating vehicle/machinery and sustainable travel

- Ensure all vehicles switch off engines when stationary - no idling vehicles;
- Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable;
- Impose and signpost a maximum-speed-limit of 15 mph on surfaced and 10 mph on unsurfaced haul roads and work areas; and
- Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.

Operations

- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems;
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
- Use enclosed chutes and conveyors and covered skips;
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate; and
- Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.

Waste Management

- Avoid bonfires and burning of waste materials.

Measures specific to construction

- Avoid scabbling (roughening of concrete surfaces) if possible;
- Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place;
- Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery; and
- For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.

Measures specific to track out

- Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use;
- Avoid dry sweeping of large areas;
- Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport;
- Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable;
- Record all inspections of haul routes and any subsequent action in a site log book;
- Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned;
- Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable);
- Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits; and
- Access gates to be located at least 10m from receptors where possible.

12.7.3 Operation Phase

There are no air quality and dust mitigation measures required for the 'Operation Phase'.

12.8 Residual Impact

Do Nothing Scenario

There is no air quality and dust impact from the 'Do Nothing scenario'.

12.8.1 Construction Phase

Step 4: Determine Significant Effects

Construction site dust control measures and good construction site management and practice is capable of effectively mitigating the potential for significant impact of fugitive dust emissions. Therefore, the potential for fugitive dust emission effects at the nearest residential properties and ecological receptors will be controlled to ensure impacts are of negligible significance.

The IAQM Guidance recommends that significance is only assigned to the effect after considering the construction activity with mitigation. Therefore, the detailed mitigation measures have been defined in a form suitable for implementation by way of a planning condition and will be included in a Construction Environmental Management Plan.

Between 10-100 sensitive receptors have been noted within 20m of the access road and proposed earthworks. The proposed construction works are within the boundary of the Lower River Shannon SAC. Using the IAQM methodology for the assessment of air quality impacts from construction activities, it is indicated that the risk of dust soiling impacts are high, impacts on human health are low and ecological impacts are high. The significance of impacts arising from the risks identified together with the proposed mitigation measures are summarised in Table 12-11.

Together with the proposed construction mitigation measures and the existing low background particulate (PM10) concentrations, the construction phase activities on the proposed site will not cause an exceedance of the air quality objectives at receptor locations.

Table 12-11. Summary of Significance of Impact including Site-specific Mitigation

Potential Impact	Significance		
	Earthworks	Construction	Track out
Dust Soiling	Negligible	Negligible	Negligible
Human Health	Negligible	Negligible	Negligible
Ecological	Negligible	Negligible	Negligible

12.8.2 Operation Phase

There is no air quality and dust impact from the 'Operation Phase'.

12.9 Monitoring

12.9.1 Construction Phase

Monitoring

Undertake daily on-site and off-site inspection, where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority if and when requested. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100 m of site boundary, with cleaning to be provided if necessary.

Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the local authority if and when requested.

Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.

Agree dust deposition and/or real-time PM10 continuous monitoring locations with the Local Authority. Where possible commence baseline monitoring at least three months before work commences on site. Further guidance is provided by IAQM on monitoring during demolition, earthworks and construction.

12.10 Cumulative Impacts

The proposed FRS will not result in any significant cumulative impacts in terms dust deposition or air pollutant emissions.

12.11 Interactions with other Environmental Effects

An assessment of the potential impact of dust deposition on ecological receptors in proximity to the proposed woks has been undertaken. A portion of Kings Island is designated within the Lower River Shannon Special Area of Conservation (SAC). The proposed construction works will take place within the SAC. Therefore, the sensitivity of the Area to Ecological Impacts is High. Appropriate construction phase mitigation measures have been outlined to ensure that the potential impact on the SAC will be negligible.

12.12 Difficulties Encountered in Compiling this Information

No difficulties were encountered in the preparation of the Air Quality & Dust Impact Assessment chapter.

12.13 Climate Change - Introduction

This chapter assesses the potential impacts of the proposed FRS on sustainability and climate change, during construction, operation and beyond the design life of the proposals. The following key issues are assessed in this chapter:

- Sustainable resource use;
- Carbon footprint and greenhouse gas emissions; and
- Vulnerability and adaptation of the proposed FRS to a changing climate.

12.13.1 Policy Framework

Climate change has been addressed in EU Directives surrounding EIAR, specifically Directive 2014/52/EU which specifies that:

Climate change will continue to cause damage to the environment and compromise economic development. In this regard, it is appropriate to assess the impact of projects on climate (for example greenhouse gas emissions) and their vulnerability to climate change.

EU Guidance on integrating climate change and biodiversity into EIA (2013) recommends that climate change should be addressed in an EIAR through the following approach:

- Consider climate change at the outset of a project;
- Analyse evolving environmental baseline trends by using a vulnerability assessment to help assess the evolution of the baseline environment and identify the most resilient alternative;
- Take an integrated approach to planning and assessment, investigating relevant thresholds and limits;
- Seek to avoid biodiversity and climate change effects from the start, before considering mitigation or compensation;
- Assess alternatives that make a difference in terms of climate change and biodiversity;
- Use ecosystem-based approaches and green infrastructure as part of project design and/or mitigation measures; and
- Assess climate change and biodiversity synergies and cumulative effects, which can be significant.

In addition to assessing the vulnerability of a project to climate change, it is important to assess whether a project is adaptable under changing climate conditions. Climate change mitigation and adaptation actions are framed and informed by policy from within the UN, EU, and have been transposed into Irish Law. These include the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, the UN Paris Agreement, the EU Climate and Energy Package, the National Climate Change Adaptation Framework (2012), the National Policy Position on Climate Change and the Climate Action and Low Carbon Development Act 2015, the National Mitigation Plan (2017), and National Adaptation Framework (2018).

Specific to the Irish context, the National Adaptation Framework (2018) recognises that extreme weather and flooding are some of the most likely effects of climate change, to which Ireland will need to adapt in the future. The framework outlines the uncertainty regarding future climate scenarios, as variability is expected due to natural changes in the climate in addition to human-induced climate change.

The response to climate change requires appropriate decisions on whether to consider a managed adaptive approach or whether to adopt a more precautionary approach. Uncertainty surrounding mitigation efforts is compounded by uncertainty surrounding the future impacts of climate change as well as embedded short-term investment horizons that do not necessarily apply when we are discussing impacts that may not arise for at least several decades.

12.14 Approach

The options selection process for the King's Island FRS included a climate change vulnerability and risk assessment which accounted for the uncertainty around climate change predictions while keeping with current-day conditions and limitations. This assessment was completed in line with OPW Guidance Note 29 on Climate Change Adaptation. The result of the assessment recommended a managed adaptive approach which would allow flood containment measures (including the flood wall and embankment options) with built-in foundations that would allow increased protection standards to the Mid-Range Future Scenario (MRFS). This approach also takes into account future decisions which will allow the options to raise the embankments and flood walls, and additional measures such as a tidal barrage and emergency warning systems.

12.15 Assessment Methodology

The following sections outline the approach taken when assessing climate change vulnerability and adaptability in this EIAR.

12.15.1 Vulnerability Assessment

A Climate Change Vulnerability and Risk Assessment was carried out at the options appraisal stage of this project[141] to inform the options development. This followed the approach recommended in the JASPERS Guidance Note: The Basics of Climate Change Adaptation Vulnerability and Risk Assessment (2017) and the EU Non-Paper Guidelines for Project managers: making vulnerable investments climate resilient. The purpose of this was to determine what climate hazards the project needs to consider and then assess the risk to the project and its flood risk management objectives.

A vulnerability assessment determines how vulnerable the project is to specific climate-related hazards in its current location, and to enable prioritisation of hazards to identify which are most significant hazards and taken forward for a more detailed location by location risk assessment. Potential drivers of climate hazards include:

- Changes in average temperature;
- Changes in average precipitation;
- Change in relative sea level;
- Change in average wind speeds;
- Changes in humidity; and
- Changes in solar radiation

Vulnerability is a function of the sensitivity of the project elements to climate hazards (irrespective of their proposed location) and the exposure or probability of these climate hazards occurring at Kings Island. Vulnerability is determined to be a combination of the following:

- Sensitivity assessment: identifies climate hazards that would have a negative effect on the project if they occurred, considering construction, assets, infrastructure and operation. The sensitivity assessment scores climate hazards as they relate to the scheme on the following system; and
- Exposure assessment: describes the level to which the area is currently affected by the identified climate hazards or could be in the future as a result of climate change. Exposure data is gathered for climate variables. The assessment has been carried out for the current and future exposure.

Such, high vulnerability is defined by the red zones, medium vulnerability in orange, both categories being evaluated in the risk assessment. The vulnerability scores for both the sensitivity assessment and exposure assessment are given based on the following scoring system:

141 King's Island Flood Relief Scheme Options Assessment Report (JBA and Arup, 2018)

Table 12-12. Sensitivity and exposure assessment scoring

High (3)	Project is so severely affected that it cannot achieve its main objectives
Medium (2)	Project is affected so that there is some impact on achieving its main objectives
Low (1)	Project is affected so that there is only a minor impact on achieving its main objectives
No (0)	No impacts on the project whatsoever

The exposure to climate change hazards is based upon:

- The National Climate Change Strategy 2007-2012;
- EPA's Ireland's Climate Strategy to 2020 and Beyond;
- EPA's Ireland's National Inventory Report 2016;
- EPA's Ireland Greenhouse Gas Emissions to 2020;
- DECLG Climate Action and Low Development Programme;
- United Nations Framework Convention on Climate Chante (UNCCC): Paris Agreement;
- EPA Research Programme 2014-2020: Ensemble of regional climate model projections for Ireland by Paul Nolan;
- Met Eireann (2013) Ireland's Climate: the road ahead; and
- EPA Report 159: Ensemble of Regional Climate Model Projection for Ireland.

Using the information from the exposure and sensitivity assessments, the vulnerability assessment then identifies which are most significant hazards and taken forward for risk assessment where:

Vulnerability = Sensitivity X Exposure

Table 12-13. Vulnerability assessment scoring

		Exposure			
		0	1	2	3
Sensitivity	0	0	0	0	0
	1	0	1	2	3
	2	0	2	4	6
	3	0	3	6	9

The results of this vulnerability assessment are outlined in the relevant sections in Table 12-14 and Table 12-15 for the selected options (reinforced concrete flood walls, and impermeable clay embankments). Further details of this analysis are presented in the Options Report[141] for the project. Climate change vulnerability was a key factor in the Options Selection phase in the development of the FRS. The key vulnerabilities identified of all viable measures in current and future climate change scenarios progressed to a more detailed risk assessment. This took into consideration the specific location, construction, infrastructure, and operation of the viable flood risk management measures. The severity and likelihood of the risks from climate hazards are examined, considering in-built adaptation measures, the flexibility of the measure to adapt and the adaptation options available for each viable flood risk management measure. The residual risks to climate change hazards on both the proposed flood risk management structures and their ability to continue to provide flood risk management in the future was assessed. The assessment was undertaken for each area and helped to inform the final scheme approach for this development.

12.15.2 Adaptability Assessment

Climate change adaptability was assessed for the proposed FRS. Adaptability has been assessed as the ability of the flood relief scheme to adapt to a changing climate, including in-built measures to facilitate and allow adaptation without restricting the range of future interventions.

The assessment of climate change adaptation involves the following steps as presented in the CFRAM Guidance Note 29 - Guidance Note 29 – Climate Change Adaptation Guidance Note (version 5), which follows a hierarchical process of integrating a managed adaptive approach into the FRMP development process.

To determine how climate change adaptability is assessed, it must be first determined whether the communities impacted by climate change are considered Highly-Sensitive or Less-Sensitive. Highly-sensitive communities are considered those where the degree of risk significantly increases under the MRSF and the HEFS, and then adaptation of any flood relief scheme, and future interventions, are likely to be required to avoid significant increases in risk in the future. Less-Sensitive communities are those where the degree of risk does not significantly increase under the MRSF and the HEFS. King's Island is highly vulnerable to the effects of climate hazards such as sea level rise under the MRSF and HEFS, increased storminess, and changes in precipitation pattern. Therefore, the community of King's Island is considered Highly-Sensitive to the effects of climate change.

Highly-sensitive communities are guided by the following:

Where a community is highly vulnerable to the potential impacts of climate change, i.e., the degree of risk significantly increases under the MRSF and the HEFS, then adaptation of any flood relief scheme, and future interventions, are likely to be required to avoid significant increases in risk in the future. This may alter the current type of measures adopted for that community and would prompt the use of the managed adaptive approach. As such, the option identification should consider potential future risk under the MRFS and HEFS, and what measures may be required to manage or reduce that risk. The design of measures to address current risk should then proceed on the basis of what may be required in the future to ensure that what is done now is adaptable to, and will not impede, future interventions, or, take an assumptive approach, where appropriate, and provide for future risks in the current designs. This may require option development for the future scenarios to be undertaken in outline form. In certain circumstances, where the potential impacts of climate change may be particularly significant, a detailed decision-tree analysis may be required to inform this option selection process and undertake the appraisal.

Climate change was considered in the options development phase of this project, which included the following steps:

- Step A: Setting and checking boundaries;
- Step B: Assessing community vulnerability;
- Step C: Assess drivers of uncertainty and change;
- Step D: Screening of the most appropriate approach to be applied in the FRMP;
- Step E: Identify adaptive measures / options;
- Step F: Constructing a decision tree (qualitative or quantitative depending on specific criteria);
- Step G: Development and Appraisal of Potential Options;
- Step H: Selection of preferred options; and
- Reporting.

This analysis was completed was completed in the early stages of the project and is detailed further in the King's Island Options Report.

12.16 Baseline Information

12.16.1 Causes of Climate Change

The Intergovernmental Panel on Climate Change (IPCC) has concluded that greenhouse gas emissions due to human activities are having an unprecedented effect on the earth's climate. Multiple lines of evidence have shown that the climate is already changing across the globe as a result of increased concentrations of greenhouse gases such as carbon dioxide (CO_2), methane (CH_3), and nitrous oxide (N_2O). The effects of a human induced changing climate are predicted to vary across the globe, resulting in increased frequency of extreme weather and temperature fluctuations outside of the natural climate variability.

According to the IPCC[142], approximately 60% of greenhouse gas emissions over the last four decades have come from the burning of fossil fuels. Ireland's National Policy Position on Climate change[143] sets out a framework to transition to a low-carbon economy based on:

- A total reduction in carbon dioxide (CO2) emissions of at least 80% (compared to 1990 levels) by 2050 across the electricity generation, built environment and transport sectors;
- Carbon neutrality across various sectors including the agriculture and land-use sector, including forestry, done in such a way which does not compromise capacity for sustainable food production.

12.16.2 Climate Change Predictions

The effects of climate change are likely to result in increased sea level and subsequently increased flood levels and greater frequency of flooding. Regional Climate Modelling (RCM) simulations for Ireland have predicted a number of changes to various climatic variables by 2050 and beyond, notably:

- Significant projected decreases in mean annual, spring and summer precipitation amounts by mid-century. The projected decreases are largest for summer, with reductions ranging from 0% to 20%. Heavy rainfall events will increase in winter and autumn (Nolan, 2015);
- Storms affecting Ireland will decrease in frequency, but increase in intensity, with increased risk of damage (Nolan, 2015);
- Intensification of the hydrological cycle, leading to both increased incidences of high and low flow periods in rivers and lakes (Nolan, 2015);
- Mean sea level rise by 0.5m in the OPW's Medium Range Future Scenario (MRFS) and 1m in the High End Future Scenario (HEFS);
- Fluvial flows are projected to increase by 20% and 30% respectively; and
- Frost days averaged over the whole country, the number of frost days (defined as a day when the minimum temperature is less than 0°C) is projected to decrease by over 50%.

12.16.3 Design Considerations

Design flood level

The King's Island FRS has been designed to manage the 0.5% AEP flood risk over a 50 year appraisal period. The design flood defence level for the whole of King's Island has been assumed as +5.1mOD Malin based on the assessment which accounts for the present day 0.5% AEP tide level (+4.8mOD Malin) and freeboard (0.3m).

The 0.5% AEP tide level at King's Island is generally consistent at circa 4.79mOD. There are some very slight differences in this level at various points around the island. As any variations in height are marginal, a blanket value of 4.8mOD has been adopted with a freeboard allowance added to account for local variation.

[142] Intergovermental Panel on Climate Change. (2014). Report: AR5 Climate Change 2014: Mitigation of Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
[143] Department of Communications, Climate Action & Environment. (2014). National Policy Position on Climate Action and Low Carbon Development (2014). Retrieved from: https://www.dccae.gov.ie/en-ie/climate-action/publications/Pages/National-Policy-Position.aspx [August 2019]

Climate change allowances

In planning to manage the water level increase as a result of climate change, the following options were considered:

- Climate change is not factored into the design and is left for future generations to manage;
- Build the scheme to be adaptable to climate change (e.g. walls have foundations which are strong enough to allow the walls to be raised by 0.5m in the future, consistent with the MRFS);
- Build the scheme to include a climate change allowance (e.g., walls are 0.5m higher than the current design flood level, consistent with the MRFS); and
- An alternative approach to managing future risk, which may not be cost beneficial in the current scenario, is adopted, such as a tidal barrier.

Each option was assessed for its adaptability to climate change, including consideration of the impact of greater wall or embankment heights. The final design has been chosen to be adaptable to climate change, cost effective, and in keeping with the current landscape aesthetic through the provision of foundations that allow walls to be raised by 0.5m in the future.

Adaptability to the HEFS (mean sea level rise of 1.0m) was not assessed for this development.

Effect of the scheme on water level

As part of detailed design, the performance of the scheme to withstand impacts of flooding post-development was assessed. This was completed through the development of the hydraulic model of the Shannon and Abbey Rivers which included 'glass wall' defences around the Island. The glass wall defences mean that no matter how high the waters reach in channel, they will not spill into the island (i.e., floodplain storage is not considered). This provides a check on the design height of the defences, and also shows the projected water level as a result of the scheme being constructed.

The modelling results show no net increase in water level in the post-scheme scenario. Small variations in modelled water level were noted, but these are associated with the numerical solution rather than a sustained difference in water level. There are two reasons for this. Firstly, as tide levels provide the dominant source of flood risk flood levels are dictated by the tide height rather than the volume of floodplain storage. Secondly, in the current (with sandbags in place) scenario, defence failure would be required before flood damages are experienced; overtopping is not predicted to occur until the higher level events. This means the change in situation between the pre- and post-scheme design is minimal in terms of defence elevation, but clearly provides a significantly improved standard of protection when integrity of the defence is considered.

12.17 Predicted Impacts

The nature of the proposed scheme is to provide protection to King's Island against the effects of extreme weather events. As such, the scheme has been designed specific to the 0.5% AEP present day tidal flood extent and has provided foundations to be adaptable to the MRFS climate change scenario. The predicted impacts with regards to climate change vulnerability and adaptability are discussed below for the Do Nothing Scenario, Construction Phase, and Operation Phase.

12.17.1 Do Nothing Scenario

The extent of the predicted 0.5% AEP tidal flood extent under existing conditions on King's Island is discussed in Chapter 9 - Surface and Groundwater, and shown in Figure 9-5 of Volume 3. Further discussion on the derivation of tide levels is provided in the Options Report.

Without adequate intervention to protect King's Island from the 0.5% AEP event, the island will be vulnerable to the effects of climate change and future flood events. As is, the island is vulnerable to climate change which will impact human beings including a number of residential homes, public spaces and businesses.

The Do Nothing Scenario reduces the ability of King's Island to adapt to future climate change, as the current embankments are in a state of poor repair and have experienced damage in recent years as a result of recent flood events.

In the "Do Nothing" scenario King's Island will experience a slight negative effect in its vulnerability and adaptability to climate change.

12.17.2 Construction Phase

Contribution to GHG emissions during the construction phase

Impacts to climate during the construction phase include emissions from transport of materials to the site, embodied CO_2 in construction materials (such as cement, steel, etc.), emissions from plant machinery and other ancillary areas such as contractor compounds, waste management, etc.

It is predicted that the greatest contribution of GHG emissions during the construction phase will be as a result of the movement of HGVs to and from the site for delivery of fill material and removal of waste. The number of HGV trips has been developed in Chapter 7 - Material Assets, under Traffic and Transportation, based on the total cut and fill volumes required, and has been estimated at 98 HGV movements per day, five days per day, over a total construction phase of 18 months. HGV emissions will depend on the distance travelled. The source of fill material, and therefore distance travelled for each HGV movement during the construction phase, is currently unknown.

Emission of GHG will also occur as a result of the use of diesel-fuelled generators onsite, and operation of plant during the construction phase.

Secondary contributions will be as a result of embodied CO_2 in construction materials (such as cement, steel, etc.). These emissions cannot be quantified pre-planning, as details of material use are not available, however in terms of national emissions are unlikely to be significant.

Climate change vulnerability during the construction phase

The scheme will be vulnerable to weather and flood events throughout the construction phase, however as the construction phase will be temporary and short-term (18 months), climate change will not be measurable or distinguishable over the time of construction.

12.17.3 Operation Phase

Contribution to GHG emissions during the operation phase

The proposed FRS will not produce any GHG emissions when operational.

Climate Change Vulnerability

A vulnerability assessment was completed for both general parts of the scheme, the embankments, and the RC flood wall, following the methodology outlined in Section 12.15.1. This was completed at the Options Report during the development of the design and is presented here.

For the identified main hazards, a vulnerability assessment is presented for the current and future exposure, for the two general categories (RC walls and embankments), as the vulnerability is slightly different amongst them.

