

10 Biodiversity

10.1 Introduction

This chapter describes the likely significant direct and indirect effects of the proposed flood relief scheme on biodiversity, including flora (plants), fauna (animals) and habitats in both the terrestrial and aquatic environment.

Chapter 4 *Description of the Proposed Scheme* provides a full description of the proposed development whilst **Chapter 5** *Construction Strategy* describes the construction aspects of the scheme. The following aspects are particularly relevant to the biodiversity assessment:

- Design:
 - The landscaping at Arklow Marsh (adjacent to the proposed embankment) and the extension to the north riverbank upstream of Arklow Bridge will provide some opportunities for habitat creation and mitigation of direct and indirect effects on biodiversity due to the loss of in-river vegetated islands and loss of habitat in the marsh.
 - The proposed installation of three roosting platforms in the river channel upstream of Arklow Bridge will provide for some mitigation of direct and indirect effects on birds due to the loss of in-river gravel beds due to the river dredging works.
 - Bat boxes and bat tubes will be permanently installed in the arches of Arklow Bridge (upstream side), in the flood walls and in the RC columns of the debris trap to mitigate direct and indirect effects on bats due to the construction works at Arklow Bridge.
 - The increase in levels of sections of the riverbank along River Walk and South Bank will provide some opportunities for riparian habitat creation and refuge areas to mitigate direct and indirect effects of the river dredging works on aquatic mammals and birds.
- Operation:
 - Maintenance activities in the river have the potential to impact on aquatic biodiversity, specifically, the maintenance of the gravel and debris traps and occasional channel dredging.
- Construction:
 - Construction activities occurring within the Avoca River channel including river dredging, works at Arklow Bridge have the potential to impact on aquatic ecology;
 - The construction of some of the flood walls along Riverbank and South Bank will encroach into the river thereby resulting in habitat loss along the riverbank;

- Construction activities in Arklow Marsh, along the southern bank of the river and the site compounds have the potential to impact on terrestrial biodiversity. Specifically, some of the working areas will require tree removal and vegetation clearance to accommodate construction activities;
- Some of the site compounds will be used to temporarily store dredge material for archaeological examination and stockpiling. There is potential for impact on biodiversity due to run-off from the dredge material;
- Construction activities will be undertaken in the vicinity of invasive plant species.

10.2 Methodology

10.2.1 General

The biodiversity assessment addresses the likely significant direct and indirect effects of the proposed development on terrestrial and aquatic biodiversity, including flora, fauna and habitats in proximity to the site.

The assessment has been carried out in three stages:

1. A desk study was undertaken to review published data describing ecological conditions within the greater area of the proposed development. Data bases included the National Parks and Wildlife Service (NPWS), the National Biodiversity Data Centre (NBDC), Inland Fisheries Ireland (IFI), Birdwatch Ireland (BWI) and the Irish Whale and Dolphin Group (IWDG).
2. Site visits and field surveys by specialist ecologists to establish the existing ecological conditions within the footprint of the proposed FRS and within the vicinity of all of the proposed development elements. The site visits and field surveys included terrestrial, river and estuarine surveys.
3. Evaluation of the proposed development and determination of the scale and extent of likely direct and indirect significant effects on biodiversity (*i.e.* flora, fauna and habitats) and the provision of appropriate mitigation and monitoring.

The biodiversity assessment for this EIAR and the NIS was prepared by AQUAFAC International Service Ltd. Other specialist ecologists who contributed included:

- Brian Keeley Ecologist and bat licensed specialist carried out bat surveys and assessments; and
- Denyer Ecology carried out a survey of bryophytes in the area around Arklow Bridge.

Walk over site surveys were also jointly commissioned by Wicklow County Council and Irish Water for the Arklow FRS and the Arklow Wastewater Treatment Plant (WwTP) projects.

The description of the baseline environment is therefore informed by environmental documents prepared for the Arklow WwTP project³. Relevant details of those surveys are included in this report where necessary. The ecologists who carried out the joint field surveys for the FRS and WWTP are listed in Section 10.2.4 below.

10.2.2 Guidance and Legislation

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

- Wildlife Act 1976, as amended;
- European Communities (EC) (Birds and Natural Habitats) Regulations 2011, as amended;
- Council Directive 2009/147/EEC, *i.e.* Birds Directive;
- Council Directive 92/43/EEC (as amended), *i.e.* Habitats Directive;
- Flora (Protection) Order, S.I. No. 356 of 2015;
- Heritage Council (2011) Best Practice Guidance for Habitat Survey and Mapping;
- Fossitt (2000) A Guide to Habitats in Ireland;
- Transport Infrastructure Ireland (incorporating the National Roads Authority, Revision 1, December 2010). Guidelines on the Management of Noxious Weeds and Non-Native Invasive Plant Species on National Road Schemes;
- National Parks and Wildlife Service, Department of Environment Heritage and Local Government (2006) Bat Mitigation Guidelines for Ireland;
- Department of Arts, Heritage and the Gaeltacht – National Parks and Wildlife Service DAHG NPWS (2012) Marine Natura Impact Statements in Ireland Special Areas of Conservation, A Working Document.
- DEHLG (2009) Appropriate Assessment of Plans and Projects in Ireland Guidance for Planning Authorities (Revised 2010);
- EC (2018) Managing Natura 2000 sites. The provisions of Article 6 of the Habitats Directive 92/43/EEC Commission Notice (2018);
- EC (2001) Managing Natura 2000 Sites: The provisions of Article 6 of the Habitats Directive 92/43/EEC;
- EC (2002) Assessment of plans and projects significantly affecting Natura 2000 sites;
- EU (2013) Guidelines on Climate Change and Natura 2000: Dealing with the impact of climate change on the management of the Natura 2000 Network of areas of high biodiversity value;

³ Arklow Wastewater Treatment Plant Project Environmental Impact Assessment Report (Arup, 2018a) and Natura Impact Statement (Arup, 2018b) are available at <https://www.water.ie/planning-sites/arklow-wastewater/environmental-documents/>

- CIEEM (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal;
- Inland Fisheries Ireland (2016) Guidelines on Protection of Fisheries during Construction Works in and adjacent to Waters;
- EPA (2017) Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports; and
- EU (2017) Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU);
- NPWS (2017) National Biodiversity Action Plan 2017-2021;
- Heritage Officer WCC - Wicklow Biodiversity Action Plan 2010-2015; and
- National Biodiversity Data Centre (NBDC) - All Ireland Pollinator Plan 2015-2020.

10.2.3 Study Area

The study area for the biodiversity assessment was defined to include all areas associated with the proposed development including permanent works, temporary working areas and construction compounds. Thus, the study area focussed on the lands within the planning boundary for the proposed flood relief scheme as shown on **Figure 10.1**. Refer also to Drawing no 1065 in Appendix 4.1 for further details on locations of temporary working areas and construction compounds (**Figures 10.2** and **10.3** below are extracted from Drawing no 1065). Some adjoining lands were included in the study area where relevant in order to provide context and baseline information on baseline ecological conditions in the vicinity of the proposed development.

As noted previously, walk over site surveys were jointly commissioned by Wicklow County Council and Irish Water for the Arklow FRS development and the Arklow WwTP project. Therefore, the study area of some of those surveys extended far beyond the planning boundary of and zone of influence for the FRS (for example; bat surveys and freshwater macroinvertebrate surveys along the Avoca River upstream at M11 bridge, terrestrial and waterbird surveys at Arklow Pond, benthic offshore surveys for the WwTP outfall). The relevant data have been extracted from these surveys to inform the biodiversity assessment of the FRS. The description of the baseline environment is also informed by environmental documents prepared for the Arklow WwTP project.

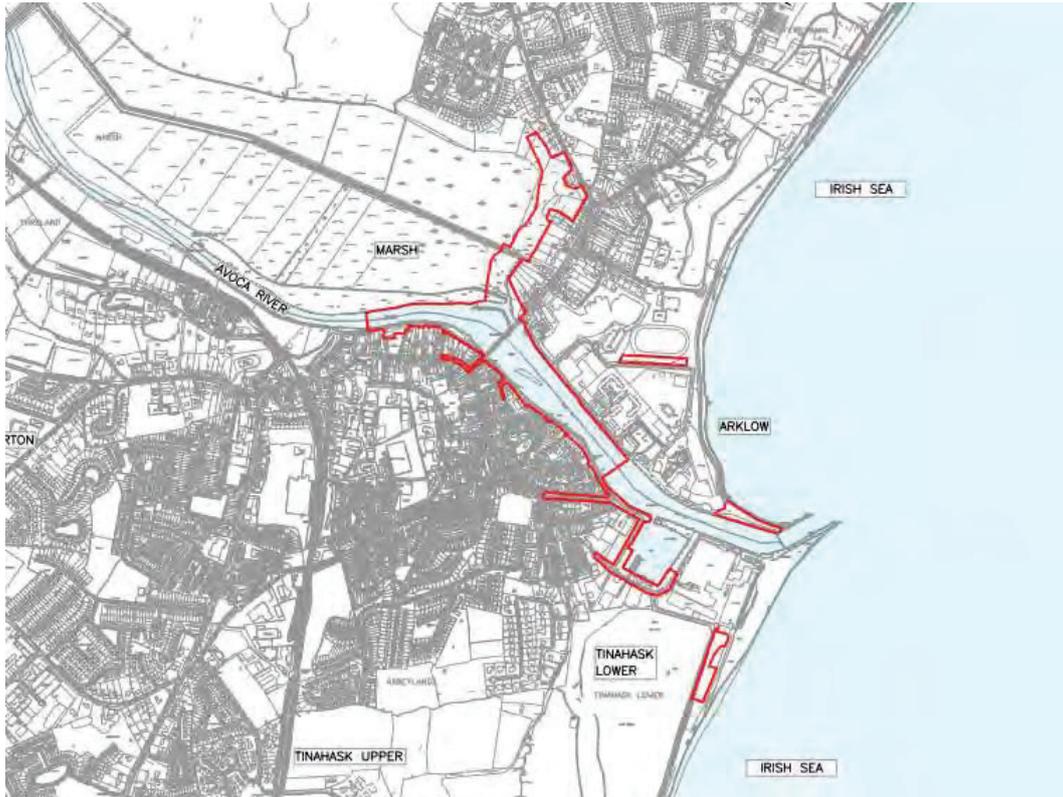


Figure 10.1: Arklow FRS planning boundary (extracted from Drawing No 1001 of Appendix 4.1 as described in Chapter 5). Red line represents planning boundary which includes all permanent works and temporary working areas required for the scheme. Do not scale



Figure 10.2: Site Compounds (extracted from Drawing No 1065 as described in Chapter 5). Site Compound 1 (SC1) located in Arklow Marsh, SC3 located on north bank (Ferrybank), SC2 located to the east near running track, SC4 located at Main St carpark on south bank near Riverwalk. Do not scale



Figure 10.3: Site Compounds (extracted from Drawing No 1065 and in Chapter 5). Site Compound 5 (SC5) located at North Pier, SC6 located at South Beach. Do not scale

10.2.4 Consultation

In its response to the 2018 Scoping Report, the Department of Culture, Heritage and Gaeltacht (on behalf of NPWS) provided a number of comments to inform the content and scope of the EIAR including:

- Guidance and legislation to be consulted
- Assessment of project effects
- Ecological surveys and baseline data
- Specific species data, alien invasive species
- Cumulative effects
- Mitigation and monitoring measures

Consultation meetings were held with IFI on 16 March 2018, and with NPWS on 27 June 2018, in respect of the proposed development and the proposed WwTP. Issues discussed relating to the FRS included the following:

- An overview of the project was provided;
- Discussion on the design development and baseline biodiversity studies undertaken including overview of Arklow Town Marsh proposed Natural Heritage Area (pNHA) and its habitats together with invasive plant species;
- Habitats Directive Annex II listed fish species that migrate through the Avoca Estuary, potential for River Lamprey adults and ammocoete larvae to be present in works areas, protocols to remove/protect fish during construction, and seasonal restrictions of in-stream works;
- Water quality protection during construction; and
- Habitats Directive Annex IV listed bat species, roost locations including Arklow Bridge, requirements for bat derogation licence and mitigation.

Inland Fisheries Ireland provided Avoca River Estuary fish data from monitoring carried out under the Water Framework Directive in 2015.

Consultation meetings were also held with IFI on 18 November 2020, and with NPWS on 5 November 2020, in respect of the proposed development. Issues discussed included the following:

- An overview of the changes to project design since the previous 2018 consultation;
- Discussion on bat surveys and bat derogation licence
- Discussion baseline biodiversity surveys undertaken in Arklow Town Marsh pNHA,
- Potential impacts on aquatic habitats and fauna due to in-stream works, water quality protection during construction;

- Habitats Directive Annex II listed fish species that migrate through the Avoca Estuary, potential for River Lamprey adults and larvae to be present in works areas, protocols to remove/protect fish during construction, and seasonal restrictions of in-stream works; and
- A bryophyte survey on Arklow Bridge.

Regard has been given to the consultations above and the relevant details have been incorporated into the impact assessment in this chapter.

10.3 Categorisation of the Baseline Environment

10.3.1 Desk Study

The desk studies carried out to inform the categorisation of the baseline environment information held by the following:

- NBDC database;
- EPA;
- IFI reports and data;
- Bat Conservation Ireland database;
- Wetland Surveys Ireland database; and
- I-WeBS data held by BirdWatch Ireland. The Irish Wetland Bird Survey (I-WeBS) is a joint scheme of BirdWatch Ireland and the NPWS.

The categorisation of the baseline environment was also informed by desk-based review of available records of protected species and habitats including the following sources:

- Conservation Status Assessment Reports, Backing Documents and Maps prepared to inform national reporting required under Article 17 of the Habitats Directive⁴ and Article 12 of the Birds Directive⁵;
- Site Synopsis, Conservation Objective Reports and Natura 2000 Standard Data Forms available from NPWS;
- Published and unpublished NPWS reports on:
 - protected habitats and species including Irish Wildlife Manual reports,
 - Species Action Plans and
 - Conservation Management Plans; and

⁴ The most recent Article 17 report *The Status of EU Protected Habitats and Species in Ireland 2019* is available at <https://www.npws.ie/publications/article-17-reports/article-17-reports-2019>

⁵ <https://www.npws.ie/status-and-trends-ireland%E2%80%99s-bird-species-%E2%80%93-article-12-reporting>

- Existing relevant mapping and databases *e.g.* waterbody status, species and habitat distribution *etc.* sources of information included:
 - EPA - <http://gis.epa.ie/>,
 - NBDC - <http://maps.biodiversityireland.ie> and
 - NPWS - <http://www.npws.ie/mapsanddata/>.

10.3.2 Site Visits and Surveys

The categorisation of the baseline environment was also informed by site visits and surveys carried out for the proposed Arklow FRS development and the Arklow WwTP project.