Table 12-14. Embankment vulnerability assessment

Climate Hazards	Embankments		
	Sensitivity	Future Exposure (MRFS)	Future Vulnerability (MRFS)
Change in average rainfall (increase or decrease)	Changes in soil moisture and groundwater have the potential to impact stability of embankment foundations, exposure to erosion, drying of embankment soil.	Average rainfall decreases in all climate projections, with an increase in intense storms (see below).	High Vulnerability
Extreme rainfall and intense storms	Embankments are designed to protect against design standard, with allowance for surface water drainage. Any extreme events or reduced maintenance could cause damage or failure to structures.	Rainfall intensity during storms increases in all climate projections.	High Vulnerability
Flooding (Coastal/fluvial)	Embankments are designed to protect against design standard. If extreme flooding or reduced maintenance were to occur, embankments could fail and/or be damaged.	Flood frequency and severity increases in all climate projections.	High Vulnerability
Coastal/soil erosion and Ground instability	Flood embankments are designed to withstand erosion during storms. More frequent and extreme storms could cause coastal and soil erosion which could impact the structural integrity of the embankment.	Likely to increase with more frequent and severe storms. Sea level rise is likely to expose more land and embankments to erosion (see below).	Moderate Vulnerability
Sea Level Rise	With sea level rise, normal high tide level may exceed the toe of the embankment more frequently. This could reduce the lifetime of the structure and/or increase maintenance requirements.	Sea level rise is projected to be 0.5m in MRFS and 1m in HEFS.	High Vulnerability
Temperature fluctuations (freeze-thaw)	Freeze thaw damage could occur in if water can freeze within the embankment or its foundations. Could result in piping failure of structure or collapse.	Frost days are projected to decrease in climate projections.	Moderate Vulnerability

Table 12-15. RC Flood Wall Vulnerability Assessment

Climate Hazards	RC Flood Wall with Alternate Glass Panelling		
	Sensitivity	Future Exposure (MRFS)	Future Vulnerability (MRFS)
Change in average rainfall (increase or decrease)	RC walls are built on existing and reinforced concrete and stone foundations which are less sensitive to changes in soil moisture and groundwater conditions.	Average rainfall decreases in all climate projections, with an increase in intense storms (see below)	High Vulnerability
Extreme rainfall and intense storms	RC flood walls are designed to accommodate surface water runoff and drainage networks. If the design standards are exceeded then damage to and/or failure of the structure could occur.	Rainfall intensity during storms increases in all climate projections.	High Vulnerability
Flooding (Coastal/fluvial)	RC flood walls are designed to protect against the design standard with a freeboard allowance to account for uncertainty. If extreme flooding or reduced maintenance were to occur, walls could fail and/or be damaged.	Flood frequency and severity increases in all climate projections.	High Vulnerability
Coastal/ soil erosion/ Ground instability (combined as result from same impact i.e. extreme/intense rainfall and drought)	RC flood walls are designed to withstand erosion during storms. More frequent and extreme storms could cause coastal and soil erosion to the ground on the front face of the wall which could impact the structural integrity of the river bank and potentially the wall foundations.	Likely to increase with more frequent and severe storms. Sea level rise is likely to expose more land and embankments to erosion (see below).	High Vulnerability
Sea Level Rise	With sea level rise, normal high tide level may exceed the toe of the walls more frequently. This could reduce the lifetime of the structure and/or increase maintenance requirements.	Sea level rise is projected to be 0.5m in MRFS and 1m in HEFS.	High Vulnerability
Temperature fluctuations (freeze-thaw)	Freeze thaw damage could occur if water can freeze within the concrete, any pointing, mortar or foundations. Could result in piping failure of structure or collapse.	Frost days are projected to decrease in climate projections.	Moderate Vulnerability

As such, both the embankments and the RC flood walls are at a high vulnerability to the effects of climate change. However, there are in-built capacity measures that have been taken at the design stage to account for the sensitivity and adaptability of the flood defence features, notably, that foundations will be provided which will allow raising of the defences by up to 0.5m. With regards to increased exposure of embankments to high water levels/increased hydrostatic, the embankments have been set back from the river bank to reduce their exposure to frequent wetting. Flood walls provide adequate foundations to resist increased pressure from high water levels.

Taking into account the vulnerability of the scheme, mitigation measures to reduce vulnerability, and the nature of the scheme being to protect King's Island from the effects of climate change, and the uncertainty associated with climate change predictions, the impact of the scheme has been determined to be Neutral under the MRFS, i.e., effects that are within normal bounds of variation, the margin of forecasting error, and baseline trends. This impact will be within the time frame of the Mid-Range Future Scenario (100 years) and so considered to be Permanent under EPA (2017). guidelines.

Climate Change Adaptability

The NAF (2018) promotes adaptation actions such as building flood defences that are able to be raised in the future, and categorises these as Grey adaptation measures, which involve technical or engineering solutions to climate impacts.

The approach taken in the design of this scheme is a managed adaptive approach, which includes consideration of containment measures (RC flood wall and embankments) with built-in MRFS foundations. This decision was made in line with CFRAM Guidance Note 29 - Climate Change Adaptation Guidance Note (version 5). The current option has been designed to assist in future policy decision-making which provides valid options for future risks associated with climate change. These future options include increased flood warning and emergency response, increasing the height of containment measures (flood walls and embankments), a tidal barrage, and floodplain storage. These options are illustrated in Figure 12-2 below.

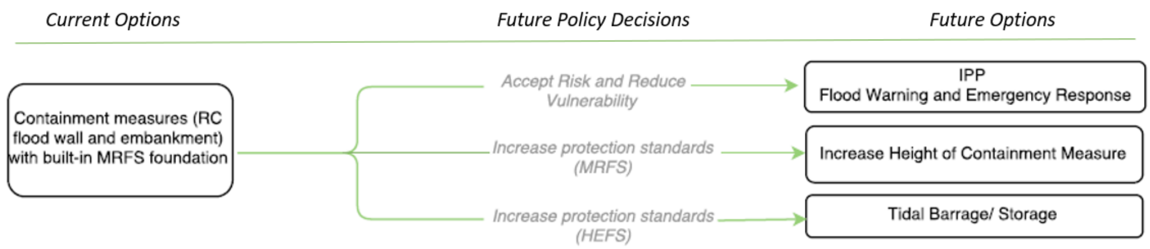

Figure 12-2. Managed adaptive approach to climate change for King's Island FRS

The structural design of the scheme has included an allowance for climate change in the MRFS. This means it will be structurally viable, in the future, to raise walls and embankments by up to 0.5m to match the projected increases in sea levels for the MRFS. However, the direct defences are not being constructed to include this allowance.

The Adaptation Options have been assessed and are presented for each section of the scheme in the JBA/Arup Options Report. Raising of the walls by 0.5m will address the sensitivity to some extent, however does not account for the full expected/projected sea level rise in the HEFS of 1.0m, or sea level rise beyond the HEFS. It should be noted that there are factors other than structural integrity which impact on the adaptation of the defence, such as cost, aesthetics, viability to the public, and land take, and it is these factors which were assessed as part of the option selection process to decide on this scheme.

There are two areas of the scheme that have not been specifically designed to be adaptable to climate change: George's Quay, and the Absolute Hotel Boardwalk.

At George's Quay, the structural stability has been assessed and confirmed that the raising required to meet the scheme FDL can be accommodated, but no additional foundations will be provided. These areas are being raised beyond the FDL to provide additional height for the required guarding level. The top of wall (TOW) levels at George's Quay will range from 5.49m AOD to 5.91m AOD. This will have a dual benefit for the guarding height but will also provide additional wall height which is already high enough to account for the MRFS. Any further raising to allow for climate change (such as the HEFS or above) has not been assessed and should be revisited at an appropriate time in the future.

The hotel boardwalk is already at the FDL height for the present day 200-year tide level, so minimal interventions have been proposed along this 50m length, just a slight raising of the boardwalk floor level to ensure no overtopping occurs. It is noted that although this part of the scheme has not been designed to be adaptable to climate change, there are no structural changes being made that will prevent it from being adaptable in the future. Additionally, this part of the scheme is small and localised, and will not increase the risk to other parts of the scheme in terms of climate change adaptability.

We can surmise that if climate change increases water level in a linear pattern, the water level will be somewhere between 0.25m (MRFS) and 0.5m (HEFS) higher in the 50yr appraisal period than present day levels. This means that in 2070, flood walls may have a significantly reduced freeboard (somewhere between 0.05m and -0.2m, i.e., overtopping may occur).

In terms of long-term future adaptability, the installation of the proposed scheme will not structurally impact or hinder future options. It will be possible in the future, to remove or replace the scheme, however this would be at a significant future cost, and potentially significant change to infrastructure within King's Island. The scheme will not impact the structural possibility of building a tidal barrage other than through alternative allocation of funding.

The impact to climate change adaptability during the operation phase of the scheme has been determined Slightly Adaptable in the Long Term, as it will be possible to adapt the island defences to the climate change MRFS. Beyond the Long Term, the defences are considered Not Adaptable and future risk will need to be managed as required.

12.18 Mitigation Measures

12.18.1 Do Nothing Scenario

If the proposed works were not to go ahead, it is likely that extreme emergency measures would be required to protect the island from the effects of climate change such as import of sand bags for flood protection, emergency response, evacuation of the island, among others. It is unlikely that emergency mitigation will be effective in protecting King's Island to the extent required when compared with the effects of climate change such as sea level rise, flooding, and other climate hazards.

12.18.2 Construction Phase

GHG emissions

During the construction phase, best environmental practices will be followed in order to mitigate for greenhouse gas emissions as a result of the proposed FRS:

- Ensure all vehicles switch off engines when stationary - no idling vehicles;
- Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable;
- Impose and signpost a maximum-speed-limit of 15 mph on surfaced and 10 mph on unsurfaced haul roads and work areas; and
- Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.

12.18.3 Operation Phase

The nature of the scheme is to provide protection from the effects of the present-day 1 in 200 year tidal flood event, with no in-built defence levels to account for climate change. The scheme has been designed to be adaptive to climate change through the provision of foundations which are strong enough to raise the scheme defences by up to 0.5m (the MRFS) in all areas but one (Area A8, the Absolute Hotel Boardwalk). A surface water drainage scheme has also been proposed as part of the FRS, which will provide increased overland runoff capacity for the island. The details of the scheme and the surface water drainage enhancements are provided in Chapter 4 - Description of the Proposed FRS.

Appropriate mitigation in the form of regular monitoring, maintenance, and adaptability features can reduce this vulnerability. Monitoring of water levels in the River Shannon should take place, as well as monitoring of the structural integrity of the scheme relative to increased water levels. Long-term monitoring can ensure the integrity of embankments and flood walls is maintained and will inform the timing and necessity of raising flood defences. Monitoring can also be used to inform maintenance and refurbishment to prolong the lifetime and resilience of flood defence assets.

These design alterations have the potential to build the adaptive capacity of the scheme through increased structural integrity, increased surface drainage, and maintenance. The full assessment including details of in-built capacity measures and adaptation options is provided in the Options Assessment Report.

There will be negligible greenhouse gas emissions from maintenance when the proposed FRS is operational.

12.19 Residual Impact

12.19.1 Do Nothing Scenario

In the Do Nothing Scenario, there will be significant social and environmental implications to the communities of King's Island as a result of the effects of climate change. The residual impact would be a Long-term, Significant Impact to climate vulnerability, and King's Island would be considered Not Adaptable to the effects of climate change.

12.19.2 Construction Phase

During the construction phase, HGV movements and machinery operating on site will contribute GHG emissions, which will be managed through mitigation measures as described in Section 12.7. The residual impact during the construction phase is Slight and Temporary, lasting only the duration of the construction phase (18 months).

With regards to climate change vulnerability, some parts of King's Island will become vulnerable to weather and flood events, however as the nature of construction will be temporary (18 months), climate change effects will not be measurable or distinguishable over the time of construction.

12.19.3 Operation Phase

The nature of the scheme is to protect King's Island from tidal flooding, to the 0.5% AEP (1 in 200 year) tidal flood event. This is relative to present day flood levels. The scheme has been designed to provide foundations which would allow the flood defence level to be raised by 0.5m in all areas except for Area A8 to account for climate change. This level was determined as it is consistent with the OPW's MRFS. The scheme is not considered adaptable to climate change beyond the MRFS.

The residual risk in the HEFS would increase substantially, with and without adaptive measures to the MRFS. In the HEFS, the freeboard would likely be eliminated, and overtopping of the defences would be possible for most of the duration of a 1 in 200 year flood event. The impact to the island under the HEFS has not been assessed, however it is predicted that the number of properties at risk will increase in the HEFS with or without adaptive measures.

Therefore the residual impact during the operation of the scheme is Not significantly vulnerable in the Long Term (i.e., the appraisal period of approximately 50 year), and Adaptable to climate change. Beyond the Long Term (past the appraisal period of 50 years), the scheme is considered to be Moderately Vulnerable, and Slightly Adaptable to the effects of climate change if mitigation measures and monitoring are implemented as specified above.

12.20 Monitoring

The scheme should be monitored over the next decades to determine the appropriateness of implementing adaptation measures as a result of climate change.

12.21 Interactions with other Environmental Effects

Chapter 7 Population and Human Health: climate change vulnerability has the potential to interact with human beings but will have an overall positive benefit to human beings. Risk is closely linked with cost when devising climate change adaptation solutions, therefore a residual risk will remain to human beings as a result of socio-economic conditions.

Chapter 14 Landscape and visual: the approach to climate change taken in the options appraisal phase of this development included consideration of a precautionary approach which assessed building defences that were high enough to account for the most extreme events in climate change scenarios. However, the visual and landscape impact of the precautionary approach of building to the MRFS level was considered significant, and so the managed adaptive approach was taken instead to allow for defences to be raised at some point in the future when it is deemed appropriate and acceptable.

12.22 Cumulative Impacts

When considering the impacts of other nearby proposals, there will be no effect on the scheme with regards to climate change vulnerability or adaptability. The proposed FRS is considered fully adaptable under the MRFS.

Therefore, there will be no cumulative impacts that may make the proposed FRS more vulnerable to climate change.

When considered cumulatively with the construction phases of the other projects considered in Chapter 16, there will be a cumulative impact with regards to contributions to overall GHG emissions.

12.23 Difficulties Encountered in Compiling this Information

There were no difficulties in compiling this information.

13 Landscape and Visual

13.1 Introduction

This report identifies the potential landscape and visual impacts of the proposed FRS.

This report covers two distinct but related areas:

1. Landscape Impact Assessment (LIA) which relates to the assessment of effects on the landscape as a resource in its own right and is concerned with how the proposed Flood Relief Scheme will affect the physical elements that make up the landscape and its distinctive character; and

2. Visual Impact Assessment (VIA) which relates to the assessment of effects on specific views and on the general visual amenity experienced by people. This deals with how the surroundings of individuals, or groups of people, may be specifically affected by changes in the content and character of views as a result of the change or loss of existing elements of the landscape and/or introduction of new elements. Visual impacts may occur from; Visual Obstruction (blocking of a view, be it full, partial or intermittent) or; Visual Intrusion (interruption of a view without blocking).

Photomontages have been produced for the proposed FRS, they are included within Volume 4. The photomontages have been selected to coincide with key viewpoints around the site, they illustrate existing views and corresponding images of the proposed FRS in place for visual receptors with and without mitigation applied i.e. residual impacts.

A Landscape Masterplan has also been produced for the proposed FRS. The Masterplan is included within the Landscape and Public Realm Design Strategy[144]. Measures to mitigate landscape and visual impacts are described and illustrated in the design rationale on the Masterplan.

13.2 Assessment Methodology

The assessment is based on the recommendations in the Guidelines for Landscape and Visual Impact Assessment (GLVIA)[145] as published by the Landscape Institute (UK) and the Institute of Environmental Management and Assessment (3rd Edition, 2013). The assessment will also take into consideration the polices on Landscape Character in the Limerick City Development Plan 2010-2016 (As Extended).

The landscape and visual assessment which was carried out during Spring of 2019, was undertaken through a combination of desk studies and field surveys by a chartered Landscape Architect.

The site-work stage involves the verification of nearby views from the initial desk-based study in Scoping Report, analysis of same by annotated photographs and the capture of additional photography from each Residential/Commercial/Community property and Open Space facility which has the potential to be impacted. The photomontages accurately represent the way in which the future development will be perceived within its surroundings. Field notes are recorded in relation to the likes of topography, land use, significant landscape features and overall landscape character. This process is used to inform the proposed project specific landscape character assessment that is the basis of landscape impact appraisal and to understand from where the site will be visible.

13.2.1 Landscape Impact Assessment Criteria

When assessing the potential impacts on the landscape resulting from a proposed project, the following criteria are considered:

- Landscape character sensitivity;
- Magnitude of likely impacts; and
- Significance of landscape effects.

[144] Nicholas de Jong Associates (June 2019) *Kings Island Flood Relief Scheme, Landscape and Public Realm Design Strategy*
[145] Landscape Institute and Institute of Environmental Management & Assessment, 2013 *Guidelines for Landscape and Visual Impact Assessment 3rd Edition.* Routledge

13.2.2 Sensitivity of the Landscape

The sensitivity of the landscape to change is the degree to which a particular Landscape Character Area (LCA) can accommodate changes or new elements without unacceptable detrimental effects to its essential characteristics.

Landscape Sensitivity often referred to as 'value' is classified using the following criteria which have been derived from a combination of industry guidelines[146] from the Landscape Institute for Landscape and Visual Impact Assessment and professional judgement.

- Very high - Areas where the landscape character exhibits a very low capacity for change in the form of development. Examples of which are very high value landscapes, protected at an international level e.g. World Heritage Site, where the principal management objectives are likely to be protection of the existing character;
- High - Areas where the landscape character exhibits a low capacity for change in the form of development. Examples of which are high value landscapes, protected at a national level e.g. National Park, where the principal management objectives are likely to be protection of the existing character;
- Medium - Areas where the landscape character exhibits a medium capacity for change in the form of development. Examples of which are medium value landscapes, protected at a Local or Regional level e.g. Open space areas mentioned within a County Development Plan, where the principal management objectives are likely to be protection of the existing character;
- Low - Areas where the landscape character exhibits a high capacity for change and has very few or no designated landscapes or open space areas; and
- Negligible - Areas of landscape character that include derelict, mining, industrial land or are part of the urban fringe where there would be a reasonable capacity to embrace change or the capacity to include the development proposals. Management objectives in such areas could be focused on change, creation of landscape improvements and/or restoration to realise a higher landscape value.

13.2.3 Magnitude of Likely Landscape Impacts

The magnitude of a predicted landscape impact is a product of the scale, extent or degree of change that is likely to be experienced as a result of the proposed project. The magnitude takes into account whether there is a direct physical impact resulting from the loss of landscape components and/or a change that extends beyond the boundary of the proposed project that may have an effect on the landscape character of the area.

- Very high - Change that would be large in extent and scale with the loss of critically important landscape elements and features, that may also involve the introduction of new uncharacteristic elements or features that contribute to an overall change of the landscape in terms of character, value and quality;
- High - Change that would be more limited in extent and scale with the loss of important landscape elements and features, that may also involve the introduction of new uncharacteristic elements or features that contribute to an overall change of the landscape in terms of character, value and quality;
- Medium - Changes that are modest in extent and scale involving the loss of landscape characteristics or elements that may also involve the introduction of new uncharacteristic elements or features that would lead to changes in landscape character, and quality;
- Low - Changes affecting small areas of landscape character and quality, together with the loss of some less characteristic landscape elements or the addition of new features or elements;
- Negligible - Changes affecting small or very restricted areas of landscape character. This may include the limited loss of some elements or the addition of some new features or elements that are characteristic of the existing landscape or are hardly perceivable;

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[146] Landscape Institute and Institute of Environmental Management & Assessment, 2013 *Guidelines for Landscape and Visual Impact Assessment 3rd Edition.* Routledge

- Neutral - Changes that do not involve the loss of any landscape characteristics or elements and will not result in noticeable changes to the prevailing landscape character; and
- Positive - Changes that restore a degraded landscape or reinforce characteristic landscape elements.

13.2.4 Significance of landscape effects

The significance of the landscape impact will be the combination of the sensitivity of the landscape against the magnitude of the change. It is summarised in Table 13-1 below.

Table 13-1. Significance of Landscape and Visual effects based on Magnitude and Sensitivity

	SENSITIVITY				
MAGNITUDE	Very high	High	Medium	Low	Negligible
Very high	Profound	very significant	significant	moderate	slight
High	very significant	significant	moderate	slight	slight
Medium	significant	moderate	slight	slight	imperceptible
Low	moderate	slight	slight	imperceptible	imperceptible
Negligible	slight	slight	imperceptible	imperceptible	imperceptible
Neutral	imperceptible	imperceptible	imperceptible	imperceptible	imperceptible
Positive	positive	positive	positive	positive	imperceptible

13.2.5 Sensitivity of Visual Receptors

Unlike landscape sensitivity, the sensitivity of visual receptors has an anthropocentric (or human-centric) basis. It considers factors such as the perceived quality and values associated with the view, the landscape context of the viewer, the likely activity they are engaged in and whether this heightens their awareness of the surrounding landscape.

Visual receptors most susceptible to changes in views and visual amenity are;

- Very high - Residents at home and travellers on a Scenic route where awareness of views is likely to be heightened;
- High - People, whether residents or visitors, who are engaged in outdoor recreation including use of public rights of way, whose attention or interest is likely to be focussed on the landscape and on particular views, and those on a scenic route where the view is not specifically in the direction of the proposed FRS;
- Medium - Visitors to heritage assets, or to other attractions, where views of the surroundings are an important contributor to the experience, and communities where views contribute to the landscape setting enjoyed by residents in the area;
- Low - People engaged in outdoor sport or active recreation on a local scale, which does not involve or depend upon appreciation of views of the landscape; and people at their place of work whose attention may be focussed on their work or activity, not their surroundings and where the setting is not important to the quality of working life, and people travelling in vehicles where their view is limited to a few minutes at any view point; and
- Negligible - Changes affecting restricted viewpoints.