10.3.2.1 Overview

Table 10.1 briefly lists the site visits and surveys commissioned specifically for the Arklow FRS development while **Table 10.2** lists surveys jointly commissioned for the Arklow FRS development and the Arklow WwTP project.

Table 10.1 and **Table 10.2** also indicate where in this section additional information of the site visits and surveys is provided.

Table 10.1: Biodiversity site visits/ surveys undertaken for the Arklow FRS development

Biodiversity Element	Site Visit/ Survey Details	Dates	Notes	Refer to:
Terrestrial habitat and plant species surveys	Terrestrial habitat and plant species walk-over surveys ^{6, 7}	July/ August 2020	A series of walkover terrestrial habitat and species surveys carried out by AQUAFAC specifically for the FRS.	See Section 10.3.3.1
	Bryophyte survey	November 2020	Survey of bryophytes in the area around Arklow Bridge carried out in November 2020 by Denyer Ecology.	See Section 10.3.3.2
	Habitat survey for <i>Equisetum x moorei</i> near Site Compound 6 (SC6)	December 2020	Specific habitat survey for <i>Equisetum x moorei</i> undertaken near SC6. This survey was carried out by AQUAFAC.	See Section 10.3.3.3
	Terrestrial baseline studies	June 2017	Arklow Town Marsh surveyed by Natura Consultants to inform baseline studies for the proposed FRS	See Section 10.3.3.1
Bird species	Breeding Birds Survey at Arklow Town Marsh pNHA	26 Apr 2017, 03 May 2017, 26 May 2017	Breeding Birds Survey undertaken at Arklow Town Marsh pNHA by Natura Environmental Consultants.	See Section 10.3.3.3
Bat species	Bat Survey Arklow Bridge and Arklow Marsh	December 2020	Bat survey at Arklow Bridge carried out by Brian Keeley to inform Bat Derogation licence and bat mitigation.	See Section 10.3.5
Marine Invertebrates and Habitat	Benthic survey	August 2020	Survey in the lower part of the Avoca Estuary of carried out by AQUAFAC to document the conditions in terms of sediment quality and benthic infaunal invertebrate communities present.	See Section 10.3.9

⁶ These surveys also recorded observations on evidence of terrestrial mammals. These observations are detailed in **Section 10.3.6**

⁷ The findings of the survey with respect to invasive species are described in **Section 10.4.5.8**.

Table 10.2: Biodiversity joint site visits/ surveys undertaken for the Arklow WwTP and the Arklow FRS development

Biodiversity Element	Site Visit/ Survey Details	Details	Notes	Refer to:
Terrestrial habitat and plant species surveys	Flora and habitat and breeding bird surveys	27 June 2016, 10 August 2016, 26 April 2017, 22 August 2017, 12 April 2018, 16 May 2018	Some of the surveys were carried out within the planning boundary of the FRS. The relevant results of the surveys informed the assessment.	See Section 10.3.3.1
	Invasive plant species surveys	10 August 2016, 26 April 2017, 22 August 2017, 12 April 2018, 16 May 2018		See Section 10.3.3.1
Bird species	Waterbird surveys	16 September 2016, 25 October 2016, 24 November 2016, 8 December 2016, 28 January 2017, 24 February 2017, 29 November 2017, 13 February 2018		See Section 10.3.3.3
Bat surveys	Bat survey River Walk, Arklow Castle, The Alps, Arklow Bridge, and the northern bank of the Avoca River at Ferrybank including Brigg's Lane	17 October 2016, 19 October 2016, 22 to 29 August 2017	Survey carried out for the Arklow FRS development and Arklow WwTP project carried out by Brian Keeley. Some of the surveys (e.g. north bank and Arklow Bridge) were carried out within the planning boundary of the FRS. The other surveys (e.g. Arklow Castle and Alps) provide general information on bat activity in vicinity of Arklow town.	See Section 10.3.5
Estuarine and marine benthic survey		24 April 2017	Survey for the Arklow FRS development and Arklow WwTP project carried out by BEC. Some of the stations were carried out within the planning boundary of the FRS just downstream of Arklow Bridge.	See Section 10.3.8
Freshwater macroinvertebrate survey		26 September 2017	Survey for the Arklow FRS development and Arklow WwTP project carried out by BEC. Two of the stations (S1, S2) were carried out within the planning boundary of the FRS.	See Section 10.3.7

10.3.2.2 Appendix List

The Appendices which accompany this chapter are listed below

Appendix No	Title
10.1	Habitat survey report for <i>Equisetum x moorei</i> near SC6 (Dec 2020) and Addendum (Feb 2021)
10.2	Bat Survey Report (2017) (Appendix 11.4 of Arklow WwTP)
10.3	Bat Derogation Licence & Application (2021)
10.4	Aquatic Ecology Report (Appendix 11.6 of Arklow WwTP)
10.5	European Site Synopsis Reports
10.6	pNHA Site Synopsis Report
10.7	Bryophyte Survey at Arklow Bridge Report

10.3.3 Terrestrial Habitat and Plant Species Surveys

10.3.3.1 Walkover surveys

A series of walkover terrestrial habitat and species surveys surveys carried out by AQUAFAC specifically for the Arklow FRS development. Walkover flora and habitat surveys were carried out within the Arklow FRS development planning boundary and areas adjacent to the boundary to determine species composition and distribution in the study area

Where the walkover surveys undertaken by AQUAFAC covered areas previously surveyed for the Arklow WwTP, the previous survey findings were updated and/ or verified.

The walkover surveys undertaken by AQUAFAC in 2020 followed the same methodology as those survey undertaken for the Arklow Arklow WwTP.

Habitats present were classified in accordance with Fossitt⁸, and also having regard to Heritage Council⁹, in order to provide a basis for habitat evaluation. Plant species scientific nomenclature follows Parnell and Curtis¹⁰, common names follow Scannell and Synnott¹¹ when common names are not given in Parnell and Curtis.

The walk-over surveys also included checks for the presence of invasive non-native plant species listed in Part 1 of the Third Schedule¹². Additional species listed as invasive non-native plant species in the TII Guidelines¹³ were also recorded, together with non-native species encountered that can be spread through distribution of plant material

Some of the habitats are small scale within the urban landscape of the proposed development and have been subject to change during the course of the baseline studies; they are therefore described in the text provided rather than by habitat mapping.

Further detail of the walkover terrestrial habitat and species surveys undertaken by AQUAFAC are provided in **Section 10.4.5**

10.3.3.2 Bryophyte Survey

A bryophyte survey was carried out by Denyer Ecology at Arklow Bridge in November 2020. The findings of the survey are also described in **Section 10.4.5.7**. The full details of the survey are provided in **Appendix 10.7**.

10.3.3.3 Habitat Survey for *Equisetum x moorei* survey

Curtis and Wilson (2007¹⁴) recorded *Equisetum x moorei* (*Equisetum hyemale x ramosissimum*) at Site Compound 6 (SC6) in July 2007. A site specific habitat survey for *Equisetum x moorei* was carried out by AQUAFAC in December 2020 at Site Compound 6 (SC6). The 2020 survey did not identify *Equisetum x moorei* at the site. Following the publication of the December 2020 survey report, the boundary of SC6 was modified to avoid directly impacting on the area where *Equisetum x moorei* was recorded in 2007.

⁸ Fossitt, Julie A (2000). A Guide to Habitats in Ireland. The Heritage Council.

⁹ Best Practice Guidance for Habitat Survey and Mapping (Heritage Council, 2011)

¹⁰ Parnell, John, and Tom Curtis (2012). Webb's An Irish Flora. Cork University Press

¹¹ Scannell, Mary J.P, and Donal M. Synnott (1987). Census catalogue of the Flora of Ireland. Stationery Office, Dublin.

¹² Part 1 of the Third Schedule, European Communities (EC) (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477/2011)

¹³ <https://www.tii.ie/technical-services/environment/planning/Guidelines-for-Assessment-of-Ecological-Impacts-of-National-Road-Schemes.pdf> and <https://www.tii.ie/technical-services/environment/planning/Ecological-Surveying-Techniques-for-Protected-Flora-and-Fauna-during-the-Planning-of-National-Road-Schemes.pdf>

¹⁴ Curtis, T. and Wilson, F. 2007. Wicklow Rare/Threatened and Scarce Plant Survey 2007. *Equisetum x moorei*. National Parks and Wildlife Service.

The full details of the 2020 survey are provided in **Appendix 10.1**. The findings of the survey are also described in **Section 10.4.5.6**.

10.3.4 Bird Surveys

As part of the Arklow WwTP project a series of 26 bird surveys were undertaken over 3 survey areas between September 2016 and February 2018 (Arup, 2018a, b¹⁵). The survey areas were the Avoca River and Estuary, Arklow Pond, and nearby coastal waters.

The results of the survey with respect to survey areas within the Arklow FRS development boundary are described in **Section 10.4.6.1**.

In 2017 a survey of the populations of breeding birds at the Arklow Town Marsh proposed Natural Heritage Area (pNHA) was undertaken for the proposed FRS development.

The results of the survey at Arklow Town pNHA are detailed in **Section 10.4.6.3**.

10.3.5 Bat Surveys

There were a number of specific surveys that were jointly carried out by Brian Keeley for both the Arklow FRS development and the Arklow WwTP project between 2016-2017 as detailed in **Section 10.3.2** above. The report for the survey is included in **Appendix 10.2**. For clarity, this survey report was also included as *Appendix 11.4* in the WwTP EIAR and has been extracted directly from that EIAR and reproduced as **Appendix 10.2** for this FRS EIAR.

An additional survey was carried out in 2020 to confirm the presence of a bat roost at Arklow Bridge and to inform the bat derogation licence. The full details of the survey and bat derogation licence and application are provided in **Appendix 10.3**.

10.3.6 Otter Surveys

Two individuals (1 adult and 1 juvenile) were observed feeding along the southern bank in the early morning during the course of fieldwork carried out by AQUAFAC in summer of 2020.

During walkover survey undertaken as part of the Arklow WwTP project evidence of otter spraint was recorded at two locations along the south bank of the Avoca River between the M11 Bridge and the start of the built-up banks in Arklow Town upstream of the FRS planning boundary. Further detail is provided in **Section 10.4.9**.

¹⁵ Arklow Wastewater Treatment Plant Project Environmental Impact Assessment Report (Arup, 2018a) and Natura Impact Statement (Arup, 2018b) are available at <https://www.water.ie/planning-sites/arklow-wastewater/environmental-documents/>

10.3.7 Freshwater Macroinvertebrate Survey 2017

The macroinvertebrate community of the Avoca River was sampled at six locations on the main channel and at one location (S7) on the channel that runs in a south-easterly direction through Arklow Town Marsh on 26 September 2017. The survey was carried out by BEC to inform both the Arklow FRS development and Arklow WwTP project. Two of the locations (S1, S2) were situated within the planning boundary of the FRS. The remaining five locations were situated further upstream. The full results of the survey are provided in **Appendix 10.4** and summarised in **Section 10.4.10**. For clarity, this survey report was also included as *Appendix 11.6* in the WwTP EIAR and has been extracted directly from that EIAR and reproduced as **Appendix 10.4** for this FRS EIAR.

10.3.8 Marine Macroinvertebrate Survey 2017

A benthic field survey was carried out by BEC on 24 April 2017 (jointly for the FRS and WwTP).

A total of 13 stations were sampled for macroinvertebrate and sediment analysis (granulometry and total organic carbon (TOC)). Three of these stations (S11, S12 and S13) were situated within the Avoca River Estuary, downstream of Arklow Bridge within the planning boundary of the proposed scheme and a therefore relevant to the proposed FRS. The remaining ten were located outside the breakwaters of Arklow Port which were relevant for the WwTP.

The results of the survey are provided in **Appendix 10.4**.

Macroinvertebrate sample analysis

In the laboratory, macroinvertebrate samples were logged to track the processing. Each freshwater macroinvertebrate sample was washed through a 1mm sieve and the residue transferred to a white tray for sorting. Macroinvertebrates present were removed and separated by major group for identification and enumeration.

Rose Bengal was added to the marine and estuarine macroinvertebrate samples on arrival in the laboratory in order to aid sorting.

After 72 hours, samples were transferred to 70% Industrial Methylated Spirits as preservative prior to sorting and identification. Samples were sorted in a white tray, with animals being transferred to labelled containers and preserved with 70% Industrial Methylated Spirits prior to identification.

The species lists produced were checked against the Pan-European Species directory Infrastructure¹⁶. Identification was carried out using stereoscopic and compound microscopes and appropriate keys.

Sediment sample analysis

Sediment analysis for granulometry and TOC was carried out by Nautilus, Dublin.

¹⁶ PESI (2017) Pan-European Species directories Infrastructure. Accessed through www.eu-nomen.eu/portal on 2017-05-31.

Data analysis

On completion of estuarine and marine macroinvertebrate and sediment sample analysis, the data were used to describe the benthic environment. R-Statistic was used to carry out data analysis on the macroinvertebrate and sediment data. The following statistical analyses were undertaken:

- **Univariate ecological indices:** On completion of sorting and identification, several ecological univariate ecological indices were calculated to characterise the invertebrate community within the study area. These included Species Richness (number of species), Shannon-Wiener diversity index and Pielou's evenness index.
- **Community structure:** Abundance data were fourth-root transformed to down-weight the importance of the highly abundant species and to give rarer species more importance (Clarke, 1993¹⁷) and used to calculate a Bray-Curtis similarity matrix.

The similarity matrix was then used in cluster analysis to find sample groupings, *i.e.* samples within a group that are more similar to each other, than they are similar to samples in different groups. Similarity profile routine (SIMPROF) was used to identify significant ($P < 0.05$) groupings and the results were represented graphically on a dendrogram.

- **Sediment:** Sediment data were fourth-root transformed and normalised to equalise variance and standardise contributory importance of each variable.

Cluster analysis based on Euclidian distances was used to find sample groupings, *i.e.* samples within a group that are more similar to each other, than they are similar to samples in different groups. Similarity profile routine (SIMPROF) was used to identify significant ($P < 0.05$) groupings and the results were represented graphically on a dendrogram.

The results of the survey are provided in **Appendix 10.4** and described in **Section 10.4.10.5**.

10.3.9 Marine Macroinvertebrate Survey 2020

A benthic survey of the lower part of the Avoca Estuary was carried out by AQUAFAC in August 2020 to document the conditions in terms of sediment quality and infauna present.

The AQUAFAC survey which followed the survey methodology outlined in **Section 10.2.6.7** is described in detail in **Section 10.4.10.5**.

¹⁷ Clarke, K.R. (1993) Non-parametric multivariate analyses of changes in community structure. *Australian Journal of Ecology* 18: 117-143.

10.4 Baseline Conditions

10.4.1 Introduction

This section provides a description of the baseline environment of the proposed development area. A description of the desk studies, site visits and survey used to inform this section are detailed in **Section 10.3** above.