13.2.6 Magnitude of Visual Impact

The magnitude of a visual effect is determined on the basis of several factors: the relative numbers of viewers, the distance from the viewpoint, the visual dominance of the proposed FRS within a view and its effect on visual amenity, as follows:

- Very high - The proposal intrudes into a large proportion or critical part of the available vista and is without question the most noticeable element. A high degree of visual clutter or disharmony is also generated, strongly reducing the visual amenity of the scene;
- High - The proposal intrudes into a significant proportion or important part of the available vista and is one of the most noticeable elements. A considerable degree of visual clutter or disharmony is also likely to be generated, appreciably reducing the visual amenity of the scene;
- Medium - The proposal represents a moderate intrusion into the available vista, is a readily noticeable element and/or it may generate a degree of visual clutter or disharmony, thereby reducing the visual amenity of the scene. Alternatively, it may represent a balance of higher and lower order estimates in relation to visual presence and visual amenity;
- Low - The proposal intrudes to a minor extent into the available vista and may not be noticed by a casual observer and/or the proposal would not have a marked effect on the visual amenity of the scene; and
- Negligible - The proposal would be barely discernible within the available vista and/or it would not detract from, and may even enhance, the visual amenity of the scene.
- Magnitude can also be described as:
- Neutral - Changes that are not discernible within the available vista and have no bearing the visual amenity of the scene; and
- Positive - Changes that enhance the available vista by reducing visual clutter or restoring degraded features.

13.2.7 Visual Impact Significance

As stated above, the significance of visual impacts is a function of visual receptor sensitivity and visual impact magnitude. This relationship is expressed in the same significance matrix as used earlier in respect of landscape impacts, see Table 13-1.

13.3 Existing Environment

King's Island is located to the north of Limerick City Centre, it is separated from the surrounding urban area by the Shannon River to the west and the Abbey River to the east. The landscape of the island is urban with a low-lying area of wetland edging the north eastern part of the island.

13.3.1 Limerick City Development Plan 2010-2016 (as Extended) Including Variations 2-6

Designated landscapes and scenic amenity

Chapter 11 - Landscape, Biodiversity and Recreation of the Limerick City Development Plan147 (LCDP) describes landscape features and scenic amenity which are important to the setting of the city. No site-specific landscape destinations are currently in place within the LCDP, however Policies LBR.1 to LBR.22 within the LCDP describe those aspects which contribute to the setting and value of the city's landscape and the methods by which designations could be put in place. The policies which most relevant to the landscape of the study area are as follows:

Policy LBR.1

It is the policy of Limerick City Council to ensure that Limerick's landscape, biodiversity and recreational facilities are preserved and enhanced, and that the overall combined potential and value of the network of open spaces and related assets within the City is recognised, retained and enhanced.

The City Council notes that preservation of character can be secured in various ways including zoning designations and by other statutory and non-statutory designations i.e. Areas of Special Amenity, Tree Preservation Orders, Landscape Conservation area and EU Designations. The study

147 Limerick City Council Planning and Economic Development Department (November 2010) *Limerick City Development Plan 2010-2016 as Extended Including Variations 2-6.*

area includes features which are included in the LCDP as of significance to the landscape character i.e. riverside walks, views along rivers, views of ridges and skylines.

Policy LBR.2

It is the policy of Limerick City Council to:

-Preserve and enhance Limericks Landscape Assets and key Landscape Sites:

-Preserve and enhance Limericks Views and prospects of Special Amenity Value

The policy notes that many of Limerick's landscape assets particularly those that have a green field character have been lost over a period of time and that the City Council has sought to review the existing landscape policy and to provide a clear policy basis for protecting those remaining spaces. The study area includes the open space around St Marys' Park and the river edges of the Shannon and Abbey Rivers in the south, these are key areas for preservation of landscape character in the study area.

Policy LBR.3

It is the policy of Limerick City Council to take a proactive approach to their landscape with policies that seek to conserve and enhance the strong distinctive landscape character of the City by protecting landscape elements of significant that are either intrinsically important or contribute to the general amenity of Limerick City. Landscape assets are a non-renewable resource that the City Council shall seek to protect.

The policy notes that planning applications in areas benefiting from landscape protection must have a design statement that includes a landscape and visual assessment.

Policy LBR.4

It is the policy of Limerick City Council to explore the potential and benefits of designating one, or more, Landscape Conservation Areas under Section 204 of the Planning & Development Act 200-2008 for the purposes of preserving Limerick's landscape character.

In terms of Views and Prospects the LCDP notes that the views most appreciated by people are those along the River Shannon and panoramic views both inside and outside the city. View types which are particularly relevant to Limerick City are:

- Linear views of Landmark buildings i.e. King John's Castle, the city walls and City skyline
- River Prospects mostly experience while crossing a bridge and where a Landmark building is visible
- Approach Road Views which give a first impression of the City

Within the study are there are linear views of Landmark buildings such as King John's Castle from points along the river in the western corner of the study area. Similarly views of Thomond Park are available along the river edge and from residential properties in St Mary's Park. There are no approach road views within the study area which give a first glimpse of the city.

Policy LBR.6

It is the policy of Limerick City Council to protect key views and vistas and the visual prominence of important city landscape and townscape features such as areas of woodland, important tree groupings and areas of special architectural heritage or heritage value.

The study area includes the open space around St. Mary's Park including the Lower River Shannon SAC, it also includes groups of mature trees along St Georges Quay which channel views down the Abbey River corridor.

Policy LBR.9

It is the policy of Limerick City Council to ensure that proposals along the River Shannon and other waterways associated with the River Shannon catchment within Limerick City will achieve an appropriate balance of uses commensurate with the sensitivity of the natural environment and avoiding impacts on the European Conservation sites and sensitive natural receptors associated with the River Shannon.

Within the study area the aspects of this policy which are relevant to the proposed FRS are:

- Wetlands- the nearest wetland is located on eastern side of St. Mary's Park (included within the Lower River Shannon SAC). The inclusion of this designated site within the study are requires consultation with DEHLG Parks and Wildlife Service, Waterways Ireland and OPW.
- Trees and Urban Woodlands-The LCDP states that trees make a valuable contribution to the landscape, local visual amenity and biodiversity of Limerick City. It also states that they help absorb pollutants, filter dust, reduce noise, produce oxygen and reduce carbon dioxide as well as enhancing the aesthetics. The City Council has not instigated any Tree Preservation Orders but the Plan states that it may consider additions within the lifetime of this plan. The mature trees along Georges Quay adjacent to Barrington's Hospital and the pubs and cafes next to Matthew Bridge, contribute to the townscape quality of the setting.

13.3.2 Defining the Study Area

For the purposes of assessing the impact of the proposed FRS on the landscape character and visual amenity it is necessary to extend the study area beyond Kings Island and to include the land use on the adjacent banks of the Abbey and Shannon Rivers where visibility of the works will be possible.

Baseline Landscape Character

Kings Island has 2 distinct landscape character zones; the first is St Mary's Park in the north which is classified as a Statutory Regeneration Area in the City Development Plan (Map 1C Regeneration Areas), the second character zone is the urban commercial and historic area of Englishtown to the south of the Detailed Study area from Sir Harry's Mall to King John's Castle.

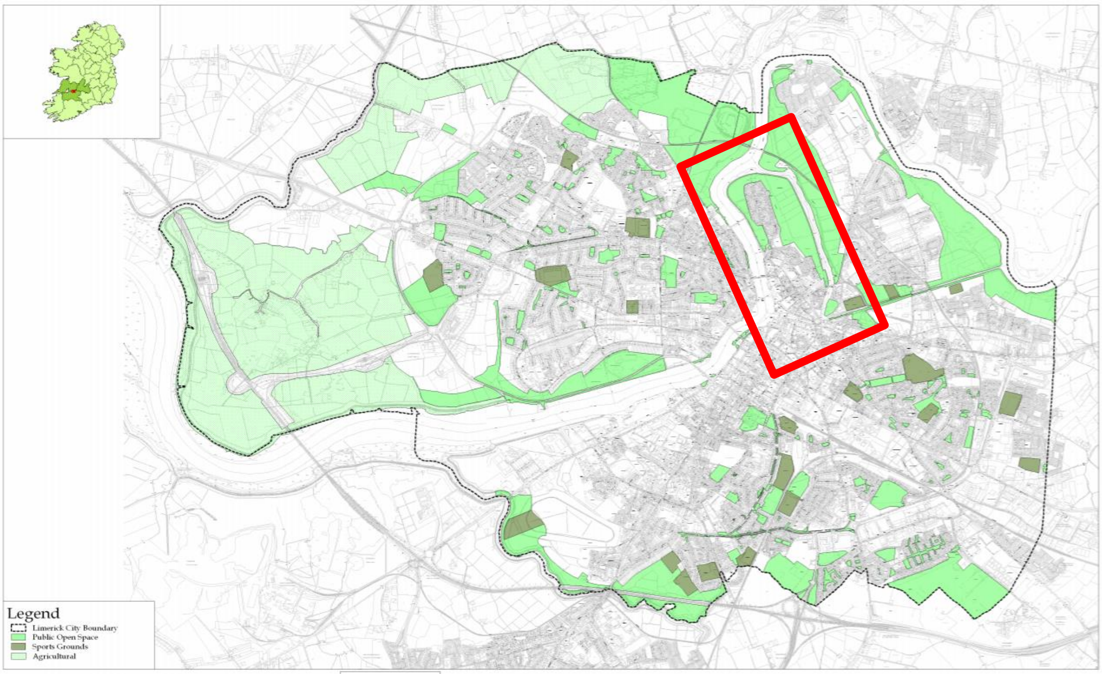

Plate 1. Public Open Space. Limerick City Development Plan (site area generally outlined in red).

St Mary's Park comprises a residential area surrounded on the west, north and east by open space which is designated as Pubic Open Space in the City Development Plan (Map 1D Open Space Provision) shown in Plate 14.1 overleaf. It comprises groups of terraced houses positioned in a grid in the centre of the northern part of the island, the houses are separated by the surrounding rivers by an area of grass open space and the existing flood defences which comprise a raised earth riverbank. The houses on the edges of the residential area i.e. St. Ita's Street and Oliver Plunket's Street to the west and St. Munchin's Street to the east are closest to the open space and to the location of the existing flood defences. Many of the properties on the eastern side of St Munchin's are either semi derelict or are being renovated. A community centre and crèche are located south of St Mary's Park, on the western side of the Island off Verdant Place.

The grassland on the west and north of St Mary's Park is amenity grass land and it acts as a buffer to the raised walkway around the Island. The western and northern portion of the open space site exhibits a high capacity for improvement and change. The open space on the eastern side of St

Mary's Park is part of the Lower Shannon Special Area of Conservation (SAC), it is often under flood and not used for recreation.

The river edge walkway which extends from the western side of St Mary's Park around the northern and eastern sides of the island, includes a track which is used by walkers as a recreation resource, it is accessed by pathways perpendicular to the residential areas. An open drainage ditch is also present to the north-western section of the open space and restricts access to the river edge walkway, the ditch hosts an ecologically significant species Opposite-leaved pondweed *Groenlandia densa* which is assessed in Chapter-8 Biodiversity.

The open space in the north of Kings Island is primarily amenity grass and includes a range of active recreation facilities including an informal horse and cart track on the western side, a handball alley to the north and a series of football pitch to the south east. The character of this zone is distinctly suburban with a natural planted soft river edge and views from the raised walkway along the river and to Woodcock Hill and the ridgelines to the north.

In terms of the built environment, the north of the island is somewhat disconnected from the rest of the city due to poor transportation connections and no bridges to access the lands to the north, west or south. The open space separates the housing from the River Shannon to the west and the Abbey River to the east. There are no designations specific to landscape character or scenic amenity in the LCDP, however policies LBR.1-22 as previously described, offer protection to Landscape, Biodiversity and recreation. The elements of the landscape character which are protected by the LCDP are the soft river edge with open views, the open space around the housing and the SAC/wetlands to the east of the housing area.

The southern part of Kings Island from Sir Harry's Mall to King John's Castle includes features within the Record of Protected Structures (Map 7A RPS Record of Protected Structures), features within the Sites and Monuments Register (Map 7B Sites and Monuments Register) and a Zone of Archaeological Potential (Map 7C Zone of Archaeological Potential). The presence of buildings of character and of heritage value gives the southern part of the study area a higher sensitivity rating than the northern part of the Island. This urban zone consists of a combination of residential, administrative, commercial, educational, ecclesiastical, and tourism elements and includes King John's Castle and other historic buildings which dominate the landscape character and are adjacent to the sensitive river bank public realm.

The existing flood defences in the southern part of Kings Island are hard defences i.e. stone walls along the river edges. These walls create a distinctly urban character and in combination with existing mature trees they channel views along the river corridor and allow water edge walkways, sitting out areas for commercial properties and formal stepped access into the river for boating activities from a floating pontoon. The elements of the landscape character which are protected by the LCDP are the linear views towards Landmark buildings, views and prospects along rivers, and urban trees and woodlands. Beyond Kings Island and on the opposite sides of the Shannon and Abbey River corridors, the land use comprises open space, agricultural lands and ecologically sensitive lands to the north and east; established residential and community areas to the west and southeast; and Limerick city centre to the south. Woodcock Hill (300mOD) to the north in County Clare forms a distant enclosing ridgeline to the Broad Study area, no other hills or ridgeline are visible.

The open space and broad river valley landscape (character type 9-River Shannon Farmland)[148] to the north incorporating a halting site and the meandering River Shannon provides an important landscape feature of the broad landscape, the low-lying topography, the agricultural landscape with hedgerows, hedge banks and trees create an intimate, vegetated landscape. Although the most sensitive elements of the landscape are the ecological designations (SAC) and high amenity value of the river banks which apply to the river corridors (watercourse and riverbanks) the relatively flat ground make the landscape visually sensitive either side of Kings Island and to the river valley to the north.

The urban settlement beyond the river corridors including Thomondgate and Moyross to the west and Lower Park to the east are established residential and community areas and have no landscape designations or significant opens space. Similarly, Limerick City Centre south of Kings Island is an established urban area with commercial, community retail and tourism properties along Bank Place, Charlottes Quay, Lock Quay area overlooking Kings Island.

148 Figure 6 County Clare Landscape Types, Landscape Character Assessment, County Clare, 2004 ERM

Images of the landscape character areas containing high value landscape features are provided in Plates 13.2-13.7 below.

Plate 13-2- Area A3 containing a Shannon River walkway and Prospects where Landmark buildings in the city are visible.

Plate 13-3 – Area A4 containing wetland is located on eastern side of St. Mary's Park (included within the Lower River Shannon SAC).

Plate 13-4- Area A4 containing the Military Cemetery off St Ita’s Street.

Plate 13-5- Area A5 containing Views and Prospects along the Abbey River and panoramic views outside the city.

Plate 13-6- Area B2 containing mature trees which contribute to the townscape setting and which channel views down the Abbey River corridor.

Plate 13-7- Area B3 containing River Prospects experienced while crossing a bridge and where a Landmark building (King John’s Castle) is visible.

13.4 Proposed Design and Elements likely to cause Landscape and Visual impacts

13.4.1 Summary of Design Development

The design of potentially viable flood risk measures has been development in Stage I of the project and is described in the Options Assessment Report[149]. The design was developed taking into consideration:

- the environmental constraints of the site;
- through proactive consultation with the public, with affected stakeholder and landowners; and
- a range of viable design options.

The preferred option was selected as a direct flood defence i.e. embankment or wall (reinforced concrete or sheet piled).

Key to the section of the preferred design was:

- the nature, adaptability and structural integrity of the existing flood defence;
- available space and land take for the new flood defence;
- aesthetics and character of the receiving landscape, and
- compliance of the new flood defence with the policies of the LCDP.

During the consideration of the options it was considered embankments were more suited to the northern part of the study area as embankments were already part of the landscape there, that there was sufficient space for this solution within the open space and that a more natural, soft landscape finish was required than a hard defence. The Preferred Option for the FRS includes an earth embankment with shallow grass slopes which are assimilated within the open space in the northern part of the study area.

In the southern urban part of the site where space is already limited, and walls form the current flood defence, it was considered in the Options Assessment that the existing walls would be maintained and adjusted to form the new higher flood defence (varying between 1.1m and 1.4m above adjacent footpath level). The Options Assessment recommended that the appearance of the finish to the walls would be considered within the context of the immediate surrounds. The Preferred Option includes stone finished walls and transparent panels at locations where a visual connection with the adjacent river is desired. The transparent panels have been included at points along St George's Quay where sitting out areas have been established and around the Court House and Limerick CC buildings to maintaining views across the river corridor.

The embankments, the walls and the transparent panels are illustrated in the Landscape Strategy Document and the photomontages in Volume 4.

13.5 Predicted Impacts

13.5.1 Do Nothing Scenario

Under the do-nothing scenario the landscape character and visual amenity of the area would be unchanged, and Kings Island would continue to be susceptible to both tidal and fluvial flood risk. During flood events he open space would continue to flood and be unavailable as an amenity resource.

13.5.2 Construction Phase

Elements of the proposed FRS which are likely to cause landscape or visual impacts during construction are listed below:

- The construction traffic around St Mary's Park including HGV's bringing fill material for the new flood embankment will cause short term impacts on the visual amenity of the open space for residents of the area and disruption for walkers on the embankment. The tranquil character of the river edge landscape will also change due to the construction activity in forming the new flood embankment, drainage, access paths and lighting;

[149] JBA Consulting Kings Island Options Report

- Access to the western side of the river edge will be closed during construction and access will be via the footpath at Oliver Plunkett Street. However, access to the existing river edge walkway on the eastern side will be maintained including an improved path through the existing sheet piled section to link to the eastern track adjacent to the Abbey River;
- A site compound is proposed in the northwest corner of St. Mary's Park. It will house the materials, and machinery and it will include night time security lighting;
- Disruption to the Star Rovers Astra turf pitch will occur during the forming of the new flood embankment along the northern and eastern sides of the playing area and incorporating an intertidal flood storage tank within the embankment east of Abbey view residential estate;
- Views towards the Jack-up rig in the river (Launch of jack-up barge, with transfer of machinery within, prior to stabilisation and erection at areas A9 and B3,) during the reinforcement and cleaning of the river wall adjacent to the Absolute hotel and the Court House;
- Removal of two immature trees at Athlunkard boat club, two mature, poorly formed trees between Abbey Bridge and Baal's bridge and six immature trees at the Limerick City and Council offices;
- Disruption to water edge footpaths and car parking along Sir Harry's Mall, Georges Quay, the Potato Market, the Court House and Limerick City and Council offices from the works to raise and upgrade the external finishes to the flood wall and install transparent panels
- Disruption to roads, carparking and footpaths for the upgrading of the storm drainage and foul sewers including installation of two new intertidal storage tanks in the car park of the Potato Market and between LCCC offices and the flood defence; and
- From outside Kings Island on the opposite river banks including properties along Bank Place, Charlottes Quay, Lock Quay area, the construction traffic will be visible entering and leaving the site in St. Mary's Park, dust arising from the works will also be visible and the activity along the riverbanks for the work to raise the existing flood walls.

13.5.3 Landscape and Visual Impacts during Construction

Impacts during construction

Sensitivity - In terms of sensitivity, the study area includes many elements of landscape and visual value mentioned in the LCDP i.e. open space around St Mary's Park including the river edge walkway, the sports pitches and boat clubs plus the two river corridors, the many commercial, educational, ecclesiastical, and tourism buildings to the south including the Potato Market, the Court House, and King John's Castle. The detailed study area also includes visually sensitive receptors including residential properties in St Mary's Park overlooking the open space and resident, workers and tourists who enjoy the scenic views along the Shannon and Abbey River corridors and the views towards the prominent historical and cultural buildings.

The presence of residential properties and valued landscape features in the detailed study area including visual corridors along rivers and view towards prominent buildings gives the area a 'High' visual sensitivity rating i.e. *People, whether residents or visitors, who are engaged in outdoor recreation including use of public rights of way, whose attention or interest is likely to be focused on the landscape and on particular views, and those on a scenic route where the view is not specifically in the direction of the proposed FRS.*

Magnitude - In terms of the magnitude (scale, extent or degree) the construction phase is due to last for 18 months and will be carried out in phases. The temporary closure of the river edge walkway on the western side of St Mary's residential estate, the setting up of the construction compound in the northwest corner of the Island (and associated construction traffic) and the temporary closure of the Star Rovers football pitches will all impinge on the landscape amenity and tranquil character of the area for a short period of time.

In the southern part of the detailed study area the upgrading of the drainage infrastructure including the installation of proposed intertidal storage tanks, the construction to the existing river edge flood walls including the raising, cleaning, reinforcing and recladding of the walls and installation of plinth and transparent panels along St George's Quay, the Court House and Council offices will be localised and limited to the river edge terms of scale of impact. The removal of vegetation will be minimal, no bankside vegetation will be removed except for two immature trees at Athlunkard boat club, two poorly formed trees between Abbey Bridge and Baal's bridge and up to six immature trees on the western side of the Council offices. This will be short term and not have a significant effect on the character of the river corridors or the streetscape quality along St. George's Quay.

Overall the magnitude of the construction works will be 'Medium' i.e. Changes that are modest in extent and scale involving the loss of landscape characteristics or elements that may also involve the introduction of new uncharacteristic elements or features that would lead to changes in landscape character, and quality'.

Construction Impact - The overall impact of the proposed flood relief works on the landscape character and visual amenity of the detailed study area during the construction phase is arrived at by a combined measurement of the sensitivity of the landscape character (High) and the magnitude (Medium) of the development as shown in Table 13-1. As such the impact before mitigation on the landscape character and visual amenity of the Detailed Study area is **Temporary to Short Term, Moderate, Negative Impact.**

13.5.4 Operational Phase

The principal elements of the proposed FRS which are likely to cause a permanent significant landscape or a visual impact during operational phase are listed below.

- Proposed earth embankment within the opens space which is approximately 2.0-2.5m above existing ground level with a 3m wide footpath (bitmac) and lighting (columns 6m in height);
- Proposed night time lighting on the embankments;
- Proposed increased flood defence 1.1-1.4m in height above adjacent footpath.