In summary, the description of the baseline environment is based on a series of baseline field surveys carried out in 2020 and surveys commissioned by Wicklow County Council and Irish Water for the Arklow FRS and the Arklow WwTP projects, a review of relevant mapping and reports by the NBDC and NPWS, and existing reports of the area including the County Wicklow Wetland Survey II (Wilson *et al.*, 2012¹⁸).

The description of the baseline environment is also informed by the AA Screening report and NIS prepared for the proposed FRS development and the environmental documents prepared for the Arklow WwTP project¹⁹.

10.4.2 Overview of Arklow Area/Avoca Catchment

The planning boundary comprises permanent works within the Avoca River channel at Arklow town, along the south bank (upstream and downstream of Arklow Bridge), along the north bank (upstream of Arklow Bridge and within Arklow Town Marsh pNHA). The planning boundary also includes lands will be required for temporary works during the construction such as site compounds. Refer to **Figure 10.1** which shows the location of the planning boundary.

The Avoca River drains a primarily upland catchment of some 650km². It enters the Irish Sea at Arklow via a short river estuary that is largely contained by existing sea and harbour walls. The Avoca River is formed by the joining of the Avonmore and Avonbeg rivers, which rise in the Wicklow Mountains. The Avonmore River flows from Lough Dan, just west of Roundwood, and flows in a generally south easterly direction for approximately 30km before meeting the Avonbeg River (which rises near Table Mountain at the top of Glenmalure Valley), just north of the village of Avoca, and becoming the Avoca River. Closer to Arklow, the Aughtim River and the Avoca River flow through steeply sloping wooded valleys and join at Woodenbridge. The valley sides, with both coniferous and deciduous woodlands, are included within the Avoca River Valley proposed Natural Heritage Area (pNHA) (Site Code 001748). The Avoca River flows through lower ground from Shelton Abbey towards the Irish Sea and forms a west - east corridor through Arklow town. Upstream of Arklow Bridge is Arklow Town Marsh pNHA (Site Code 001931).

¹⁸ Wilson, F., Crushell, P. Curtis, T. & Foss, P.J. 2012. The County Wicklow Wetland Survey II. Report prepared for Wicklow County Council and The Heritage Council.

¹⁹ Arklow Wastewater Treatment Plant Project Environmental Impact Assessment Report (Arup, 2018a) and Natura Impact Statement (Arup, 2018b) are available at <https://www.water.ie/planning-sites/arklow-wastewater/environmental-documents/>

This pNHA includes the Avoca River channel, and the wetland habitats that extend northwards from the bank of the river.

Due to the presence of a tidal node or amphidromic point in the part of the Irish Sea, tidal variations at Arklow are low and the predicted range is given as 0.73m during Spring tides. However, under storm surge events this is probably greater. The river is tidal to *ca* 0.5km upstream of the Arklow Bridge but again under storm surge events, this would be extended westwards. Low salinity sea water (< 5 practical salinity units) will penetrate the upper *ca* 10 cms of the river bed.

10.4.3 Protected Areas: European Sites

The proposed development does not lie within or adjacent to any European sites.

An *AA Screening report and NIS* have been prepared for the proposed development. Specifically, this report focuses on the potential effects of the proposed development on the European sites within the Natura 2000 network.

Sites, species and habitats protected under Directive 92/43/EEC (Habitats Directive) and Directive 2009/147/EC (Birds Directive) are referred to as Natura 2000 sites. Natura 2000 sites are also referred to as European sites. These terms are synonymous. European sites in Ireland that form part of the Natura 2000 network of protected sites comprise SACs designated due to their significant ecological importance for habitats and species protected under Annex I and Annex II respectively of the Habitats Directive, and SPAs designated for the protection of populations and habitats of bird species protected under the EU Birds Directive (Council Directive 2009/409/EEC). Features for which SACs and SPAs are designated are called Qualifying Interests (QIs) and Special Conservation Interests (SCIs) respectively. Collectively SCIs and QIs are referred to as conservation features.

The AA Screening report and NIS considers *in situ* and *ex situ* effect to conservation features of European sites (*i.e.* potential effects to conservation features within or away from European sites respectively).

The AA Screening and NIS report, and conclusions are summarised in **Section 10.4.3.1** and **Section 10.4.3.2** below.

10.4.3.1 AA Screening and NIS Summary

The European sites within 15km of the proposed development site as presented in **Figure 10.4** are:

- Buckronev – Brittas Dunes and Fen SAC (Site Code 000729) (4.9km north of development)
- Kilpatrick Sandhills SAC (Site Code 001742) (6.8km south)
- Slaney River Valley SAC (Site Code 000781) (13.3km west)
- Magharabeg Dunes SAC (Site Code 001766) (14.8km north)

The QIs of the SACs are listed in **Table 10.3**.

For the QIs, screening exercises were undertaken of the potential effects of the FRS development. The full screening exercises are presented in the AA Screening and NIS report. In summary, the screening exercises demonstrated that the potential effect of the FRS on the QI habitats and species could be screened out (discounted).

The AA screening also considered potential for effects to Otter *Lutra lutra* which listed as a QI for Wicklow Mountains SAC (Site Code 002122), which is located over 40km upstream of the FRS *via* the Avonmore, Avonbeg and Avoca rivers. A screening exercise undertaken demonstrated that the FRS would not result in potential *ex situ* effects to the QI of the SAC - effects could be screened out (discounted).