13.5.5 Night-time Visual Effects from Lighting

Low level pedestrian lighting has been included along the top of the embankment in the north of the scheme within the design for the proposed FRS. The lighting design is described in section 4.2.3. The light fittings on the proposed embankment around St. Mary’s Park will be mounted at 6m above ground level and at approximately 30m centres. The columns would be of aluminium and their colour and finish is as shown in the Landscape Strategy Document accompanying the planning application.

The lights will be on during hours of darkness to provide a minimum light level for security to the footpath on the proposed embankment; the lights would be dimmable with individual photocells fitted to each light fitting, which would allow the lights to switch on automatically at dusk at a low output and slowly dim up to their full output as the natural light decreases. The lighting will also be controlled by occupancy/motion sensors so that it would remain at a low output if there was no pedestrian traffic (or mammal activity) nearby. This will also mitigate light overspill into the rear of residential properties on St Munchin’s Street although tree planting in this area will filter the lighting from the embankment into the rear of the properties.

13.5.6 Landscape impacts during Operational Period

In order to assess the impact on the landscape character of the permanent design aspects, each element is considered within the context of the local landscape character of each area/flood cell as shown below:

Area A1 - The existing flood wall was raised by 0.6m in 2017 and was finished with stone to match the finish of the wall on the river side. The concrete coping installed at that time is visually intrusive and creates a negative visual impact on the area from both sides of the river. In this location the valued landscape elements are the river edges of the Shannon River, the river edge walkway and the river corridor views of the hills to the north and the view of landmark buildings (Thomond Park to the west and Villiers Alms Houses to the east).

Sensitivity - Within Area A1 the presence of valued landscape features gives the area a 'High' landscape character sensitivity rating.

Magnitude - The addition of the proposed coping, the small section of wall -top railing are small in scale within the context of the urban environment. However, the white colour of the existing and proposed coping will be visually intrusive within the historic setting. Overall the magnitude of the proposed flood defence in this location is 'Low'.

Impact - The significance of the landscape impact will be the combination of the sensitivity of the landscape 'High' against the magnitude of the change 'Low' as summarised in Table 13-1. The resulting impact before mitigation is **Permanent, Slight, Negative**.

Area A2 - The existing flood embankment will be replaced with a new reinforced concrete wall which will require piled foundations. The proposed wall will be taller than 1.2m and block visibility of the river corridor. In this location the valued landscape elements are the river edges of the Shannon River, the river edge walkway and the river corridor views of the hills to the north and the view of landmark buildings (Thomond Park to the west and Villiers Alms Houses to the east).

Sensitivity - Within Area A2 the presence of valued landscape features gives the area a 'High' landscape character sensitivity rating.

Magnitude - The proposed wall is small in scale within the context of the urban environment. However, the height of the wall and the white colour of the proposed coping will be visually intrusive within the historic setting. Overall the magnitude of the proposed flood defence in this location is 'Low'.

Impact - The significance of the landscape impact will be the combination of the sensitivity of the landscape 'High' against the magnitude of the change 'Low' as summarised in Table 13-1. The resulting impact before mitigation is **Permanent, Slight, Negative**.

Area A3 - North West embankment -The proposed earth embankment is approximately 2.0-2.5m in height (5.5m AOD) and based on a slope gradient of 1 in 3 on the river side and 1 in 2 on the land side the land take is approximately 16m in width at the base and is approximately 900 lin. m in length. The raised embankment will be located approximately 4.5m inland of the existing sandbag flood wall on the western side of St Marys Park. In this location the valued landscape elements are the open space around St Marys' Park, the river edges of the Shannon River, the river edge walkway and the river corridor views of the hills to the north and the view of landmark buildings (Thomond park to the west and Villiers Alms Houses to the east) .

Sensitivity - Within Area A3 the presence of valued landscape features which are mentioned in the LCDP gives the area a 'Medium' landscape character sensitivity rating.

Magnitude - The proposed embankment is a permanent engineered feature which is large in scale and would stretch the entire length of this area. It would dominate the open space and appear as a formal engineered bank which would lead to a change in character. The embankment would also require removal of the ditch containing the Opposite pond weed (*Groenlandia densa*) which will be repositioned at the foot of the new embankment. From within the open space views are not possible of the river corridor due to the presence of the existing flood bank; the proposed embankment does not worsen this aspect. Similarly, the new embankment will provide an upgraded replacement walkway to maintain views of the river corridor and views beyond. Over all the magnitude of the proposed flood defence in this location is 'High'.

Impact - The significance of the landscape impact will be the combination of the sensitivity of the landscape 'Medium' against the magnitude of the change 'High' as summarised in Table 13-1. The resulting impact before mitigation is **Permanent, Moderate, Negative**.

Area A4 - St Mary's Park/ SAC -The proposed earth embankment is approximately 2.0-2.5m in height (5.5m AOD) and based on a slope gradient of 1 in 3 on both sides, the land take is approximately 16m in width at the base and is approximately 500 lin.m in length. The raised embankment will be located approximately to the rear of the properties on St Munchin's Street, St Ita's Street and Assumpta Park. In this location the valued landscape elements are the open space including the Lower Shannon Special Area of Conservation around the eastern side of St Marys' Park, the river edges of the Abbey River, the river edge walkway, the military cemetery off St. Ita's Street, and the river corridor views.

Sensitivity - Within Area A4 the presence of valued landscape features gives the area a ' Medium' landscape character sensitivity rating.

Magnitude - The proposed embankment is a permanent engineered feature which is large in scale and would stretch the entire length of this area. It would dominate the open space and appear as a formal engineered bank which would lead to a change in character. The embankment would not encroach on the legal SAC boundary (see Chapter 8- Biodiversity) but it would require uptake of land within a buffer to a SAC, where sensitive habitats are likely to exist. From within the open space views are not possible of the river corridor due to the presence of the existing flood bank; the proposed embankment does not worsen this aspect. However, the proposed embankment with lighting along the footpath will bring activity in the form of pedestrians, lighting and noise into a quiet low-lying area and contribute to an overall change in character. Over all the magnitude of the proposed flood defence in this location is 'High'.

Impact - The significance of the landscape impact will be the combination of the sensitivity of the landscape 'Medium' against the magnitude of the change 'High' as summarised in Table 13-1. The resulting impact before mitigation is **Permanent, Moderate, Negative**.

Area A5 - Star Rovers to Athlunkard Boat Club-The proposed earth embankment is approximately 2.0-2.5m in height (5.5m AOD) and based on a slope gradient of 1 in 3 on both sides, the land take is approximately 16m in width at the base and is approximately 550 lin.m in length. The raised embankment will be located to the north and east of the existing sports pitches at Star Rover club ground and to the rear of the properties on Assumpta Park and to the front of properties in Abbey View. In this location the valued landscape elements are the open space, the sport pitches, the river edges of the Abbey River, the river edge walkway and the river corridor views.

Sensitivity - Within Area A5 the presence of valued landscape features gives the area a 'Medium' landscape character sensitivity rating.

Magnitude - The proposed embankment is a permanent engineered feature which is large in scale and would stretch the entire length of this area. It would dominate the open space and appear as a formal engineered bank which would lead to a change in character. The embankment would encroach on the edge of the all-weather sport pitches and would require uptake of land within a buffer to a SAC, where sensitive habitats are likely to exist. From within the open space views are not possible of the river corridor due to the presence of the existing flood bank; the proposed embankment does not worsen this aspect. However, the proposed embankment with lighting along the footpath will bring activity in the form of pedestrians, lighting and noise into a quiet low-lying area and contribute to an overall change in character. Over all the magnitude of the proposed flood defence in this location is 'High'.

Impact - The significance of the landscape impact will be the combination of the sensitivity of the landscape 'Medium' against the magnitude of the change 'High' as summarised in Table 13-1. The resulting impact before mitigation is **Permanent, Moderate, Negative**.

Area A6 - Athlunkard Boat Club -The proposed earth embankment is approximately 2.0-2.5m in height (5.5m AOD) and based on a slope gradient of 1 in 2 on both sides, the land take is approximately 16m in width at the base and is approximately 60 lin. m in length. The raised embankment will be graded down to ground level within the boat club ground to enable vehicular access to the club house and water's edge. The flood defence changes from embankment to flood wall (to replace the existing wall) north of the club house due to the urban nature of this area and because of space restrictions. The proposed flood defence wall will be 2m in height and 150 lin.m in length and pass to the rear of the boat house (with 2m clearance of the boat house) to join with Athlunkard Street at O'Dwyer's Bridge. The embankment and wall will be visible for resident in Abbey View and Athunkard Street. The existing concrete wall behind the boat house will be raised by approximately 0.4m in height to provide a flood defence of 2.72m. In this location the valued landscape elements are the open space, the sport pitches, the river edges of the Abbey River, the river edge walkway and the river corridor views.

Sensitivity - Within Area A6 the presence of valued landscape features and the boat club building which is a Recorded Structure gives the area a 'Medium' landscape character sensitivity rating.

Magnitude - The proposed embankment is a permanent engineered feature which is large in scale and would stretch part of this area. It would dominate the open space and appear as a formal engineered bank which would lead to a change in character. From within the open space views are not possible of the river corridor due to the presence of the existing flood bank; the proposed embankment does not worsen this aspect. However, the proposed embankment with lighting along the footpath will bring activity in the form of pedestrians, lighting and noise into a quiet low-lying area and contribute to an overall change in character. Additionally, the increase in height of the concrete wall will be unsightly and cause overshadowing in the pedestrian lane leading from Athlunkard Street to Abbey View. The overall the magnitude of the proposed flood defence in this location is 'Medium'.

Impact - The significance of the landscape impact will be the combination of the sensitivity of the landscape 'Medium' against the magnitude of the change 'High' as summarised in Table 13-1t. The resulting impact before mitigation is **Permanent, Moderate, Negative**.

Area A7- A10 -Sir Harry's Mall to Baal's Bridge The existing flood wall will be raised along this section by approximately 0.5m to maintain a wall height of 1.2m above ground level. At Sir Harry's Mall (A7) a raised platform has been designed incorporating the public footpath to enable pedestrians to maintain a view of the Abbey River. The flood wall and raised platform/footpath will be visible from the front of properties in Sir Harry's Mall. South of the Absolute Hotel boardwalk a section of the flood wall will be raised to 1.4m in height. The average eye level is 1.5m high therefore certain pedestrians will lose visual connectivity with the river. At Baal's Bridge 2 mature trees which are poorly formed will be removed and replaced after the completion of the works. In this location the valued landscape elements are the river edges of the Abbey River, the river edge walkway and the river corridor views.

Sensitivity - Within Area A7-A10 the presence of valued landscape features gives the area a 'High' landscape character sensitivity rating.

Magnitude - Raising the height of the proposed flood wall is a permanent engineered feature, the change is small in scale within the context of the urban environment. The raised wall and reinstatement of adjacent footpath/road surface disrupted in the wall reinforcement works will not dominate the open space, it will be in keeping with the form of the urban setting although the finishes to the wall will be noticeable leading to a slight change in character. Over all the magnitude of the proposed flood defence in this location is 'Low'.

Impact - The significance of the landscape impact will be the combination of the sensitivity of the landscape 'High' against the magnitude of the change 'Low' as summarised in Table 13-1. The resulting impact before mitigation is **Permanent, Slight, Negative**.

Area B1/B2 - The existing flood wall will be raised along this section by approximately 0.5m to maintain a wall height of 1.2m above ground level. Significant drainage works will be implemented in areas B1 and B2. Along St George's Quay the mature trees close to the river's edge will be protected and retained to maintain the mature high-quality streetscape setting. In this location the valued landscape elements are the river edges of the Abbey and Shannon River, the river edge walkway and the river corridor views of historic features.

Sensitivity - Within Area B1/B2 the presence of valued landscape features gives the area a 'High' landscape character sensitivity rating.

Magnitude - Raising the height of the proposed flood wall is a permanent engineered feature, however the changes are small in scale within the context of the urban environment. The finishes to the reinforced flood wall will be noticeable leading to a change in character mostly from across the river. Overall the magnitude of the proposed flood defence in this location is 'Medium'.

Impact - The significance of the landscape impact will be the combination of the sensitivity of the landscape 'High' against the magnitude of the change 'Low' as summarised in Table 13-1. The resulting impact before mitigation is **Permanent, Moderate, Negative**.

Area B3 - Between cells B2 and B3 the road surface at the junction of Bridge Street, the Potato market and Georges Quay will have regrading works implemented to raise the ground level to ensure that George's Quay is protected in the event that new flood gates at Curragower Boat club fail during a flood event. At the Potato Market the cantilevered opening in the market wall will be glazed to provide the flood defence, a new ramp and steps will be created to access the footbridge and a new automatic flood gate and manual barrier will be constructed at the entrance to the Curragower boat club to the west of the Potato market. The work to the water's edge from the Potato Market to the St John's Castle will involve a reduction in the width of the boardwalk around the courthouse, mass concrete backing and new plinth to strengthen the existing flood wall, increased footpath height and increased flood defence height. Significant drainage works will be implemented in area B3; two tidal storage tanks are proposed for the Potato Market car park and the river edge walk way north of the LCCC offices and proposed foul and storm sewers to enable decommissioning of the three existing foul pumping stations.

At the LCCC offices 6No. semi mature trees will be removed, they will not be replaced as the space will be used for archaeological interpretation of a historic mill. In this location the valued landscape elements are the river edge of the Shannon River, the river edge walkway, the river corridor views of historic features and landmark buildings plus distant views in a northern direction of the hills and ridgelines of County Clare.

Sensitivity - Within Area B3 the presence of valued landscape features gives the area a 'High' landscape character sensitivity rating.

Magnitude - The regrading of the road junction, the raising the height of the proposed flood defence (transparent panels), the reduction in width of the board walk, the proposed railings at the Courthouse and the proposed drainage works are permanent engineered features. The changes are medium in scale within the context of the urban environment, they involve the introduction of new features that lead to an altering of the landscape character. Overall the magnitude of the proposed flood defence and drainage upgrade in this location is 'Medium'.

Impact - The significance of the landscape impact will be the combination of the sensitivity of the landscape 'High' against the magnitude of the change 'Medium' as summarised in Table 13-1. The resulting impact before mitigation is Permanent, Moderate, Negative.

13.5.7 Visual Impacts during Operational Period

Detailed Study area Visual Receptor Sensitivity, Magnitude and Significance of Impact

The visual assessment measures the extent to which the proposed FRS can be seen from residences, work places, tourist routes and viewpoints. Visual receptors are those people who can see the proposed FRS prior to mitigation.

Visual receptors are referenced and listed (Appendix F, Volume 2 and Figure 11.2) in numerical order as R-Residential, C-Community/Commercial facility, OS-Open Space/Park and T-Tourist facility and V- Vehicular route /Road and described below.

In the northern part of the site residents living in properties over-looking the open space i.e. St. Ita's Street, Oliver Plunkett Street and St. Munchin's Street are most likely to have close views to the works will experience the highest levels of change to their existing views.

Walkers, cyclist and people using the existing river edge path for recreation will experience changes to their visual amenity. People working and travelling through the urban part of Kings Island the site in the south of Kings island and tourists visiting the heritage site who have a view of the proposed FRS.

Visual impact is described in terms of Visual Obstruction where the receiver’s views are physically blocked by the proposals; Visual Intrusion where the receiver’s views are affected by the proposed FRS (or by users of the proposed FRS).

As with the landscape impact, the visual impact of the proposed FRS will be assessed as a function of sensitivity versus magnitude as shown in Table 13-1.

Potential visibility of the proposed FRS within the Detailed and Broad study area was assessed during the site visits in 2018 and 2019.

The visual impact of the Detailed study area is summarised below. No residents, recreational users or tourists within the detailed study area will experience the highest levels of adverse visual impact i.e. Profound, Very significant or Significant. Moderate, Slight, Imperceptible and Positive visual impacts will result from the proposed flood defences as described below.

Moderate negative visual impacts

A total of 107No. residential properties in reference points R3 (34No. west facing properties on Oliver Plunkett Street), R4 (24No. north west facing properties on Oliver Plunkett Street), R5 (33No. west facing properties on St Munchin's Street) and R8 (16No. north and east facing properties on Assumpta Park) will experience moderate adverse visual impacts before mitigation as a result of the proposed embankment, footpath and night-time lighting.

In accordance with the methodology described earlier in this chapter residential properties are considered very high in sensitivity. The proposed embankment approximately 2m high (2m above adjacent amenity grass land), a footpath and night-time lighting (columns 6m high) will cause a minor intrusion of the existing short distance view and will bring light into a dark location at night. The proposals will not however obstruct the wider long-distance views of Woodcock Hill to the north its adjacent ridgelines nor will it obstruct views towards landmark focal points including Thomond Park stadium (see photomontage 2 and 3).

Users of the Open Space (OS1 and OS4) around St Mary's Park including the river edge walk and the grass amenity area will also experience moderate negative visual impacts from the reduced visibility across the river resulting from the proposed engineered embankment. In accordance with the methodology described earlier in this chapter people who are engaged in outdoor recreation are high in sensitivity to the change in their amenity space.

Visitors to the military cemetery (Ref OS3) off St Ita's Street are also considered high in sensitivity. They will have their sense of privacy altered by the proposed embankment and footpath which will allow walker to overlook the cemetery and intrude upon east facing long distance views. Visitors to the cemetery will experience moderate adverse visual impacts.

Slight negative visual impacts

A total of 167No. residential properties in reference points R2 (35No. west facing properties on Oliver Plunkett Street and properties on St Ita's Street with rear east facing views), R7 (23No. east facing properties on Assumpta Park), R9 (12 No. properties with an oblique east facing view off Abbey Park perpendicular to the Abbey River), R10 (15No. properties on R463 close to O'Dwyer's Bridge) will have an oblique east facing view towards the embankment which will obstruct their middle distance views. R11 and R12 (24No. east facing properties on Sir Harry's Mall) will also have a slight change to their views from an increase in wall height which will obscure a small art of their water edge view. R13, R14, R15 and R16 (63 No. east facing properties on Clancy's Strand, Brown's Quay and New Road,) on the western side of the Shannon will also have a direct view towards the flood defences in the general setting of the King John's Castle grounds. These properties will experience slight adverse visual impacts before mitigation as a result of the proposed flood defences including walls, embankments, footpath and night-time lighting.

Users of the Open Space (OS2, OS5 and OS6) on the western side of St Mary's Park will also experience slight negative visual impacts from the reduced visibility from towards the river resulting from the proposed engineered embankment.

Some visitor facilities, commercial properties and vehicular drivers close to the flood defences will have low levels of visual intrusion of their views due either to the change in the height of the flood defence being so small or the not having visibility towards the flood fence. These include: Visitors to the Absolute hotel (C1), Users of the Potato Market (T4), the Council offices(T1), St John's Castle (T2) and (T3) Jones Mausoleum and St. Munchin's Cemetery.

13.6 Mitigation Measures

13.6.1 Do Nothing Scenario

Under the do-nothing scenario the proposed flood defences will not be implemented and the landscape character of Kings Island will be further eroded by flood damage.

13.6.2 Mitigation Measures during Construction

During the construction phase impacts to the landscape character of the open space in the north of Kings Island will be mitigated by minimising disruption to the existing river edge walkway. Access around the western side of the open space and adjacent to the River Shannon will be disrupted as people are diverted to the footpath on Oliver Plunkett Street during construction and walkers will be directed to the track on the eastern side of the island.

Within the southern part of Kings Island pedestrian access will be disrupted but not prevented as the work to construct the raised wall proceeds.

Construction techniques have been development to minimise damage to and removal of the mature trees on George's Quay to provide protection during the adjacent wall repairs. Tree surgery to the existing mature trees including raising of the tree crown and removal of lower branches and basal shoots will prevent damage by construction work. Additionally, prevention of machinery and storage of building supplies within the tree root protection areas will minimise any damage to these valuable resources and maintain the sylvan charm of George's Quay during construction.

13.6.3 Mitigation Measures during Operation Phase

Mitigation measures to reduce landscape and visual impacts include:

- Painting the light-coloured coping in Area A1 a darker shade of grey to reduce the levels of visual intrusion;
- Raising the existing ground level in Area A2 to maintain a wall height of 1.2m above ground level to allow river edge views and painting the coping a darker shade of grey to reduce its visual intrusion;
- Profiling of the embankment around St Mary's Park in Areas A3-A6 to remove the engineered appearance and give a more natural landform. On the western and northern sides of the St Mary's Park this will comprise grading out of the 1 in 3 slope on the eastern side of the embankment to an approximate gradient of 1 on 20. The gradient on the 'wet'

side will remain a 1 in 3 slope (1 in 2.75 at Star Rovers Pitch). The surface of the embankment will be seeded with meadow grass to ensure the appearance is as natural as possible and to match the existing ground level in the open space. The meadow grass will reduce maintenance requirements and increase biodiversity. On the western side of St Mary's Park where the proposed embankment is located between the rear garden of properties on St Munchin's street and the Special Area of Conservation the embankment will narrow to avoid encroachment onto the SAC and knotweed bund and will allow for occasional widening to accommodate a footpath (gradient 1 in 20) and associated break out areas. A scrub hedge at the foot of the embankment will be incorporated into the design to act as barrier planting to prevent access to the sensitive SAC.

- Directional lighting (Areas A3-A6) will be implemented along the top of the embankment with the lighting columns on the outside of the footpath to direct the light away from the adjacent SAC (in the River Shannon and between St. Munchin's Street and the Abbey River);
- Semi mature trees (Area A4) will be planted at the base of the embankment parallel to St. Munchin's Street and Assumpta Park to filter visibility into the rear of properties (refer to the Landscape Strategy Document). The trees will have a clear stem of 2m to provide low level views trough the planting for security purposes;
- Connecting access paths (Areas A3-A4) at approximately 150m intervals and at a 1 in 20 gradient from residential areas onto the embankment and one enhances access to the River Shannon for fishermen (refer to Arup scheme design drawings);
- Stone finish to existing flood wall raised in height in Area A6 to the rear of Athlunkard Boat club. A random rubble finish, laid to courses with a rough racked coping will enhance the wall, match the gates into Athlunkard boat house on Athlunkard street and match the random rubble wall on Sir Harry's Mall on the opposite side of the road;
- Stone finish to existing flood wall raised in height in Area A7 at Sir Harry's Mall with rough-hewn stone in a snecked pattern with a double chamfered rectangular stone coping. The footpath will also be raised to maintain a wall height of 1.1m above ground level to allow river edge views;
- Different stone finishes in Area 10 will be separated by a new pier to define the change between the two sections of wall. Replacement trees will be planted to mitigate the loss of 2 trees in this location.;
- Along George's Quay in areas B1 and B2 the new concrete flood wall will have a flamed finish stone facing and rounded stone coping to resemble the existing small section of stone. Sections of stone wall will be replaced with transparent panels to allow connectivity with the Abbey River for pedestrian and vehicular users;
- Within the Potato Market the new wall at the south western end will be built parallel, but offset slightly, from the existing boundary wall with the Curragower Boat Club. The wall is to be faced with rough-hewn stone in a snecked pattern laid to courses with a double chamfered rectangular stone coping. The wall on the western side of the Potato Market will also be faced with rough-hewn stone in a snecked pattern laid to courses with a double chamfered rectangular stone coping;
- At Curraghower boat club a new flood wall will be constructed along this edge in proximity to vehicular movement. This will consist of a concrete core faced and coped to match the outer face of the Potato Market wall;
- At Merchants Quay a new section of flood wall will be constructed between the memorial fountain and the location of the former mill. This will be a concrete core faced with rough-hewn stone in a snecked pattern laid to courses and coped to match the northern section of wall. The existing northern wall will be replaced with a new concrete wall. This will be faced with rough-hewn stone in a snecked pattern laid to courses and coped to match the existing. The wall across the steps will be moved northwards and replaced with a transparent panel to open up views of the steps. The relocated section of stone wall will then form a return to the wall rising up along the edge of the steps.

13.7 Residual Impacts

13.7.1 Residual Impact during Construction

The negative impact associated with the proposed construction works on the landscape character of the detailed study area will be minimised though the implementation of a site-specific Construction Environmental Management Plan and Traffic Management Plan. This will ensure that impacts on the residential properties and users of the open space associated with dust and noise from traffic during the creation of the embankments and walls are in regulated accordance with agreed mitigation measures. It will also ensure that construction traffic, materials and plant are housed in the compound, that security lighting in the compound is directional away from the residential properties and that pedestrian diversion routes are made available to access the open space areas and to the river edge walkway on the eastern side of St Mary's Park.

Additionally, the construction programme will ensure that disruption to the astroturf pitch football pitches at Star Rovers will be minimised by scheduling the majority of the works during summer (out of season) although some disruption to the playing season will occur and by limiting construction of the surrounding flood embankment to a narrow corridor around the football pitches and not across the playing area. The trees lost during the construction phase will be replaced with the proposed tree planting to the rear of St Muchin's street and Assumpta Park during the first planting season after the end of the construction works.

The residual impact on the landscape character and visual amenity will be **Short term, Slight, Negative Impact.**

13.7.2 Residual Impact during Operational Period

On maturity of the landscape proposals the moderate visual impacts experienced by the 107No. residential properties in Oliver Plunkett Street, St Munchin's Street and Assumpta Park and the visitors to the military cemetery off St Ita's Street will reduce to slight adverse as visibility of the proposed FRS reduces. The residual impact will be Permanent, Slight, Negative Impact.

A summary of Landscape and Visual Impacts during construction and operational period and mitigation is included in Appendix F.

13.8 Photomontage

Eleven photomontages have been compiled from public locations to illustrate the residual landscape and visual impact of the proposed FRS. The photomontages are included within Volume 4 and described below.

Photomontage 1 - view towards proposed flood embankment from Brown's Quay on western bank of River Shannon

This photomontage illustrates the proposed earth embankment along the western side of Kings Island as seen from residential properties on Brown's Quay 120m west of the site (Figure 13-1 and Appendix F). The change along this view point will be perceived as increased natural river bank vegetation which will obscure a part of the ground floor of residential properties along Oliver Plunket Street and St Ita's Street and night time lighting along the top of the embankment. The sensitivity of the residential properties is very high, the magnitude of the change is negligible, therefore the overall visual impact (as shown in Table 13-1) from this view point is assessed as Slight adverse and Not Significant.

Photomontage 2 - view towards proposed flood embankment from the junction of St. Ita's Street and St Munchin's street

This photomontage illustrates the proposed earth embankment along the western side of Kings Island as seen from residential properties on the junction of St. Ita's Street and St Munchin's Street 65m from the embankment (reference R2 in LVIA Figure 13-1). The change along this view point will be perceived as increased natural river bank vegetation which will obscure a part of the ground floor of residential properties along Brown's Quay in Thomond Gate and beyond to landmark buildings of Thomond Park Rugby stadium. Night time lighting along the top of the embankment will also be visible as will the grey coping of the upgraded river flood wall adjacent to the community centre and creche. The sensitivity of the residential properties is very high, the magnitude of the change is negligible, therefore the overall visual impact (as shown in Appendix F) from this view point is assessed as Slight adverse and Not Significant.

Photomontage 3 - view towards proposed flood embankment from Oliver Plunket Street

This photomontage illustrates the proposed earth embankment along the western side of Kings Island as seen from residential properties along Oliver Plunket Street 23-100m east of the embankment (reference R3 in LVIA Figure 13-1). The change along this view point will be perceived as increased height and width of the natural river bank vegetation which will obscure visibility of the buildings and vegetation on the western side of the River Shannon. Visibility of the landmark buildings Thomond Park Rugby stadium will not be altered. Night time lighting along the top of the embankment will also be visible and upgraded pedestrian link paths to access the embankment. The sensitivity of the residential properties is very high, the magnitude of the change is low, therefore the overall visual impact (as shown in Appendix F) from this view point is assessed as Slight adverse and Not Significant.

Photomontage 4 - view towards proposed flood embankment from outer embankment walkway, outside site

This photomontage illustrates the proposed earth embankment along the eastern side of St Mary's Park as seen from the walking track on the eastern side of King Island 300m east of the embankment (reference OS2 in LVIA Figure 13-1, Volume 3, and Appendix F). The change along this view point will be reduced visibility of the rear of residential properties along St Munchin's Street due to the embankment and the standard trees and night time lighting will be visible along the top of the embankment. Visibility of the landmark buildings Thomond Park Rugby stadium will not be altered. The sensitivity of the Open Space viewpoint is high, the magnitude of the change is positive, therefore the overall visual impact (as shown in Table 13-1) from this view point is assessed as Positive and Significant.

Photomontage 5 - view towards proposed flood embankment from Assumpta Park

This photomontage illustrates the proposed earth embankment along the northern and eastern side of the Star Rover Sports pitches as seen from residential properties along Assumpta Park 150m west of the embankment (reference R7 in LVIA Figure 13-1, Volume 3, and Appendix F). The change along this view point will be perceived as removal of trees and bushes along the existing ditch north of the sport pitches, enclosing of the space and obstruction of ground level long distance views. Visibility of the skyline formed by hills to the north will remain. Night time lighting along the top of the embankment will also be visible and new pitch fencing. The sensitivity of the residential properties is very high, the magnitude of the change is negligible, therefore the overall visual impact (as shown in Appendix F) from this view point is assessed as Slight adverse and Not Significant.

Photomontage 6 - view towards proposed flood wall at Athlunkard Boat club from O'Dwyers Bridge outside the site

This photomontage illustrates the proposed flood wall adjacent to the Athlunkard Boat Club and earth embankment as it passes round the Star Rover Sports pitches as seen from vehicular traffic and road/footpath users on O'Dwyer's Bridge. (reference V2 in LVIA Figure 13-1, Volume 3, and Appendix F). The change along this view point will be perceived as general improvements to the riverside grounds of the boat club incorporating a new improved wall. Visibility of the skyline formed by hills to the north will remain. Night time lighting along the footpath and top of the embankment will also be visible and new pitch fencing. The sensitivity of the vehicular users is low, the magnitude of the change is negligible, therefore the overall visual impact (as shown in Table 13-1) from this view point is assessed as Imperceptible and Not Significant.

Photomontage 7 - view towards proposed flood wall at Sir Harry's Mall looking in a northerly direction

This photomontage illustrates the proposed flood wall long Sir Harry's Mall from adjacent residential properties (reference R12 in Figure 13-1, Volume 3, and Appendix F). The change along this view point will be perceived as an increased height to the river wall (new coping and facing to the wall to match existing) and a general improvement to the footpath. The footpath will have a stepped arrangement to raise the footpath and maintain river views over the wall. The sensitivity of the residential properties is very high, the magnitude of the change is negligible, therefore the overall visual impact (as shown in Table 13-1) from this view point is assessed as Slight adverse and Not Significant.

Photomontage 8 - view towards proposed flood wall in front of the Gaelcolaiste Luimni on Sir Harry's Mall from Lock Quay

This photomontage illustrates the proposed flood wall adjacent to the Gaelcolaiste Luimni on Sir Harry's Mall from Lock Quay across the river as seen from users of the commercial buildings, vehicular traffic and road/footpath users. (reference C4 in Figure 13-1, Volume 3, and Appendix F). The change along this view point will be perceived as general improvements to the riverside wall, cleaning and repair of stone and slight raising of the wall height and new tree planting. Visibility of the Gaelcolaiste Luimni will remain. The sensitivity of the vehicular users is low, the magnitude of the change is negligible, therefore the overall visual impact (as shown in Table 13-1) from this view point is assessed as Imperceptible and Not Significant.

Photomontage 9 - view towards proposed flood wall along Georges Quay from Charlotte's Quay

This photomontage illustrates the proposed flood wall in front of Bon Secours Hospital Limerick at Barrington's and the river side properties either side from Charlotte's Quay across the river as seen from users of the commercial buildings, vehicular traffic and road/footpath users. (reference C5 in Figure 13-1, Volume 3, and Appendix F). The change along this view point will be perceived as general improvements to the riverside wall, cleaning and repair of stone, slight raising of the wall height, incorporation of transparent panels and new tree planting. The sensitivity of the commercial and vehicular users in this attractive townscape setting is medium, the magnitude of the change is positive, therefore the overall visual impact (as shown in Table 13-1) from this view point is assessed as Positive and Significant.

Photomontage 10 - view towards proposed flood wall around the Court House from Curraghgour Boat Club next to the Potato Market

This photomontage illustrates the proposed flood wall around the Court House from the adjacent walkway at Curraghgour Boat Club. (reference T4 in Figure 13-1, Volume 3, and Appendix F). The change along this view point will be perceived as general improvements to the riverside wall, cleaning and repair of stone, removal of the metal railings, introduction of a stone plinth ledge and inclusion of transparent glass panels. The sensitivity of the commercial and vehicular users in this attractive townscape setting is medium, the magnitude of the change is positive, therefore the overall visual impact (as shown in Table 13-1) from this view point is assessed as Positive and Significant.

Photomontage 11 - view towards proposed flood wall around the Court House from Curraghgour Boat Club next to the Potato Market

This photomontage illustrates the proposed flood wall from Clancy's street on the western side of the River Shannon 150m from the County Hall and Court House. (reference R13 in Figure 13-1, Volume 3, and Appendix F). The change along this view point will be perceived as general improvements to the riverside wall, cleaning and repair of stone, removal of the metal railings, and inclusion of transparent glass panels. The sensitivity of the residential properties is very high, the magnitude of the change is negligible, therefore the overall visual impact (as shown in Table 13-1) from this view point is assessed as Imperceptible and Not Significant.

13.9 Monitoring

Monitoring of the growth of the planted material around the site boundary and within the staff parking will be carried out during the 18-month Defects Liability Period and the subsequent establishment period to ensure any screen planting which has failed to establish is replaced in the next planting season.

13.10 Interactions with other Environmental Effects

Interaction with the fauna and flora (Chapter 8-Biodiversity) was required. Due to the presence of the SAC protected fauna (bats, badgers and nesting birds) adjacent to the embankment on the western and eastern side it was necessary to ensure that embankment sides were reduced to a 1 in 3 gradient to minimise impacts on the SAC and the 6m high lighting columns were directional inward and away from the SAC.

Interaction with Human Beings was required due to the intrusion of existing views from both the construction works including the site compound at northwest corner of site and the permanent embankments, in particular visually sensitive receptor R5 on St. Munchin's Street.

13.11 Cumulative Impacts

The site is situated in an island location surrounded by watercourses and connected by bridges to Limerick city. There is the possibility that cumulative interactions as a result of increasing development in the area may result and changes to the wider landscape character and visual amenity may occur as a potential future impact.

A number of projects have the potential for cumulative impacts with the King's Island Flood Relief Scheme. These are described in detail in Chapter 16 Cumulative Impacts and none indicate significant cumulative impacts. Some of these projects have not yet gone to planning stage. All these projects will have to consider cumulative impacts from this EIAR.

The potential cumulative impacts of these schemes from a landscape and visual impact point of view is summarised below. If the construction periods of these developments overlap, there is potential to impact on wider landscape character, open space, valued landscape features and visual amenity. These effects will be temporary.

Killaloe Bypass/Shannon Bridge Crossing and R494 Improvement Scheme

This scheme has received planning permission and is located approximately 16.5km north-east of the Kings Island FRS site. Due to the distance from the present project, no cumulative impacts on the wider landscape character including the adjacent banks of the Abbey and Shannon Rivers, open space, valued landscape features and visual amenity are expected.

Limerick Northern Distributor Road

Phase 1 of this scheme has commenced, with Phase 2 currently in design stages. Phase 1 comprises the Coonagh-Knockalisheen Distributor Road which will link to Limerick city via the Knockalisheen Road north west of Kings Island and on the western side of the River Shannon. The project areas do not overlap, and it is therefore anticipated that it will not have any cumulative impacts with the King's Island FRS from a landscape character and visual amenity point of view.

Limerick City and Environs Flood Relief Scheme (FRS)

The proposed Limerick City and Environs FRS upgrade is currently at the ‘Further Information’ stage of its planning application. As it is not possible to state in known detail whether the Castletroy FRS upgrade will present cumulative impacts in combination with the King’s Island Flood Relief Scheme at this stage. The project areas do not overlap, and it is therefore anticipated that it will not have any cumulative impacts with the King's Island FRS from a landscape character and visual amenity point of view.

Castleconnell Flood Relief Scheme (FRS)

The proposed Castleconnell Flood Relief Scheme, Co. Limerick is in the early stages of its planning development. The project areas do not overlap, and it is therefore anticipated that it will not have any cumulative impacts with the King's Island FRS from a landscape character and visual amenity point of view.

Opera Site, Limerick City

The proposed regeneration of the Opera Site includes a mixed-use development, comprising offices, retail, culture, licenced premises and other ancillary uses. The Opera Site is located on Charlottes Quay on the opposite side of the Abbey River and south of the R445, approximately 50m south of the King’s Island site boundary. The site occupies the majority of a city block and is bound by streets all around. The project is expected to take 4 years and 6 months, and it is anticipated that construction will overlap with the present project should both projects receive statutory consent.

The LVIA for the Opera project[150] states that during construction impacts will occur on the townscape character or visual amenity within the locality or the wider study area as a result of the visibility of construction activity such as demolition works, the construction/restoration of buildings, associated scaffolding and tall equipment such as cranes and containers. The effects on townscape and visual amenity will be temporary, adverse, major within 500m of the proposed Opera site. The 500m radius overlaps with Kings island landscape character areas/flood cells A9, A10, B1, B2 and B3. Although the Opera Site has not received planning permission and is therefore not a committed

[150] AECOM, (2019) Environmental Impact Assessment Report- Mixed Use Development - Opera Site, Limerick. Limerick City and County Council. Unpublished Report.

scheme, given the above, it is therefore anticipated that there could be cumulative impacts during construction with the King's Island FRS from a landscape character and visual amenity point of view.

Limerick Urban Centre Revitalisation - O'Connell Street

The Limerick Urban Centre Revitalisation - O'Connell Street, otherwise known as the LUCROC project, is a commitment to the revitalisation of O'Connell Street. The project is located between the junctions of Denmark Street and the Crescent, with Phase I between Denmark Street and Cecil Street, approximately 400 metres in length. This proposed revitalisation projected is located approximately 330m south-west of the King's Island FRS site, and the River Shannon (Lower) is located approximately 200m from the development area.

A planning application for Phase I of this project has recently been submitted under the Part 8 planning process. It is anticipated that, should the LUCROC project be granted planning permission, it would be constructed over the following two years, i.e. the construction period may overlap with the King's Island Flood Relief Scheme.

The Scoping Report for the LUCROC project [151] states that it is likely that there will be temporary negative effects on the surrounding landscape during the construction phase of the proposed development. Physical effects to the streetscape of O'Connell Street are predicted and will involve the excavation of the street and removal of existing surface materials, installation of new utilities, build-up of the street, repaving the street to include installation of new high quality public realm, planting trees and other decorative plants, and installation of new street lighting and artworks. During the construction phase, the presence of hoardings, building materials, construction vehicles etc. will result in a temporary effect to the landscape and visual setting. Similar to the Opera site, LUCROC has not received planning permission and is therefore not a committed scheme. However, it is possible if construction periods were concurrent that there could be cumulative impacts with the King's Island FRS from a landscape character and visual amenity point of view.

Mungret Local Infrastructure Housing

The Mungret Local Infrastructure Housing includes the upgrading of roads to allow for the development of 450 homes by 2021, with a potential estimate of 2,700 homes to be provided on the lands. The infrastructure will also ensure the delivery of a post primary school in the area within the next 3 years. The project areas do not overlap, and it is therefore anticipated that it will not have any cumulative impacts with the King's Island FRS from a landscape character and visual amenity point of view.

International Rugby Experience Building, O'Connell Street

The International Rugby Experience Building on O'Connell Street involves works at No. 42 O'Connell St/No.1 Cecil Street to create a rugby museum and cultural site. The site is located approximately 670m south-west of the proposed King's Island FRS site on the other side of the Abbey River. The International Rugby Experience Building received Conditional Permission on 14th of February 2018, with an amendment granted Conditional Permission on 2nd of April 2019.

Due to the nature and location of the International Rugby Experience Building development in Limerick City, 225m away from the Shannon River, it is possible if construction periods were concurrent that there could be cumulative impacts with the King's Island FRS from a landscape character and visual amenity point of view.

Corbally Housing Development, Corbally Road

The housing development proposed within the Corbally area is located adjacent to the Corbally Road to the east and the railway lines to the north and north-east. This proposed development is located approximately 215m east of the proposed King's Island FRS site.

The development is currently in the planning stage. As it is not possible to state in known detail whether the Corbally Housing Development Housing will present cumulative impacts in combination with the King's Island FRS at this stage, no detailed assessment of likely cumulative impacts can be assessed as part of the EIAR for this project.

[151] ARUP (2019) Limerick City and County Council Limerick Urban Centre Revitalisation - O'Connell Street Report for EIA Screening.

13.12 Difficulties Encountered in Compiling this Information

No difficulties were encountered in compiling this information

14 Cultural Heritage

14.1 Introduction

This chapter comprises an archaeological and architectural heritage impact assessment of the King's Island Flood Relief Scheme (FRS), Limerick City. A cultural heritage constraints study for the FRS[152] identified archaeological sites and areas on Kings Island which have protection under planning and heritage legislation; archaeological monitoring of site investigations along the works area subsequently took place[153]. Information from these previous studies is here updated and considered in relation to the most recent designs.

King's Island covers an area of just over 70 ha. and lies between the Shannon River to the west and its tributary, the Abbey River to the east. The Abbey River branches eastward from the Shannon at the northern end of the island and joins it again at a confluence at the south-western end. From its beginnings as the site chosen for the Viking town, the southern half of King's Island has been the focus of settlement for over one thousand years.

The King's Island FRS covers land within the historic town of Limerick and is close to numerous archaeological monuments, including King John's Castle, a National Monument in State care. As the location of the Anglo-Norman Englishtown, King's Island contains some of the finest built heritage in the City, with an impressive medieval quarter and fine public buildings of later date. A large portion of the south western extent of the island, approximately 13 ha. was enclosed within the historic City Wall, and its remains are also considered a National Monument[154].

The designs were mapped in relation to recorded archaeological sites and the proposed FRS works area was inspected to assess the potential impact of the works on recorded and unrecorded archaeology. Background research, mapping and field inspection informs recommended mitigation measures regarding the archaeological heritage of King's Island.

The architectural heritage section of this impact assessment identified built heritage within the study area of King's Island that would be directly or visually impacted by the works area. The works area is not within an Architectural Conservation Area (ACA). The perimeter of the southern half of the island was inspected to assess the potential impact of the works on Protected Structures and buildings of architectural interest noted on the National Inventory of Architectural Heritage (NIAH) at particular locations. A combined strategy of research, mapping and field inspection informs recommended mitigation measures for the architectural heritage of King's Island.

14.2 Assessment Methodology

This study aims to assess the baseline archaeological, architectural and cultural heritage environment (hereafter referred to as cultural heritage environment or cultural heritage resource), to evaluate the potential or likely impacts that the proposed FRS will have on this environment and, where appropriate, to suggest mitigation measures to ameliorate potential impacts, in accordance with the policies of:

- Department of Culture, Heritage and the Gaeltacht;
- The National Monuments Acts (1930-2005);
- Limerick City Development Plan 2010-2016 (as Extended); and
- Best practice guidelines.

This chapter is also completed in compliance with Part IV of the Planning and Development Act 2000. It follows the Department of the Environment *Architectural Heritage Protection - Guidelines for Planning Authorities* (2011) and The Royal Institute of the Architects of Ireland *Guidelines for the Conservation of Buildings.*

The residual impact that the proposed scheme will have on the baseline environment is also identified and evaluated.