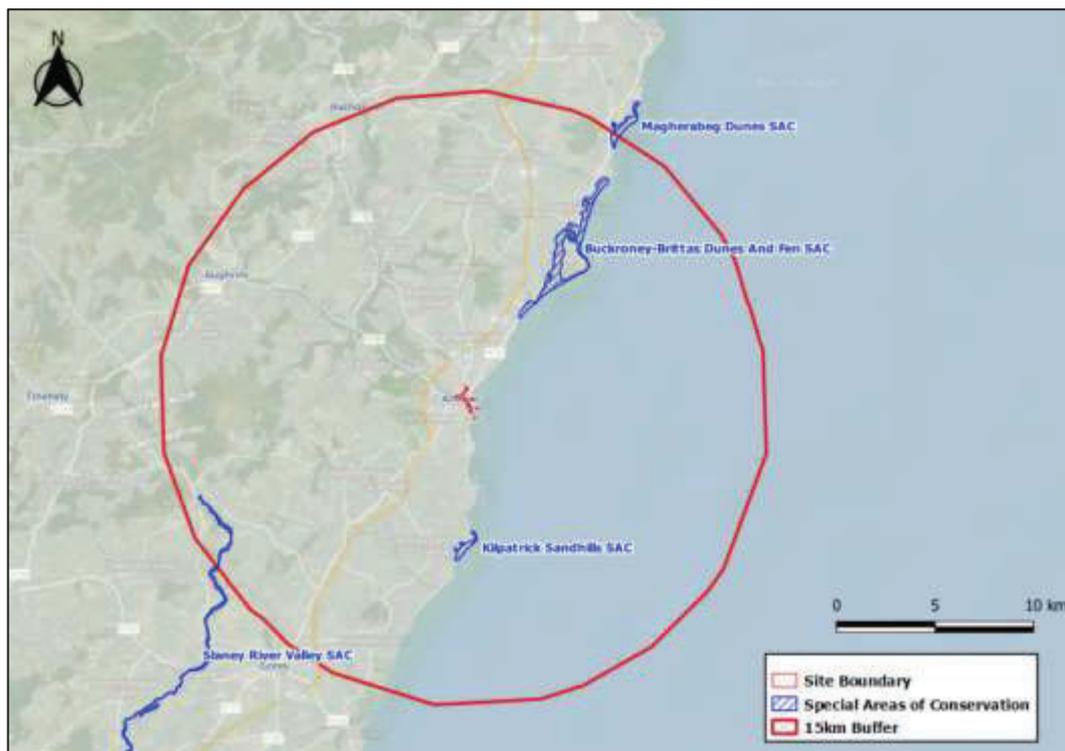


Figure 10.4: SACs within 15km of the proposed development

Table 10.3: QIs of SACs within 15km of the proposed FRS development

SAC	Qualifying Interests
Buckronee-Brittis Dunes and Fen SAC	Habitats
	1210 Annual vegetation of drift lines
	1220 Perennial vegetation of stony banks
	1410 Mediterranean salt meadows (<i>Juncetalia maritimi</i>)
	2110 Embryonic shifting dunes
	2120 Shifting dunes along the shoreline with <i>Ammophila arenaria</i> (white dunes)
	2130 Fixed coastal dunes with herbaceous vegetation (grey dunes)*
	2150 Atlantic decalcified fixed dunes (<i>Calluno-Ulicetea</i>)*
	2170 Dunes with <i>Salix repens</i> ssp. <i>argentea</i> (<i>Salicion arenariae</i>)
	2190 Humid dune slacks
7230 Alkaline fens	
Kilpatrick Sandhills SAC	Habitats
	1210 Annual vegetation of drift lines
	2110 Embryonic shifting dunes
	2120 Shifting dunes along the shoreline with <i>Ammophila arenaria</i> (white dunes)
	2130 Fixed coastal dunes with herbaceous vegetation (grey dunes)*
	2150 Atlantic decalcified fixed dunes (<i>Calluno-Ulicetea</i>)*
Slaney River Valley SAC	Habitats
	1130 Estuaries
	1140 Mudflats and sandflats not covered by seawater at low tide
	1330 Atlantic salt meadows (<i>Glauco-Puccinellietalia maritima</i>)

SAC	Qualifying Interests
	1410 Mediterranean salt meadows (<i>Juncetalia maritimi</i>)
	3260 Water courses of plain to montane levels with the <i>Ranunculion fluitantis</i> and <i>Callitriche-Batrachion</i> vegetation
	91A0 Old sessile oak woods with <i>Ilex</i> and <i>Blechnum</i> in the British Isles
	91E0 Alluvial forests with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i> (<i>Alno-Padion</i> , <i>Alnion incanae</i> , <i>Salicion albae</i>)*
	Species
	1365 Harbour Seal (<i>Phoca vitulina</i>)
	1355 Otter (<i>Lutra lutra</i>)
	1103 Twaite Shad (<i>Alosa fallax fallax</i>)
	1106 Salmon (<i>Salmo salar</i>)
	1099 River Lamprey (<i>Lampetra fluviatilis</i>)
	1029 Freshwater Pearl Mussel (<i>Margaritifera margaritifera</i>)
	1096 Brook Lamprey (<i>Lampetra planeri</i>)
	1095 Sea Lamprey (<i>Petromyzon marinus</i>)
Magherabeg Dunes SAC	1210 Annual vegetation of drift lines
	2110 Embryonic shifting dunes
	2120 Shifting dunes along the shoreline with <i>Ammophila arenaria</i> (white dunes)
	2130 Fixed coastal dunes with herbaceous vegetation (grey dunes)*
	2150 Atlantic decalcified fixed dunes (<i>Calluno-Ulicetea</i>)*
	7220 Petrifying springs with tufa formation (<i>Cratoneurion</i>)*

A total of 24 protected mobile SCI bird species designated for distant SPAs have been recorded in the vicinity of the proposed development area (see **Table 10.4**²⁰). For the SCI species, screening exercises of potential effects were undertaken. The screening exercises considered the likelihood of species from the SPAs to occur in the Arklow FRS development area and thereby be affected by project impact mechanisms (*i.e.* potential for *ex-situ* effects).

The assessments of the likelihood of the species from their associated SPAs to occur in the development area are based on species ecology (habitat preferences, feeding guilds, typical diet, foraging behaviour *etc.*) and maximum recorded foraging ranges. Of the 24 SCI species, 7 SCI species were brought forward to the NIS for further assessment of *ex situ* effects due to the loss of marsh habitat and in-river habitat. The 7 SCI species and SPAs brought forward to the NIS are presented in **Table 10.5**. Site Synopsis Reports for the SPAs are presented in **Appendix 10.5**.

Following a comprehensive evaluation of the potential direct, indirect and cumulative impacts, it was concluded in the NIS that following the implementation of mitigation the development does not pose a **risk of significant adverse *ex situ*** effects to the SCIs.

Table 10.4: SCIs of distant SPAs

Special Conservation Interest Species
A053 Mallard (<i>Anas platyrhynchos</i>)
A052 Teal (<i>Anas crecca</i>)
A059 Pochard (<i>Aythya ferina</i>)
A061 Tufted Duck (<i>Aythya fuligula</i>)
A067 Goldeneye (<i>Bucephala clangula</i>)
A229 Kingfisher (<i>Alcedo atthis</i>)
A017 Cormorant (<i>Phalacrocorax carbo</i>)
A001 Red-throated Diver (<i>Gavia stellata</i>)
A160 Curlew (<i>Numenius arquata</i>)
A130 Oystercatcher (<i>Haematopus ostralegus</i>)
A140 Golden Plover (<i>Pluvialis apricaria</i>)
A137 Ringed Plover (<i>Charadrius hiaticula</i>)
A142 Lapwing (<i>Vanellus vanellus</i>)
A028 Grey Heron (<i>Ardea cinerea</i>)
A169 Turnstone (<i>Arenaria interpres</i>)

²⁰ Further detail of the SCI bird species listed in **Table 10.4** is included in **Section 10.4.6** below.

Special Conservation Interest Species
A125 Coot (<i>Fulica atra</i>)
A004 Little Grebe (<i>Tachybaptus ruficollis</i>)
A183 Lesser Black-backed Gull (<i>Larus fuscus</i>)
A184 Herring Gull (<i>Larus argentatus</i>)
A179 Black-headed Gull (<i>Chroicocephalus ridibundus</i>)
A182 Common (or Mew) Gull (<i>Larus canus</i>)
A050 Wigeon (<i>Anas penelope</i>)
A043 Greylag Goose (<i>Anser anser</i>)
A395 Greenland White-fronted Goose (<i>Anser albifrons flavirostris</i>)

Table 10.5: SCIs and associated SPAs brought forward to NIS

Special Conservation Interest Species	Site (Site code) (Distance to development)
A160 Curlew (<i>Numenius arquata</i>)	Wexford Harbour and Slobs SPA (004076) (44.6km)
A130 Oystercatcher (<i>Haematopus ostralegus</i>)	Wexford Harbour and Slobs SPA (004076) (44.6km)
A142 Lapwing (<i>Vanellus vanellus</i>)	Cahore Marshes SPA (004143) (27.1km)
A183 Lesser Black-backed Gull (<i>Larus fuscus</i>)	Poulaphouca Reservoir SPA (004063) (41.2km)
	Wexford Harbour and Slobs SPA (004076) (44.6km)
	Lambay Island SPA (004069) (75.9km)
	Saltee Islands SPA (004002) (78.2km)
	Ballymacoda Bay SPA (004023) (152.6km)
	Ballycotton Bay SPA (004022) (163.8km)
	Cork Harbour SPA (004030) (169.6km)
A184 Herring Gull (<i>Larus argentatus</i>)	Ireland's Eye SPA (004117) (66.4km)
	Saltee Islands SPA (004002) (78.2km)
	Skerries Islands SPA (004122) (85.4km)
A179 Black-headed Gull (<i>Chroicocephalus ridibundus</i>)	The Murrough SPA (004186) (21.3km)
A050 Wigeon (<i>Anas penelope</i>)	The Murrough SPA (004186) (21.3km)
	Cahore Marshes SPA (004143) (27.1km)
	Wexford Harbour and Slobs SPA (004076) (44.6km)
	Tacumshin Lake SPA (004092) (69.3km)

10.4.3.2 Conclusion of NIS

The conclusion of the NIS was that the proposed development does not pose a risk of adversely affecting (either directly or indirectly) the integrity any European site, either alone or in combination with other plans or projects, and there is no reasonable scientific doubt in relation to this conclusion. Further details are provided in the NIS.