[152] Moore, D. and B. Quinn (2015). Cultural Heritage Constraints Study for Kings Island Flood Relief Scheme. Report by Moore Group for JBA Consulting.
[153] O'Donoghue, J. and A Hawkes (2016). Archaeological Monitoring Report, Site Investigation Phase 2 (2016), King's Island Flood Relief Scheme, Limerick. Report by Julianna O'Donoghue Archaeological Services for Priority Geotechnical.
[154] Department of Environment, Heritage and Local Government, (2008). *National Policy on Town Defences*.

For the purposes of this report the definition of "cultural heritage" is taken broadly from the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage, 1972, which considers the following to be "cultural heritage":

- Tangible cultural heritage;
- Movable cultural heritage (artefacts);
- Immovable cultural heritage (monuments, archaeological sites, etc);
- Underwater cultural heritage (shipwrecks, underwater ruins and cities); and
- Intangible cultural heritage (oral traditions, folklore etc).

This impact assessment addresses Cultural Heritage under the two headings of archaeology and architectural/built heritage.

Known cultural heritage sites were reviewed and incorporated into project Geographical Information System (GIS) mapping along with aerial photography and Ordnance Survey Ireland (OSI) mapping. Sites mapped included the following:

- UNESCO World Heritage Sites including the tentative list of candidate sites;
- National Monuments, be they in the ownership or guardianship of the State, in the ownership of a local authority or monuments under preservation orders;
- Record of Monuments & Places (RMP) and Sites and Monuments Record (SMR) from www.archaeology.ie, archived by the National Monuments Service;
- Records of Protected Structures from Limerick City Development Plan;
- National Inventory of Architectural Heritage (NIAH) for Co. Limerick; and
- Cartographic Sources: Cartographic sources consulted include the Historic Mapping of the Ordnance Survey (O.S) (six-inch series and twenty-five-inch series for Limerick City) and the Irish Historic Towns Atlas No. 21 Limerick (2010).

All townlands located within 2km of the proposed FRS site were listed and crossed referenced with:

- National Monuments, a list for Co. Limerick available from www.archaeology.ie;
- Preservation Orders, a list available from the National Monuments Service; and
- The Register of Historic Monuments, a list available from the National Monuments Service.

The Limerick City Development Plan 2010-2016 (as extended) was reviewed to obtain a comprehensive understanding of the cultural heritage of the area. The development plan contains lists of cultural heritage sites including national monuments, recorded monuments, architectural conservation areas, protected structures and protected views, and recognises the importance of the city's landscape.

The plans also outline the city's heritage policies and objectives that aim to protect and promote the archaeological, architectural and cultural heritage of the region. There are a number of important policies and objectives in the Limerick City Development Plan seeking to protect and enhance the cultural heritage of the wider city and their generation areas including its riverine environment. These include:

ACT13

It is the policy of Limerick City Council to protect heritage buildings through the proper planning and sustainable development of City of Limerick.

BHA2

It is the policy of Limerick City Council to protect and enhance the archaeological value of the sites (and their settings) located within the 'Zone of Archaeology Potential' and all other features listed in the Sites and Monuments Record (SMR).

BHA3

It is the policy of Limerick City Council to require Archaeological Impact Assessment be carried out on all development proposals that are likely to impact upon in-situ archaeological structures or deposits within the Zone of Archaeology Potential.

Policy BHA.6 - Protection of Limerick's Medieval City Walls

It is the policy of Limerick City Council to secure preservation in-situ of the historic medieval city walls as identified in the Conservation and Management Plan for Limerick City Walls, 2008, and will have regard to the preservation and enhancement of the line of the city wall when considering development proposals in its vicinity. Disturbance, removal and alteration of the line of the city wall will not be permitted.

BHA12

It is the policy of Limerick City Council to protect all structures indicated on the Record of Protected Structures which shall include structures or parts of structures which are of special social architectural, historical, archaeological, artistic, cultural, scientific social or technical interest and continually review the Record where necessary.

BHA10

It is the policy of Limerick City Council that all development proposals which will impact on riverine, inter-tidal and sub-tidal environments should be accompanied by an Archaeological Assessment.

BHA10A

It is the policy of the Council to seek the preservation (in situ, or at a minimum, preservation by record) of all known and all previously unrecorded sites and features of historical and archaeological record in riverine, lacustrine, estuarine and or marine environments.

This evaluation was carried out with due regard to these policies and other relevant information contained within the plan.

To assess the potential impact of the proposal the following sources were also consulted or reviewed:

- Excavations Bulletin;
- Topographical files of the National Museum of Ireland;
- Cartographic Sources;
- Toponyms;
- Aerial photographs; and
- Published archaeological inventories.

The baseline historical research included a search of the British and Irish Archaeological Bibliography (www.biab.ac.uk). The National Library of Irelands catalogue (http://catalogue.nli.ie/) was also consulted. Other sources consulted include the Ordnance Survey Records for the area, www.duchas.ie and a number of local history publications.

The assessment involved a desk-based review of current information on recorded cultural heritage sites, structures or features and associated documents/reports, collating spatial data, including the project designs, into GIS to review the potential impact of the proposed works and field inspections to assess the potential impact on previously recorded cultural heritage sites, structures or features, areas of archaeological potential that may be affected, and to identify previously unrecorded cultural heritage sites, structures or features that may be affected by the proposed works. The desk-based work and fieldwork informed the assessment of predicted impacts and formulation of mitigation measures.

To assess the potential impact of the development on the cultural heritage, spatial data on previously recorded cultural heritage and any associated constraint zones were projected on to the FRS designs in a GIS. The initial cultural heritage study identified two National Monuments in State care (plus sections of the town walls, which have the same statutory protection as a National Monument), one archaeological monument that is the subject of a Preservation Order and 96 sites listed on the RMP/SMR on King's Island. Architectural heritage features include 44 Protected Structures and 38 entries in the NIAH. It is noted that there is a high degree of overlap between the entries in the Record of Protected Structures and the NIAH. The present assessment considers a project area, which extends beyond King's Island and extends to two areas which are located on the mainland to the south east of the Island.

The proposed FRS area was inspected by William Anderson (Moore Group) on 27 May 2019, by Billy Quinn (Moore Group) on the 6th September 2019 and by Nigel Malcolm (Moore Group) on the 2nd and 22nd of October 2019. The whole length of the project area was walked to visually assess the potential impacts of the project on archaeology. Particular attention was paid to locations where planned works are proposed in proximity to recorded sites (especially in the southern parts of Kings Island) as well as assessing areas where there has potentially been less ground disturbance (especially in the north). The proposed FRS area was also inspected by Anne Carey (Historic Buildings Consultant) on Monday, 1st of July 2019 and Wednesday, 2nd of October 2019.

14.3 Existing Environment

14.3.1 Limerick and King's Island – historical summary

Kings Island is strategically located in a national context, positioned near a fording point that guards the approaches from the estuary to the River Shannon providing access to the country's interior. From the very earliest of times our first inhabitants utilised this waterway and its tributaries to camp and forage. Indeed, the earliest known human burial in Ireland, dated to 7530-7320 BCE, was found at nearby Hermitage, Castleconnell, on a bend of the River. Nearer the Island, worked Neolithic era lithics have been recovered from the riverbed and a spiral headed pin was found near Baal's Bridge. Other recovered finds include a twisted ring and bridle boss, both of bronze, and a roman coin from near Thomond Bridge.

Chroniclers have argued that the site of 'Regia' featured on Ptolemy's map of Ireland (150 AD) is King's Island[155].The Annals reference Limerick (meaning the Bare marsh) as being linked to the High King Cormac mac Airt and St. Patrick is said to have visited it in the middle of the fifth century to baptise an Eóganachta King, Carthann the Fair. Tradition has it in 652 St. Munchin, having been consecrated bishop by St. Patrick, built the first Cathedral in Limerick.

In the ninth century the community was sufficiently large enough to become a target of Viking Attacks. These raids eventually led to a permanent Danish settlement in 922 by the Viking Thomar Mac Elgi. The proto town referred to as Inis Sibtonn, now King's Island, developed from a *longphort* translating literally as 'Ships Camp'. Present day Athlunkard Street references this encampment. Initially this base was used to stage inland raids on monastic houses along the Shannon, Lough Corrib and Ossary[156]. The shallow draught of Viking ships made the boats highly manoeuvrable and easy to land. The medieval harbour of Limerick, of which there is little information, probably developed as trade increased to accommodate and safeguard heavier cargo vessels.

In later years the town developed into a flourishing trading town centred on the south-western end of the island.

In the mid-10th century, in response to Viking attacks, the men of the Dál I gCais, led by Matghgamin, challenged the Norsemen under the command of Imar at Sulchóit (Solohead). The Vikings were routed from the field and were pursued to their stronghold at Limerick. The Annals record that Matghgami's Men 'followed them 'into the fort and slaughtered them in the streets and the houses'. It further adds that 'the fort and the good town they reduced to a cloud of smoke and to red fire afterwards'. This defeat did not eradicate the settlement but left it militarily crushed. In the succeeding years the Norse exploited local tribal tensions to grow their influence. This resulted in the murder of Matghgamin, King of Munster, by Máel Muad mac Brain (ancestor of the O'Mahoneys) with his chief ally Donnubán mac Cathail (ancestor of the O'Donovans). In retribution, Brian Bóroimhe (Boru) avenged his brother's death by systematically killing Mathgamain's murders. In 976, with unabated zeal, he eventually killed Aralt, Son of Imar, and made a prodigious slaughter of the foreigners. This final defeat saw the remaining Limerick Norse converting to Christianity and settling down to a relatively stable life under Brian, the unopposed King of Thomond and Munster.

Limerick continued under Ui Bhrian influence until the end of the twelfth century, ruled by Domnall Mór Ua Briain until his death in 1194. The town was walled, with a moat, and was centred around its port to the south-west of the island but was accessed only by a fording point. One of the most significant buildings in the town, St. Mary's Cathedral, was begun by Domnall Mór in the mid-to-late twelfth century. The town was taken briefly by the Anglo-Norman's between 1175 and 1176 and they constructed a wooden bridge on the site of the current Baal's Bridge and a ringwork at the site of King John's Castle.

In the 12th century the invading Normans under Prince John battled with the O'Brien's, Kings of Thomond for control of the town. Following the death of Domnall Mór Ua Briain, the last styled King

[155] Lewis, S. (1837). *A Topographical Dictionary of Ireland*, S. Lewis & Co
[156] Bairead F. Rev. (1942). *The Northmen of Limerick. North Munster Antiquarian* Journal Vol. III. pp. 213-222.
S. Spellissy, The history of Limerick City (Limerick, 1998)

of Limerick, the Normans completed their conquest and quickly began the construction of a castle bearing the kings own name. In 1175 the Anglo Normans under the command of Raymond Les Gros took the town. In 1195 they set about building the castle and strengthening the defences with a stone-built wall. By 1212 it is recorded that a significant part of the structure was completed.

By the 13th century much of Englishtown was fully enclosed from the south of the Island to the north of King John's Castle[157]. Under Norman rule the town developed its ports and grew in prosperity, with Kings Island as the strategic core. The expansion of Limerick in the late-medieval period involved the development of a settlement on the mainland, south of the historic core on King's Island. Accessed from King's Island via Baal's Bridge, this area was known as Irishtown and construction on its walls began in the fifteenth century. It was around these two settlements that Limericks town walls were erected, in plan the walls formed an hourglass shape connected by the historic Balls Bridge. Some of the City's most significant buildings date to the later medieval period, including King John's Castle at Thomond Bridge and St. Mary's Cathedral.

The fifteenth century was a time of economic growth, with the emergence of elite families in the town. The political troubles of the sixteenth century, particularly in association with the Dissolution of the Monasteries, brought tensions between new arrivals and the older established families.

Limerick City played a pivotal role during the civil wars of the 17th century, these conflicts led to town defences being reinforced with the addition of stone bastions, earthen ramparts and ravelins. The town was besieged by Oliver Cromwell in 1651 and twice by the Williamites in the 1690s. The Jacobite force finally capitulated to William of Orange on 3 October 1691, the terms were reputedly signed on the Treaty Stone, an irregular block of limestone which once served as a mounting block for horses now displayed on Clancy Strand. Following this final assault, the walls became redundant. In 1760 the town was officially declared non-fortified and the walls were incrementally dismantled.

Despite the considerable upheaval in mid-to-late seventeenth century, overall economic growth in the city continued. Between 1690 and 1750 the outward face of the streets of the city were significantly altered with the rebuilding or re-facing of the building stock in Classical style. New buildings, also in Classical style, were constructed in the historic centre, including the County and City courthouses (1732 and 1765).

In the mid-eighteenth-century growth within the walls of the medieval town had reached capacity and the area to the south-west of Irishtown became the focus of a new and very different development. This area was known as Newtown Pery after the landowner and instigator of many building schemes within his estate, Edmund Sexten Pery, MP. The construction by Sexten Pery of John's Square in 1751-56 to the design of Francis Bindon was an inspiring development and by 1769 a plan was in place that resulted in the establishment of tall, lofty and spacious Georgian terraces set in wide streets in a grid pattern further to the south-west. Over time the administrative centre shifted from King's Island to the newer development outside the medieval city, most significantly with the construction of a new Georgian Custom House in 1765-69, to a design by the Italian architect Davis Ducart, following the acquisition of a parliamentary grant by Sexten Pery.

Despite the fact that by the early-nineteenth century King's Island had been eclipsed by its more fashionable neighbour, Newtown Pery, developments still continued within the historic centre. The County Courthouse was constructed on Merchant's Quay in 1809 and the (now demolished) City Gaol was constructed in 1813, on a site just to the north of the courthouse. To the south of the courthouse, the Potato Market was laid out and opened in the early-1840s. Barrington's Hospital was constructed along George's Quay in 1829-30 and the visually striking Toll House, overlooking Thomond Bridge, was built in 1840. In the early-twentieth century the Athlunkard Boat Club clubhouse was built on the eastern side of the island, in 1923-24 and St. Ann's Vocational School (now Limerick Institute of Technology-School of Art) was built on George's Quay in 1938. Local authority housing, St. Mary's Park, was built to the north of the historic centre in the early-1930s.

14.3.2 Archaeological heritage

Figures showing archaeological heritage in relation to the proposed FRS site boundary are presented in Figures 14-1 to 14-5 in Volume 3.

[157] Collins, T., N. Darmody, B. O'Mahony, L. G. Lynch, F. Coyne and D. Humphreys 2008. Limerick City Walls Conservation Management Plan. Report by Aegis Archaeology, Architectural Conservation Professions and Minogue & Associates for Limerick City Council and The Heritage Council.

World Heritage sites

There are no World Heritage Sites in the study area, nor are there any sites contained in the tentative list of candidate World Heritage Sites.

National Monuments

On a national level, the highest degree of protection granted to archaeological monuments are those afforded National Monument status, which are protected under the National Monuments Act of 1930 and its various amendments. Any works on or in the vicinity of such sites requires Ministerial Consent.

There are two National Monuments in State care (Ownership or Guardianship) within the project area: King John's Castle (NM 288) and Fanning's Castle (NM 383). Additionally, the town defences (City Wall), including walls, gates and towers both above and below ground are also considered National Monuments in State care (National Policy on Town Defences, 2008) (Table 14-1) (See Volume 3, Figures 14-1 to 14-4).

The works area adjoins King John's Castle in Area B3 and runs close to the City Wall alignment at several points including Area A1 (Verdant Place), B1/B2 (George's Quay), and B3 (Potato Market, Court House, and Limerick City and County Council's Offices) (See Volume 3 Figures 14-3 to 14-5).

Table 14-1: National Monuments within the proposed FRS site area

Nat. Mon. No	Legal Status	Name	Description	Address	SMR No.	ITM Reference (E,N)
288	National Monument in State Guardianship	King John's Castle	Castle	Castle Street/Nicholas Street	LI005-017014-	557691, 657821
383	National Monument in State Ownership	Fanning's Castle	Castle	Mary Street, Limerick City	LI005-017004-	557924, 657535
N/A	National Monument in State Guardianship	Town defences	Wall	Kings Island	LI005-017010	Various

Other archaeological monuments afforded the same level of protection as National Monuments in Sate care and requiring Ministerial Consent include archaeological monuments which are the subject of Preservation Orders and archaeological monuments in the ownership of a local authority.

A Temporary Preservation Order was issued in relation to St. Dominic's Abbey, in September 1993 (4/1993 TPO). Saint Dominick's Abbey was located just inside the Town Wall at its north eastern extent and is now home to a nursing home which was opened in 1994. The SMR Database records a religious house (LI005-017047-) and a burial ground (LI005-017121-) at the site. It would seem likely given the dates and the SMR reference that the TPO related to excavations associated with the construction of the nursing home. There are no works proposed in the vicinity of this site.

Sites which are in the ownership of local authorities often relate to religious sites and graveyards that were vested to the Burial Boards by the Church Temporalities Commission. Established under the Irish Church Act 1869 the Commission was created to prepare for the disestablishment of the Church of Ireland in 1871 and deal with subsequent changes in property ownership. The Burial Boards were subsequently subsumed into the relevant local authorities, along with any lands that they were responsible for. Although there are a number of archaeological monuments indicated as burial grounds or with religious associations located on King's Island, further analysis indicates that most relate to areas where these features were indicated on historic mapping or encountered during development. The closest upstanding religious site to the proposed works is St. Mary's Cathedral which is in the ownership of the Church or Ireland.

It is noted that Thomond Bridge was constructed in 1836 but was constructed on an earlier bridge that is recorded as an archaeological monument (SMR No. LI005-017002-). As this bridge is in the ownership of Limerick City Council and given its importance as an early crossing point of the

Shannon it is viewed as being of National importance and, for the purposes of this report, has been assumed to be of National Monument Status.

Record of Monuments and Places

The Record of Monuments and Places (RMP) was compiled in response to the 1994 amendment to the National Monuments Act and remains the primary legal document. This inventory consists of a nationwide set of 6" maps by County, with accompanying indexes, which show the location of archaeological monuments with associated Zones of Notification (see Figures 14-1 and 14-5 of Volume 3). When it is proposed to conduct work within the Zone of Notification indicated, notification must be given to the relevant Minister at least two months prior to the commencement of the proposed works.

As the RMP inventory is a paper study, it has not been updated since each county was first published[158].The RMP has been largely superseded by the SMR Database, an online resource available at www.archaeology.ie (see below).

It should be noted that archaeological monuments in the RMP are protected by the National Monuments Act, but that the care and preservation of these features depends largely on the interest and respect of the individual landowners. County and City Development Plans have policies asserting the protection and preservation of archaeological sites, including those identified in the Record of Monuments and Places as well as archaeological monuments which have been identified subsequent to the publication of the RMP. County and City Development Plans often also afforded protection to previously unrecorded archaeology which may be encountered during works.

The southern areas of the proposed FRS are within the RMP Zone of Notification for the Historic Town of Limerick (SMR No. LI005-017----, detailed description derived from www.archaeology.ie is provided in Appendix G1). On the east of King's Island this Zone starts in the middle of Area A7, covering the whole south of the island; on the west side the Zone continues to encompass much of Area A1.

The reference system for archaeological monuments in the RMP is the SMR Number, which is the same as that which is used for the SMR Database (see below).

SMR Database

The most up-to-date record of archaeological monuments, the SMR Database, is available for viewing and download on the National Monuments Service website, www.archaeology.ie. This record is regularly revised and includes a number of additional sites that do not feature in the RMP. On their website the National Monuments Service also make available National Monuments Service (NMS) Zones of Notification. Further information relating to the entries contained in the SMR Database is available in the paper files of the National Monument Service which are available to be viewed by appointment at the National Monuments Service's Archives Unit in Dublin.

Within the Project Area there are 111 recorded archaeological monuments, including the record for the historic town of Limerick (LI005-017----). Of the 111 sites, 14 are not on King's Island but are within the Project Area. Information on the location of these sites in relation to the designs for the proposed FRS is contained in Plate 14-2.

There is considerable variety in the type of material documented, though the majority is medieval in date. According to their National Monuments classifications, there are 43 different site types. Among them are religious houses of five different orders, four classifications of castle, four burial grounds and numerous medieval structures including 15 medieval houses.

Table 14-2: Archaeological Monuments (SMR) within the proposed FRS site area; SMR numbers in bold denotes sites within or directly beside proposed works

SMR No.	Class	ITM Reference	Distance from works area (m)
LI005-017----	**Historic town**	**E 557809, N 657730**	**Intersects works areas in south of Island including Areas A1, A7, A8, A9, A10, B1, B2, and B3**
LI005-017001-	**Bridge – Baal's Bridge**	**E 558054, N 657423**	**Situated between and adjacent to Areas B2 and B3**

[158] Hanley 1997. 'Fish Lane/Sir Harry's Mall, King's Island, Limerick', Excavations Bulletin 1997: 351.