10.4.4 Protected Areas: Proposed Natural Heritage Area

Upstream of Arklow Bridge is Arklow Town Marsh pNHA (Site Code 001931). This pNHA includes the Avoca River channel, and the wetland habitats that extend northwards from the bank of the river.

The NPWS site synopsis report for the Arklow Town Marsh pNHA is included in **Appendix 10.6**. The Avoca River enters the Irish Sea at Arklow via a short riverine estuary that is largely contained by existing man-made sea and harbour walls.

A section of the pNHA (Arklow Marsh, north bank of Avoca River and river channel upstream of Arklow Bridge) is located within the planning boundary of the proposed development (see **Figure 10.5**).

The total area of the Arklow Town Marsh pNHA measures approximately 83.84ha and comprises part of the Avoca River and a large wetland area on the north bank (NPWS 2009²¹ see **Appendix 10.6**).

Habitats, flora and fauna of Arklow Town Marsh pNHA are described in detail in the sections below.

There are also two other pNHAs close by, one just to the north of Arklow Town, Arklow Sand Dunes (Site Code 001746) and the second *ca* 3km to the south of Arklow Town, Arklow Rock – Askintinny (Site Code 001745). Due to a lack of connectivity between the Avoca River and these two sites, they cannot be impacted by the proposed flood relief scheme in Arklow.

²¹ NPWS 2009. Site Synopsis Site Name: Arklow Town Marsh Site Code: 001931.
<https://www.npws.ie/protected-sites/nha>

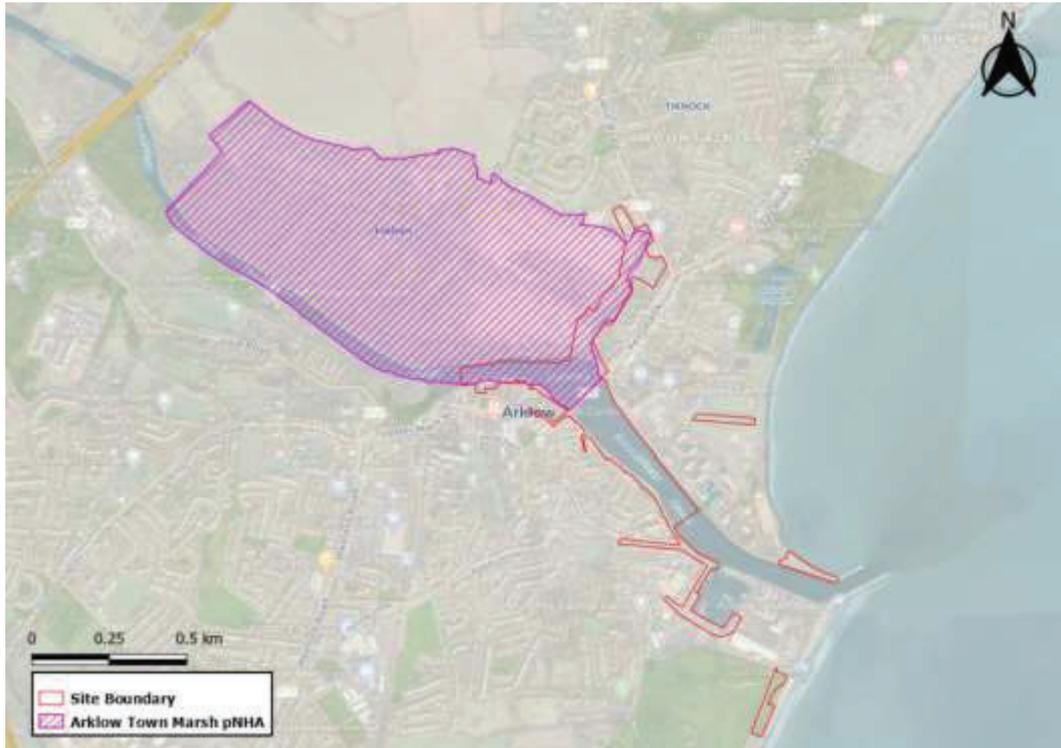


Figure 10.5: Arklow FRS planning boundary relative to the Arklow Town Marsh pNHA.

10.4.5 Habitats and Flora

10.4.5.1 Overview

A series of walkover habitat surveys have been conducted for the Arklow FRS development and Arklow WwTP project (see **Section 10.3.3.1**) along River Walk along the south bank of the river upstream of the bridge, at Arklow Town Marsh pNHA and along on the north bank upstream of Arklow Bridge and along North Quay and South Bank (downstream of Arklow Bridge) and at Arklow Bridge.

Walkover surveys have also been carried out at the locations proposed for construction compounds (SC1-SC6), shown on **Figures 10.2** and **10.3**. The habitat types are listed in **Table 10.6** and shown in **Drawing No 001** below.

Table 10.6: Habitats (Refer also to Habitat Mapping on Drawing No 001)

Habitat (Fossitt classification)	River Walk & South Bank	North Quay (downstream of bridge)	Arklow Bridge	Arklow Town Marsh pNHA	SC1	SC2	SC3	SC4	SC5	SC6 ²²
BC4 Flower beds and borders	✓	✓								
BL1 Stone walls and other stonework	✓	✓								
BL3 Buildings and artificial surfaces								✓		✓
CC1 Sea walls, piers and jetties									✓	
CW2 Tidal rivers/ FW2 Depositing lowland rivers ²³	✓	✓	✓	✓						
ED2 Spoil and bare ground	✓	✓								
ED3 Recolonising bare ground	✓	✓		✓						