SMR No.	Class	ITM Reference	Distance from works area (m)
LI005-017002-	**Bridge – Thomond Bridge**	**E 557575, N 657846**	**Situated at the southern extent of Area A1**
LI005-017003-	House - medieval	E 557913, N 657634	Within the walled town approx. 120 m from works in Area B2
LI005-017004- National Monument 383	Castle - tower house	E 557932, N 657533	Approx. 35 m to the north of works in Area B2
LI005-017005-	House - medieval	E 557957, N 657569	Approx. 90 m to the north of works in Area B2
LI005-017006-	House - medieval	E 557854, N 657702	Approx 140 m to the east of works in Area B3
LI005-017007- RHM - MG1288	House - medieval	E 557826, N 657685	Approx 110 m to the east of works in Area B3
LI005-017008-	House - medieval	E 557871, N 657534	Approx. 25 m to the north of works in Area B2
LI005-017010-	**Town defences**	**E 557639, N 657897**	**In the vicinity of works in Areas A1, B1, B2 and B3**
LI005-017014- National Monument 288	**Castle - Anglo-Norman masonry castle King John's Castle**	**E 557689, N657804**	**Adjacent to the northern extent of Area B3**
LI005-017015- St. Mary's Cathedral	Cathedral St. Mary's Cathedral	E 557824, N 657645	Cathedral building located approximately 64 m to the north east of works in Area B3
LI005-017016-	Graveyard	E 557812, N 657608	Graveyard wall located approximately 10 m to the north east of proposed gravity sewer at Merchant's Quay
LI005-017017-	Graveslab	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017018-	Cross-slab	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017019-	Wall monument	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017021-	Graveslab	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017022-	Graveslab	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017024-	Memorial stone	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017025-	Memorial stone	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017026-	Graveslab	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017027-	Graveslab	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017028-	Armorial plaque	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017029-	Tomb - effigial	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017030-	Memorial stone	E 557824,	Indicated as associated with St. Mary's Cathedral, see

SMR No.	Class	ITM Reference	Distance from works area (m)
		N 657645	LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017031-	Graveslab	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017032-	Graveslab	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017033-	Graveslab	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017034-	Graveslab	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017035-	Memorial stone	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017036-	Graveslab	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017037-	Memorial stone	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017038-	Memorial stone	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017039-	Architectural fragment	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017040-	Architectural fragment	E 557824, N 657645	Indicated as associated with St. Mary's Cathedral, see LI005-017015. Could be associated with graveyard, see LI005-017016-
LI005-017043-	Church St. Munchin's C of I Church	E 557686, N 657922	Church Building located approx. 40 m to the east of works in Area A1
LI005-017044-	Graveyard	E 557686, N 657922	Graveyard wall located approximately 12 m to the east of works in Area A1
LI005-017045-	Memorial stone	E 557686, N 657922	Indicated as located within St. Muchin's Church see LI005-017043-. Could be associated with graveyard, see LI005-017044-.
LI005-017046-	Religious house - Augustinian nuns	E 557924, N 657759	Approx. 220 m to the east of works in Area B3
LI005-017047-	Religious house - Dominican friars	E 557793, N 657940	Approx. 150 m to the east of works in Area A1
LI005-017051-	Barracks	E 557860, N 657869	Approx. 160 m to the east of works in Area A1
LI005-017069-	**Mill - unclassified**	**E 557964, N 657464**	**In the vicinity of proposed drainage works in Area B2**
LI005-017072-	**Quay**	**E 557761, N 657536**	**In the vicinity of proposed drainage works in Area B3 at the Potato Market**
LI005-017073-	**Battery**	**E 557710, N 657515**	**Just to the west of proposed flood defences along the western extent of the Potato Market in Area B3**
LI005-017074-	**Mill - unclassified**	**E 557688, N 657681**	**In the vicinity of proposed flood defence works in Area B3, to the east of Council's Offices.**
LI005-017075-	**Mill - unclassified**	**E 557699, N 657686**	**In the vicinity of proposed flood defence works in Area B3, to the east of Council's Offices.**
LI005-017098-	Mill - unclassified	E 557951, N 657428	Approx. 30 m to the south of proposed works in Area B2, on south side of Abbey River.
LI005-017099-	Castle - unclassified	E 558075, N 657264	Approx. 170 m to the south of works in Area B1
LI005-017100-	Market-house	E 558075,	Approx. 170 m to the south of works in Area B1

SMR No.	Class	ITM Reference	Distance from works area (m)
		N 657264	
LI005-017101-	**Castle - unclassified**	**E 557694, N 657684**	**In the vicinity of proposed flood defence works in Area B3, to the east of Council's Offices.**
LI005-017103-	Castle - unclassified	E 557878, N 657617	Approx. 111 m to the east of works in Area B3
LI005-017114-	Church	E 557771, N 657752	Approx. 90 m to the east of the works in Area B3
LI005-017115-	**Religious house - Fratres Cruciferi**	**E 558079, N 657465**	**Just to the north of drainage and flood defence works in Area A10**
LI005-017119-	Monumental structure	E 557519, N 657793	On the opposite side of the Shannon River (west) from works Area B3
LI005-017120-	Architectural fragment	E 557838, N 657922	Approx. 200 m to the east of works in Area A1
LI005-017121-	Burial ground	E 557793, N 657940	Approx. 150 m to the east of works in Area A1
LI005-017122-	Quay	E 557997, N 657395	Approx. 40 m to the south of works in Area B2, opposite bank of Abbey River
LI005-017123- RHM MG1288	House - medieval	E 557857, N 657694	Approx. 117 m to the east of works in Area B3.
LI005-017124-	**Castle - ringwork**	**E 557720, N 657809**	**Original earthwork associated with King John's Castle which is adjacent to the northern extent of Area B3.**
LI005-017125-	House - medieval	E 557719, N 657796	Located within King John's Castle, identified during excavations. King John's Castle is adjacent to the northern extent of Area B3.
LI005-017126-	House - 16th/17th century	E 557870, N 657680	Approx. 150 m north east of works in Area B3.
LI005-017127-	Well	E 557710, N 657924	Approx. 75 m to the east of works in Area A1.
LI005-017128-	House - 16th/17th century	E 557975, N 657549	Approx. 85 m to the north of works in Area B2.
LI005-017129-	House - medieval	E 557820, N 657690	Approx. 113 m to the east of works in Area B3.
LI005-017130-	House - medieval	E 557920, N 657566	Approx. 60 m to the north of works in Area B2.
LI005-017131-	Excavation - miscellaneous	E 557905, N 657584	Approx. 75 m to the north of works in Area B2.
LI005-017132-	Excavation - miscellaneous	E 557890, N 657534	Approx. 20 m to the north of works in Area B2, likely associated with the construction of The Mews.
LI005-017137-	Excavation - miscellaneous	E 558040, N 657364	Located to the south of the Abbey River and Charlottes Quay, likely associated with new development to south of same. Approx. 45 m south of works in Area B1/B2.
LI005-017138-	Castle - unclassified	E 558040, N 657364	Located to the south of the Abbey River and Charlottes Quay, likely associated with new development to south of same. Approx. 45 m south of works in Area B1/B2.
LI005-017139-	Kiln - corn-drying	E 558040, N 657364	Located to the south of the Abbey River and Charlottes Quay, likely associated with new development to south of same. Approx. 45 m south of works in Area B1/B2.
LI005-017140-	**House – medieval** **Associated with undercroft in City Wall**	**E 557710, N 657709**	**Just to the east of works in Area B3**
LI005-017141-	Kiln	E 558054, N 657574	Approx. 60 m to the west of works in Area A7.
LI005-017142-	Excavation - miscellaneous	E 558054, N 657574	Approx. 60 m to the west of works in Area A7.
LI005-017144-	Graveyard	E 557760, N 657774	Approx. 50 m to the north of drainage works in Area B3.

SMR No.	Class	ITM Reference	Distance from works area (m)
LI005-017145-	Burial ground	E 558059, N 657612	Approx. 71m to the west of the works in Area A7.
LI005-017147-	Fortification	E 557498, N 657835	Located at the west end of Thomond Bridge on the opposite (west) side of the Shannon River to proposed works.
LI005-017148-	Excavation - miscellaneous	E 558039, N 657498	Approx. 60 m to the north of works in Area A10/B1.
LI005-017149-	Excavation - miscellaneous	E 557965, N 657588	Approx. 115 m to the north of works in Area B2.
LI005-017150-	Excavation - miscellaneous	E 558015, N 657295	Approx. 136 m to the south of works in Area B1. South of Abbey River.
LI005-017151-	Excavation - miscellaneous	E 557945, N 657485	Approx. 13 m to the north of works in Area B2, within the grounds of Barrington Hospital.
LI005-017152-	Excavation - miscellaneous	E 558000, N 657580	Approx. 128 m to the north of works in Area B2.
LI005-017153-	**Excavation - miscellaneous**	**E 558058, N 657453**	**Just to the north of works in Area A10.**
LI005-017154-	**Burial ground**	**E 558079, N 657465**	**Just to the north of works in Area A10.**
LI005-017155-	Cross - Market cross	E 557851, N 657614	Approx. 70 m to the north of regrading works between Areas B2 and B3.
LI005-017156-	Castle - unclassified	E 557713, N 657873	Approx. 70 m to the east of works in Area A1.
LI005-017164-	College	E 557788, N 657664	Approx. 70 m to the east of works in Area B3.
LI005-017165-	Religious house - Knights Hospitallers	E 557825, N 657563	Approx. 10m to the north of regrading works on Bridge Street between Areas B2 and B3.
LI005-017166-	House - medieval	E 557650, N 657960	Approx. 20 m to the east of works in Area A1.
LI005-017167-	House - medieval	E 557736, N 657725	In the vicinity of drainage works in Area B3
LI005-017168-	House - medieval	E 557730, N 657700	In the vicinity of drainage works in Area B3
LI005-017169-	House - medieval	E 557760, N 657650	Approx. 40 m to the east of proposed gravity sewer in Area B3, within what is now the Council's Offices.
LI005-017170-	Town hall	E 557965, N 657545	Approx. 70 m to the north of works in Area B2.
LI005-017171-	Armorial plaque (present location)	E 557700, N 657870	Approx. 65 m to the east of works in Area A1
LI005-017172-	Excavation - miscellaneous	E 557920, N 657814	Approx. 190 m to the east of drainage works in Area B3.
LI005-017173-	Excavation - miscellaneous	E 557790, N 657827	Approx. 110 m to the north east of drainage works in Area B3.
LI005-017174-	Excavation - miscellaneous	E 557780, N 657990	Approx. 155 m to the east of works in Area A1.
LI005-017175-	Excavation - miscellaneous	E 557915, N 657670	Approx. 150 m to the north east of grading works on Bridge St. between Areas B2 and B3.
LI005-017176-	Excavation - miscellaneous	E 558075, N 657510	Approx. 40 m to the west of works in Area A8.
LI005-017177-	**Burial ground**	**E 558090, N 657475**	**Just to the north of works between Areas A9 and A10.**
LI005-017178-	Excavation - miscellaneous	E 558090, N 657605	Approx. 40 m to the west of works in Area A7.
LI005-017179-	Excavation - miscellaneous	E 557740, N 657930	Approx. 111 m to the east of works in Area A1
LI005-017180-	Sheela-na-gig (present location)	E 557763, N 657424	Within the Hunt Museum, approx. 80 m to the south of works in Area B3.
LI005-017181-	Excavation -	E 558090,	Approx. 26 m to the west of works in Area A8.

SMR No.	Class	ITM Reference	Distance from works area (m)
	miscellaneous	N 657520	
LI005-017182-	House - medieval	E 558130, N 657330	Approx. 110 m to the south of works in Area A10. South of the Abbey River.
LI005-018----	Bastioned fort	E 557558, N 658574	Located roughly centrally within the northern half of Kings Island. The accuracy of early mapping makes it difficult to estimate the distance but could be as close as 30 to 40 m from the proposed works compound in Area A4.
LI005-019----	Water mill - unclassified	E 557568, N 657625	Located towards the opposite (west) bank of the Shannon River approx. 110 m to the west of works in Area B3.
LI005-078001-	Church	E 557910, N 657331	Approx. 120 m to the south of works in Area B2, south of Abbey River.
LI005-078002-	Graveyard	E 557909, N 657336	Approx. 120 m to the south of works in Area B2, south of Abbey River.
LI005-079----	Religious house - Franciscan friars	E 558054, N 657574	Approx. 40 m to west of works in Area A7.
LI005-109----	Burial	E 557780, N 658053	Approx. 150 m to the east of works in Area A1.
LI005-110----	Weir - fish	E 557623, N 657656	Located roughly in the middle of the Shannon River to the west of works in Area B3.

There are 19 archaeological monuments that are within or in the immediate environs of the works area. In addition, the historic town area (LI005-017----) spans the whole southern half of the works area, from the middle of Area A7 in the east and the north of Area A1 in the west. These 20 sites , including the Historic Town, are highlighted **in bold** in

Table 14-2 and information on the nature and extent of these sites is detailed in a gazetteer (Appendix G1).

Topographical Files of the National Museum of Ireland

The topographical files of the National Museum of Ireland (NMI) identify all recorded finds held in the NMI archive that have been donated to the state in accordance with National Monuments legislation. The files sometimes include reports on excavations undertaken by NMI archaeologists in the early 20th century. Valuable information that can be gleaned might include the exact location, ground type, depth below ground level and condition when found, of each find. However, the amount and the usefulness of the information available on each find can vary considerably.

A review of the NMI finds database on Heritage Council's www.heritagemaps.ie website, noted that there are seven National Museums points (two of which seem to record the same objects) recorded within the Project Area (Table 14-3).

It is noted that a huge quantity of finds were recovered during works, particularly in-stream works, associated with the Limerick Main Drainage and Lower Shannon Navigation Projects, over 11,000 artefacts. A report on the finds is available to view at the National Monument Service Archive under licence number 98E0581, Ed O'Donovan.

Table 14-3: National Museum of Ireland Finds Database records within the proposed FRS site area.

Name	Object Type	ITM Reference
1978:327	Bronze coin (Roman)	E 557581, N 657781
1972:187-195	Six glazed potsherds, two unglazed potsherds; and piece of bottle glass	E 557902, N 657879
The Arthur Crucifix	The Arthur Crucifix	E 557818, N 657635
O'Dea Mitre and Crozier	O'Dea Mitre and Crozier	E 557816, N 657618
O'Dea Mitre and Crozier	O'Dea Mitre and Crozier	E 557839, N 657573
Bronze bridle boss	Bronze bridle boss	E 557681, N 657582

Twisted bronze ring (from ring brooch)	Twisted bronze ring (from ring brooch)	E 557681, N 657561

14.3.3 Previous archaeological fieldwork

The Excavation Bulletin is both a published annual directory and an online database that provides summary accounts of all the excavations carried out in Ireland and Northern Ireland from 1969 to 2018. The database gives access to almost 15,000 reports and can be browsed or searched using multiple fields, including Year, County, Site Name, Site Type, Grid Reference, Licence No., Sites and Monuments Record No. and Author. In general, the database contains information on sites for which final excavation reports have been received. The Excavations Bulletin contains at least 80 summary reports which relate to archaeological work on King's Island.

There has been a considerable amount of archaeological fieldwork carried out on King's Island, including land crossed by or close to the proposed works area. In this section, relevant reported archaeological fieldwork to the present project is summarised.

Two large-scale archaeology and heritage projects based on King's Island, which investigated the Limerick's town walls and King John's Castle – contain detailed reviews of archaeological investigations in Limerick.

The *Limerick City Walls Conservation Management Plan*[159]is a detailed assessment and heritage management plan of Limerick's historic town walls and contains important information on land close to the proposed FRS. This project integrates the results of previous historical and archaeological investigations, and maps the town walls, which at several points is believed to be in the vicinity of works associated with the FRS.

Excavations within King John's Castle during the 1990s gathered substantial information on the archaeology of the site before, during and after the castle's construction[160].. Although mostly focusing outside the land crossed by the FRS, the findings have relevance to the present project, especially for areas close to the castle's southern walls and the southwest tower, which adjoins the works area.

Directly related to the proposed FRS, archaeological monitoring of geotechnical pits was carried out in May 2016[161&162]. This involved monitoring the mechanical excavation of 37 trial pits, nine of which were found to contain features of potential archaeological significance. These features were 'composed mainly of remnants of earlier quay walls and were found in areas alongside and underlying existing quays at Merchant's Quay/Potato Market, George's Quay and Sir Harry's Mall'[161]. Further details in Section 14.3.8 of this Chapter.

Successive investigations in 'Englishtown' in more recent years have regularly identified material of archaeological potential at depths of up to 2-5m. This material varies from rubble stone to organic rich silt. Much of the material confirms the early cartographic sources indicating that many of the existing property boundaries had their origins in the early medieval period. Excavations have exposed ditches, pits, hearths and small post-holes.

In advance of the Limerick Main Drainage O'Donovan (Licence No. 98E0581) excavated three trenches, two at either end of Baals Bridge and one at Creagh lane. All the trenches noted masonry features identified as being part of the City Defences.

Artefacts recovered from the 50 trenches excavated within the bed of the Abbey River between Matthew Bridge to Baal's Bridge, as part of the Main Drainage works, recovered objects dating from the prehistoric period (worked flint) to the post-medieval period. To date, no Bronze Age objects have been recovered. Several pre-Viking Age artefacts have been recovered, including a possible Iron Age horse bit, an Early Christian bronze zoomorphic object and a spiral-headed pin. A number of Viking Age stick-pins and a coin (c. 1035), minted in London for King Cnut, were also found. Medieval and post-medieval artefacts include beads, coins, horse equipment, pins, brooches, tools and weapons. A small assemblage of locally manufactured and imported medieval pottery has been

[159] Collins, T., N. Darmody, B. O'Mahony, L. G. Lynch, F. Coyne and D. Humphreys (2008). Limerick City Walls Conservation Management Plan. Report by Aegis Archaeology, Architectural Conservation Professions and Minogue & Associates for Limerick City Council and The Heritage Council.
[160] Wiggins, K. 2016. A Place of Great Consequence. Archaeological Excavations at King John's Castle, Limerick, 1990-8. Dublin: Wordwell Books.
[161] O'Donoghue, J. 2016. 'King's Island, Limerick', Excavations Bulletin 2016: 643. https://excavations.ie/report/2016/Limerick/0026040/
[162] O'Donoghue, J. and A Hawkes 2016. Archaeological Monitoring Report, Site Investigation Phase 2 (2016), King's Island Flood Relief Scheme, Limerick. Report by Julianna O'Donoghue Archaeological Services for Priority Geotechnical.

recovered from the riverbed. Fifty medieval coins dating from 1200 to 1540 were recovered; they are largely Irish, although Scottish, French and English coins are also included. An early post-medieval (c. 1600) seal bearing the 'Lymerick Port' coat of arms was also recovered from the riverbed. Objects dating from the Williamite siege of the city, including iron and stone cannon, musket balls of various sizes, gun flints, spurs, fragments of iron mortar bombs, grenades, iron bayonets and coins (Jacobite gun money), have been retrieved.

Likewise, investigations along George's Quay exposed material in the original line of the town wall at a depth of 5m below the existing quay. It is notable that much of the material abutting the wall was a result of infilling dating to the 1760's when much of the existing quay was constructed.

Celie O'Rahilly undertook archaeological test trenching following demolition of the City Gaol and prior to construction of the new City and County Council's Offices. O'Rahilly discovered a section of the City Wall to the north of the City Goal, at Nolan's Cottages which had been built on the foundations of a brewery. To the west and connected to the City Wall was a two arched bridge which appears to be indicated on historic maps from the 16th Century (Plate 14-1) onwards as an access to a mill which stood out in the stream of the Shannon River. A return at the end on the section of bridge may have been associated with the Mill. Associated with the western most arch of bridge O'Rahilly also found a tunnel that appears to be indicated on Eyres' Map of 1752 (Plate 14-5). Further details regarding these structures are presented in the Archaeological Testing Regime in Appendix G2.

The archaeological potential of the subject area is well documented. Artefacts recovered from the Shannon and the Abbey River number in their thousands and range in date from the Pre-historic times to the recent past. Notwithstanding significant changes in modern times pre-development testing continues to record In situ deposits at varying depths on the Island. Examples pertinent to the scheme are outlined in the following table.

Table 14-4: Summaries of Relevant Excavations.

Location	Description	Licence	Author	ITM Reference
Kings Island	Excavations on the site on the line of the proposed Northern Relief Road commenced in November 1989. A series of early ditches were excavated in Areas 2 and 3 which showed that many of the existing property boundaries had their origins in the early medieval period. In addition to the ditches, the earliest phase also contained a number of pits, hearths and small post-holes for which there was little or no dating evidence.		Brian Hodkinson	E 557760 N 657844
Broad Street/ George Street Limerick	Monitoring of pre-development engineering site investigations associated with Limerick Main Drainage was carried out from 7 to 9 June 1998 by John Ó Néill and this writer[163]. Three test-trenches were opened in areas where their location corresponded to the supposed location of the town defences. Two were dug at both ends of Baal's Bridge on Broad Street and George's Quay. The final trench was excavated at the foot of Creagh Lane on George's Quay. All three trenches yielded evidence of the survival of masonry structures between 0.45m and 1.3m below the existing street level, under surviving road surfaces. At Baal's Bridge the masonry structures were interpreted as being portions of the gates on either side of the bridge. The trench at the foot of Creagh Lane on George's Quay revealed the location of the town wall running parallel to the river along the centre of the present road. The trench depth never exceeded 1.4m below the present ground level, the specified depth limit in the engineering site investigations contract. Eighteenth-century fill was identified outside (Abbey River side) of the 'town wall' along George's Quay. This suggests that an area of relatively low archaeological potential may lie outside the town wall, between it and the present quay. Test excavations were carried out at Nos 4-5 George's Quay (C. O Rahilly, pers.	98E0581	Ed O'Donovan	E 557957 N 657466

[163] Kelly E.P and O'Donovan E., (1998) 'A Viking longphort near Athlunkard, Co. Clare', Archaeology Ireland 46, 13–16

Location	Description	Licence	Author	ITM Reference
	comm.) A single trench was excavated into the deposits on the site, where 0.8m of demolition rubble was identified over two layers of black, sticky, silty clay.			
Broad Street/ George Street Limerick	Three cuttings were excavated on George's Quay and one at Broad Street before construction activity associated with the Limerick Main Drainage Scheme. In addition, a programme of excavation (50 trenches) was initiated in the Abbey River before the first phase of pipe-laying in the riverbed Georges Quay The layers that abutted the structures were 18th- and 19th-century in date and were deposited as a result of reclamation and quay construction. Broad Street excavations at Broad Street indicated a long archaeological sequence commencing in the mid-13th century up to the present day. The cutting measured 35m east-west by between 5m and excavated to a depth of 5m below the street level. Baals Bridge to Matthew Bridge Extensive excavations of the riverbed from Matthew Bridge to Baal's Bridge exposed a large, important and eclectic collection of archaeological objects including dating from the prehistoric period (worked flint) to the post-medieval period.	98E0581	Ed O'Donovan	E 557354 N 657614
Verdant Place/Island Gate, Limerick, Limerick	This site was tested before development for local authority housing, with an additional area at the northern end where the proposed pumping station for the Main Drainage Scheme will be built. Based on the material it is reasonable to assume that the area west of the access to the Island Gate was gradually reclaimed by using it as a 'town dump' from the mid-17th century, just as the area around St Francis's Abbey was used in the medieval period. By the early 19th century, however, the reclaimed area was built on, with the quay in place. As structural remains were identified 0.6m below the surface, possibly of the gate or a building associated with it, further work in Cut 5 was deferred until a larger area could be opened up and investigated.		Celie O Rahilly	E 557560 N 658144
Barrington's Hostel, George's Quay/Mary Street, Limerick, Limerick	Testing was carried out of a site proposed for development at the corner of George's Quay and Mary Street in Limerick city. Substantial stone walls in this location were thought to relate to the large, classically influenced building called the Mont de Piété. Built in 1836 and demolished in 1892.Based on site photographs it hs been suggested that the lower foundations relate to the City Walls.	02E1429	Colm Moloney	E 558035 N 657443
St Mary Cathedral, King's Island, John's Ward B, (Site 18), Limerick, Limerick	In November 1990, Limerick Civic Trust undertook work along the Merchant's Quay boundary wall of the Cathedral ground/graveyard in order to put in a sloped access from the quay.The harbour wall 1m thick and built of block stones, was located running parallel and c. 1.5m from the Cathedral perimeter wall.		Celie O'Rahilly	E 557760 N 657544
11 St Peter's Street, King's Island, Limerick, Limerick	The southern boundary of the site has been identified as part of a late 16th- to early 17th-century house. A single test-trench was manually dug roughly in line with this wall to establish whether or not there had been a continuation of the wall, or possibly an adjoining wall. The trenching revealed that there were no subsurface archaeological remains present on the site.	03E0884	Tracy Collins	E 557860 N 657644
'St John's Hospital', Irishtown, And 'King's Island',	Five trial cuts were carried out under a general licence for the King's Island/Englishtown in the grounds of the Convent of Mercy near the		Celie O Rahilly	E 557354 N 657614

Location	Description	Licence	Author	ITM Reference
Englishtown, Limerick, Limerick	Dominican Priory of St Saviour164. Two of these were located to the west near Old Dominick Street. These yielded a considerable depth of rubble which, owing to its unstable nature, could not be bottomed out. There were possibly cellars along here. In the 3 cuttings opened towards the east near the City Wall, deposits of archaeological potential were noted. These were up to 2m below the present ground levels.			
Sir Harry's Mall, Limerick, Limerick	Excavations were undertaken at the site of a proposed FRS at Sir Harry's Mall[165]. A total of 90 human skeletons, as well as considerable quantities of disarticulated bone, were recovered during the excavation. It is likely that the cemetery was associated with the nearby Priory of Ss Mary and Edward (the Fratres Cruciferi), which was founded in 1211/12. The burials post-date the construction of the town wall in 1237. The priory was dissolved in 1538 and demolished in the later 18th century. Indications are therefore that the site may have been used for formal burial from the fourth or fifth decade of the 13th century up until at least the 16th century. Some inhumations – in particular a late prone burial – suggest clandestine use of the cemetery after it went out of official use.	05E0376	Linda G. Lynch,	E 558121 N 657573
Barrington's, George's Quay, Limerick, Limerick	An excavation was carried out in advance of the construction of a commercial building at Barrington's, George's Quay, Limerick. Testing had been conducted on this site by the writer in 2002[166] (Excavations 2002, No. 1217, 02E1429). The excavation identified a number of post-medieval cellars and post-medieval building remains.	06E0225	Colm Moloney	E 558002 N 657468
Sir Harry's Mall, King's Island, Limerick, Limerick	Six trial pits were excavated in the bank of the Abbey River adjacent to Sir Harry's Mall. The results were very similar for each of the trial pits, the only significant difference being the quantity of topsoil overlying the riverbed material at each location. In each of the trial pits, below the topsoil, if present, was a depth of up to 3m of demolition rubble. This rubble contained a mix of modern and 18th- and 19th-century ceramics. It also contained car parts, sections of shopping trolleys and an array of modern metal finds. The majority of the rubble was made up of masonry and red brick. Below the demolition rubble in the two pits where this depth was reached was sterile river mud.	2006:1292	Kevin Lohan	E 558121 N 657573
Sir Harry's Mall, Limerick	Following the demolition of the structures and the clearance of the site five trenches were opened. All were 4m in length. There was up to 1.5m of modern overburden on the site, with inclusions of red brick, modern glass, crockery, plastics, metal etc. This overlay a black, humic-rich sandy silt with frequent inclusions of animal bone, oyster shells, leather and clay-pipe stems. This layer was up to 2.5m in depth. This overlay a sandy dark-grey material with water-rolled medium stones. The humic layer is interpreted as material dumped in the post-medieval period and has been recorded in other sites in the area. A large volume of butchered animal bone was present in the rear of the site.	08E0374	Linda G. Lynch	E 558113 N 657791
Courthouse Lane/River Lane, Limerick, Limerick	This site is located to the east of the proposed Northern Relief Road, in the corner bounded by Courthouse Lane to the west and River Lane to the north. Five cuttings were made to coincide with the proposed housing. The only archaeology found, occurring in all five cuts, was a deposit of organic		Celie O Rahilly	E 558072 N 657643

[164] Hodkinson, B. J. 1990. 'The Priory of the Hospital of Sts Mary and Edward, King and Martyr, known as Holy Cross, OSA, near the bridge of Limerick', North Munster Antiquarian Journal 32, 41-49.
[165] Lynch, L. G. 2007. '"All shall forgotten lie" Archaeological excavations at Sir Harry's Mall, Limerick City', North Munster Antiquarian Journal 47, 11-19.
[166] Hodkinson, B. J. 2002. 'The topography of pre-Norman Limerick', North Munster Antiquarian Journal 42, 1-6.

Location	Description	Licence	Author	ITM Reference
	material overlying natural clay			

14.3.4 Cartographic analysis

There is a wealth of cartographic information on Limerick, which has been thoroughly and frequently mapped from the sixteenth century onwards. The most detailed source of cartographic information is the *Irish Historic Towns Atlas for Limerick*[167] which contains reproductions of 27 maps of Limerick including historical maps that date from the late medieval period (1587) until the early twentieth century as well as panoramic views and prospects. These maps are a vital source of evidence for the historical topography of the works area, and an important guide to the presence, location and nature of archaeological remains that are both recorded and previously unrecorded.

The earliest maps are largely pictorial representations, depicting buildings and features as two-dimensional elevations of the features themselves, as opposed to the plan form of later maps. These maps include various iterations of the 'City of Lymerike' (1587) (Plate 14-1), The Hunt Museum Map (1600), Speed's 'Map of Lymericke' (1610), and Webb's Map 'Limerick Leagver' (1651). Although these are useful references it is not possible to overlay them in a meaningful way over modern, measured surveys. Features of note that are represented on these early maps include King John's Castle, the City Walls, Thomond Bridge, Baal's Bridge, the harbour and a Mill building located in the Shannon River to the south of King John's Castle, which was accessed via a bridge. The map also indicates a gated opening in the City Wall which provided access to the Mill. A surface on the City Wall associated with this gate, the bridge to the Mill and remains of a return possibly associated with the Mill were discovered by Celie O'Rahilly during archaeological excavations associated with the construction of the new Council's Offices at Merchant's Quay.

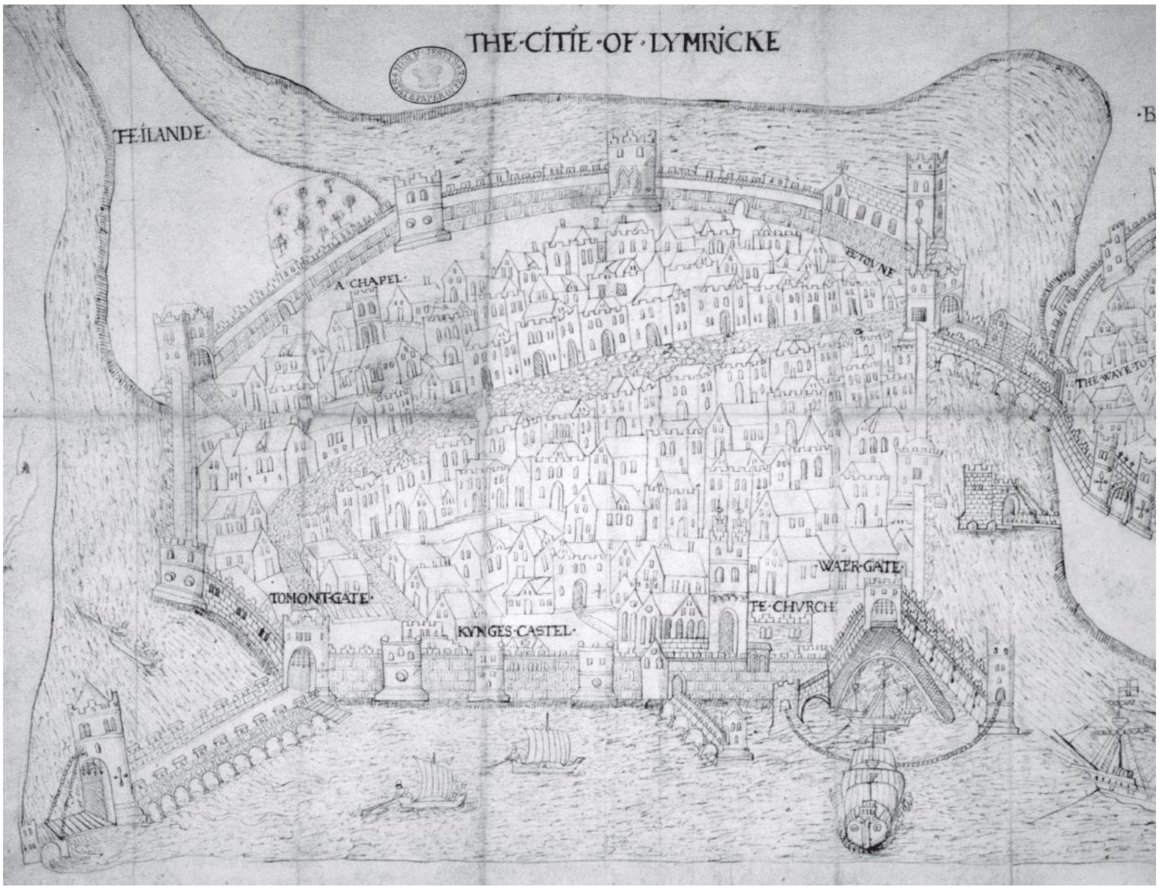

Plate 14-1. Extract from 'The Citie of Lymricke' 1587 (The National Archives - Irish Historic Towns Atlas 21 Limerick Map 5).

It is noted that the majority of development on King's Island prior to the 20th Century was associate with the walled town, in the south west corner of the Island and, as a result, many of the maps

[167] O'Flaherty, E. 2010. Limerick. Irish Historic Towns Atlas 21. Dublin: Royal Irish Academy.

concentrate on this area to the exclusion of the northern half of the Island. A fort is indicated in the north of the island on William Webb's map from 1651 (Plate 14-2) and various maps following this date to the start of the 20th Century, when it appears as 'Cromwell's Fort (Site of)' on OSI's 25 Inch Map.

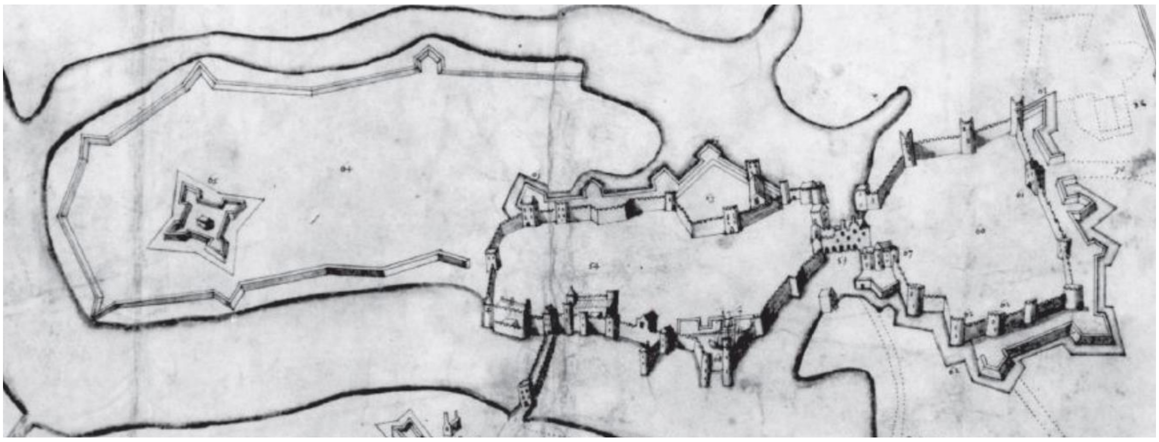

Plate 14-2. Extract from William Webb's map, 1651 (Worcester College, Oxford – Irish Historic Towns Atlas 21, Map 10)

One of the earliest plan form maps of Limerick is Thomas Philip's from 1685 (Plate 14-3) and it shows surprising spatial accuracy given its early date. The location and scale of features shows good alignment, particularly along the southern and south western margins of King's Island. It is immediately evident that the Abbey River was much wider at the time and that, as a result, an earlier iteration of Baal's Bridge was longer. This has been backed up by archaeological excavations to the north of Baal' Bridge, association with the Limerick Main Drainage Project, which found part of an earlier bridge (O'Donovan, Excavation Licence 98E0581). The City Walls show a close alignment to that provided in the Limerick City Walls Conservation Management Plan[168].

The Mill is evident in the Shannon although there is now more substantial development between it and the coast. It can be seen that there is a second Mill on the western side of the Shannon. Connecting the two mill is an inverted v-shaped race, constructed in the River, pointing up-stream which would have diverted water to the two mills. A similar pair of mills and associated race is evident in the Abbey River to the south of Kings Island.

The layout of the quays within the harbour is also indicated. In the south eastern corner of the quays area is a gated entrance into the quays. This is depicted on The Citie of Lymricke as 'Water Gate' and appears to be associated with the City Walls and an enclosing, possibly defensive, wall extending to the north of the Mill.

A substantial tower is evident on the southern side of this gate which is part of the City Wall. It would seem likely that this would also have served as a defensive element overlooking the Abbey River. The tower on the northern end of Baal's Bridge, found by O'Donovan, is also indicated.

[168] Collins, T., N. Darmody, B. O'Mahony, L. G. Lynch, F. Coyne and D. Humphreys 2008. Limerick City Walls Conservation Management Plan. Report by Aegis Archaeology, Architectural Conservation Professions and Minogue & Associates for Limerick City Council and The Heritage Council.

Plate 14-3. Extract from Thomas Phillips' map, 1685 (National Library of Ireland - Irish Historic Towns Atlas 21 Limerick Map 12).

By the mid 18th Century little appears to have changed on King's Island. Eyres' map of 1752 (Plate 14-4) shows similar detail to that of Phillips. The City Wall is the most prominent feature, followed by King John's Castle, the Harbour and the two bridges.

It is evident that there has now been a significant amount of development to the west of the City Wall associated with the Mills in the Shannon River. A more detailed look at this area ('Q' Mills and Breweries) (Plate 14-5) appears to show tunnels which directed water under the mills, one of which was discovered by O'Rahilly during excavations associated with the Council's new offices. Another interesting feature of Eyres' map is Sections, one of which is across the entrance into the Harbour (Plate 14-6).

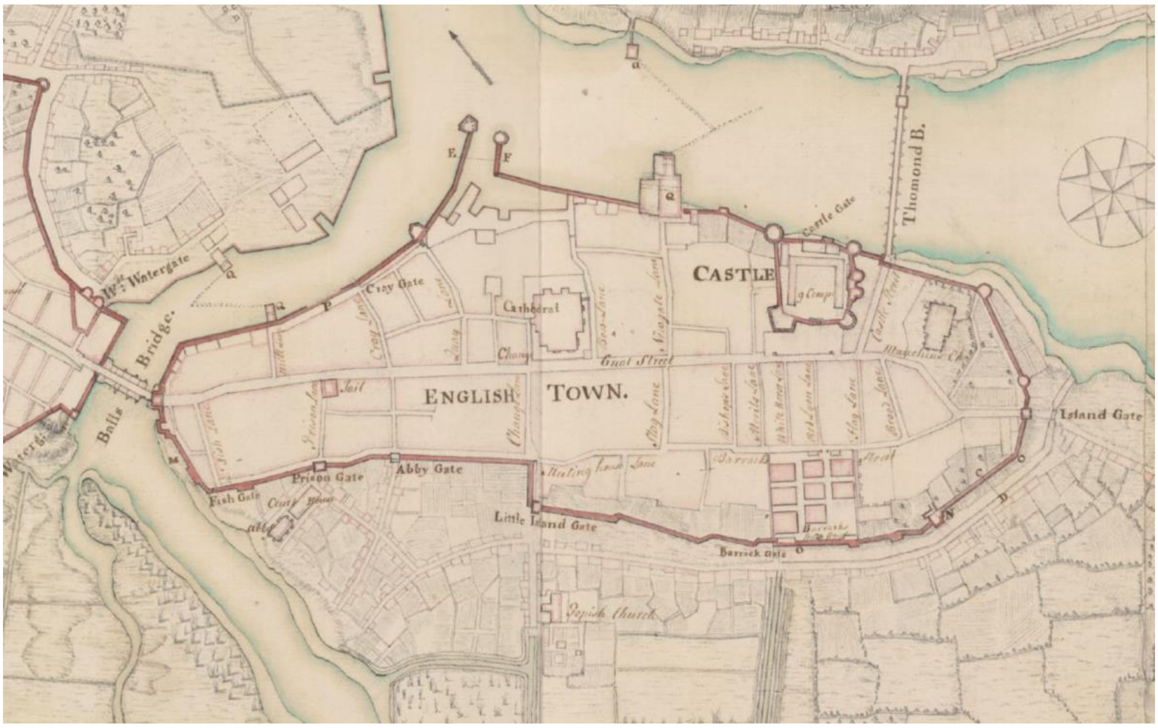

Plate 14-4. Extract from William Eyres' map, 1752 (British Library – Irish Historic Towns Atlas 21 Limerick Map 15).

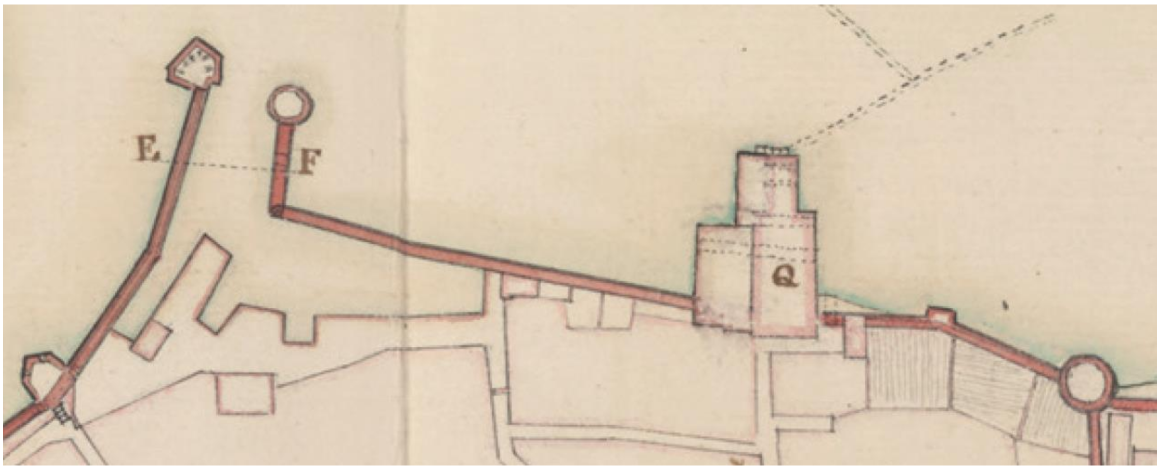

Plate 14-5. Detailed extract of Eyres' Map showing the Mills and Harbour (British Library – Irish Historic Towns Atlas 21 Limerick Map 15).

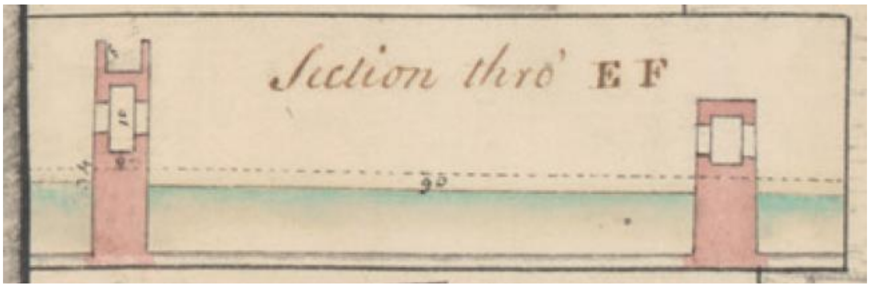

Plate 14-6. Section E-F from Eyres Map through the entrance into the Harbour (British Library – Irish Historic Towns Atlas 21 Limerick Map 15).

During the latter half of the 18th Century there were significant changes to the harbour. Previously there had been only a single entrance into the Harbour, at the south west corner of King's Island. Once inside the Harbour there were extensive quays, including a quay extending inside the City Wall to the north, as is indicated in both Phillips' (Plate 14-3) and Eyres' maps (Plate 14-5). By the