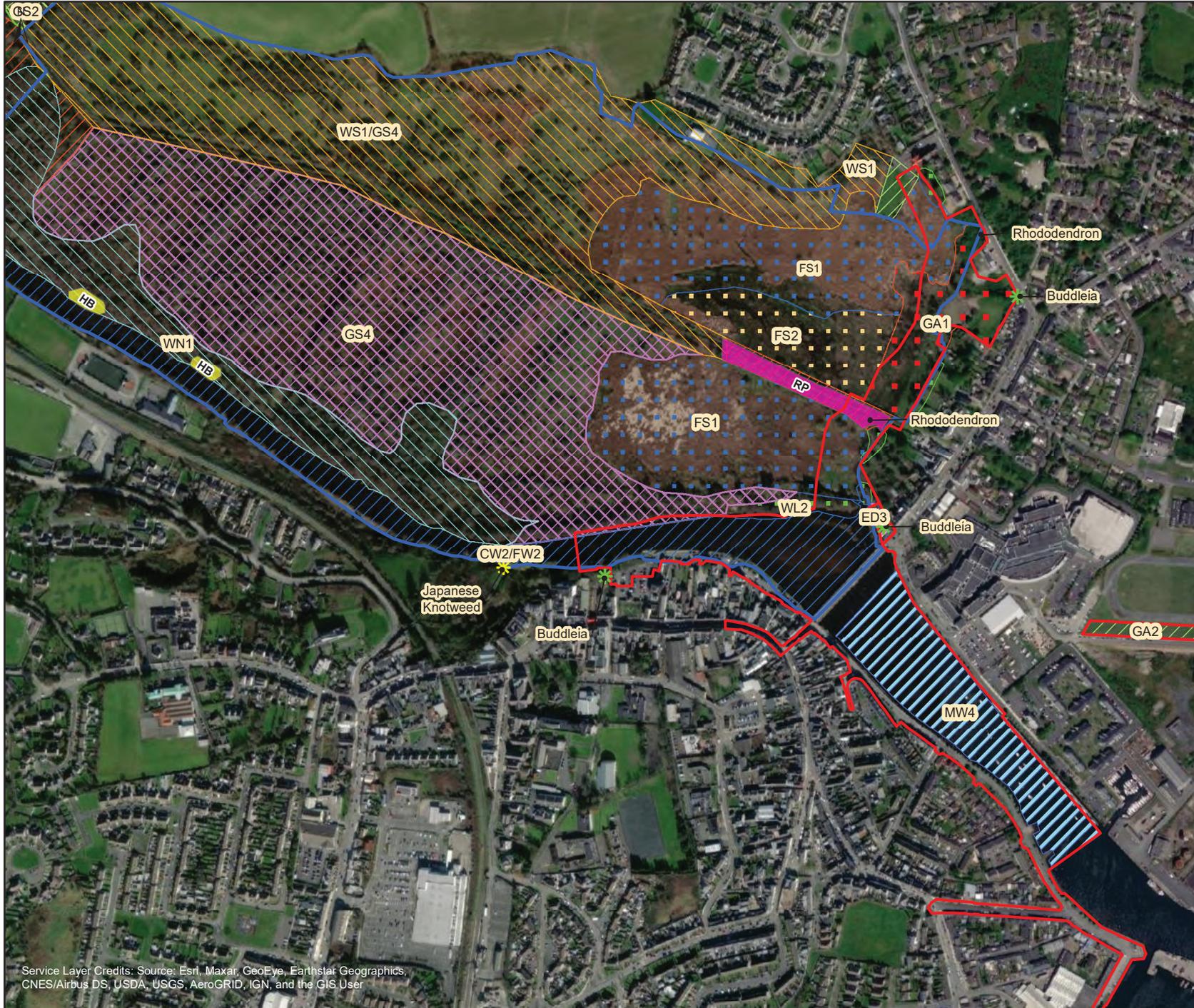
²² Moore's horsetail *Equisetum x moorei* initially identified at SC6. Boundary of SC6 was modified to avoid areas where *Equisetum x moorei* was previously recorded (see **Section 10.3.3.3** and **Appendix 10.1** for details).

²³ Includes vegetated islands and gravel bank areas located immediately upstream of the Arklow Bridge.

Habitat (Fossitt classification)	River Walk & South Bank	North Quay (downstream of bridge)	Arklow Bridge	Arklow Town Marsh pNHA	SC1	SC2	SC3	SC4	SC5	SC6 ²²
FS1 Reed and tall sedge swamp				✓						
FS2 Tall-herb swamp				✓						
FW4 Drainage ditches / FW3 Canals				✓						
GA1 Improved agricultural grassland / GS4 Wet grassland				✓	✓					
GA2 Amenity grassland	✓	✓				✓				✓
GM1 Marsh				✓						
GS4 Wet grassland				✓						
MW4 Estuaries	✓	✓	✓							
WL2 Treelines	✓	✓		✓						
WN1 Oak-birch-holly woodland				✓						
WS1 Scrub		✓		✓			✓			

Habitat (Fossitt classification)	River Walk & South Bank	North Quay (downstream of bridge)	Arklow Bridge	Arklow Town Marsh pNHA	SC1	SC2	SC3	SC4	SC5	SC6 ²²
WS1 Scrub / GS4 Wet Grassland				✓						
WS3 Ornamental non-native shrub	✓	✓		✓						
RP Rhododendron (<i>Rhododendron ponticum</i>)				✓	✓					
HB Himalayan balsam (<i>Impatiens glandulifera</i> ²⁴)				✓						
BD Butterfly-bush (<i>Buddleia davidii</i>)	✓				✓		✓			
JK Japanese Knotweed (<i>Fallopia japonica</i>)	✓									

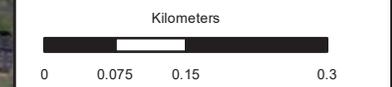
²⁴ The invasive species Himalayan balsam is recorded at three locations adjacent to the Avoca River within the Arklow Town Marsh pNHA (see Drawing No 001). These areas are located approximately 500m, 800m and 900m north west of the Arklow FRS planning boundary.



Legend

- Arklow FRS Boundary
- pNHA Boundary
- Invasive Species (Approximate location, do not rescale)
- HB Himalayan Balsam
- RP Rhododendron ponticum
- * Buddleia
- * Japanese Knotweed
- Habitat**
- CW2 Tidal rivers / FW2 Depositing lowland rivers
- ED3 Recolonising bare ground
- FS1 Reed and tall sedge swamps
- FS2 Tall-herb swamps
- GA1 Improved agricultural grassland / GS4 Wet land
- GA2 Amenity grassland
- GS2 Dry meadows and grassy verges
- GS4 Wet grassland
- MW4
- WL2 Treelines
- WN1 Oak-birch-holly woodland
- WS1 Scrub
- WS1 Scrub / GS4 Wet Grassland

D2	2021-04-16	LM	LG	FP
Issue	Date	By	Chkd	Appd



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Client
Wicklow County Council
Office of Public Works

Job Title
Arklow Flood Relief Scheme

Habitat and Invasive Species Survey

Scale at A4
1:8,000

Job No 605246-40	Drawing Status Issue
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Drawing No 10.6	Issue I1
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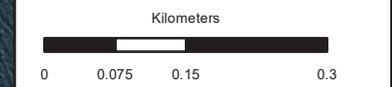
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User



Legend

- Arklow FRS Boundary
- pNHA Boundary
- Invasive Species (Approximate location, do not rescale)**
- HB Himalayan Balsam
- RP Rhododendron ponticum
- ✱ Buddleia
- ✱ Japanese Knotweed
- Habitat**
- CC1 Sea walls, piers and jetties
- CW2 Tidal rivers/FW2 Depositing lowland rivers
- ED3 Recolonising bare ground
- FS1 Reed and tall sedge swamps
- FS2 Tall-herb swamps
- GA1 Improved agricultural grassland / GS4 Wet land
- GA2 Amenity grassland
- GS4 Wet grassland
- MW4
- WL2 Treelines
- WN1 Oak-birch-holly woodland
- WS1 Scrub
- WS1 Scrub / GS4 Wet Grassland

D2	2021-04-16	LM	LG	FP
Issue	Date	By	Chkd	Appd



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Job Title
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Habitat and Invasive Species Survey

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Job No 605246-40	Drawing Status Issue
Drawing No 10.7	Issue I1

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

10.4.5.2 Arklow Town Marsh pNHA including North Bank and River channel

Arklow Town Marsh pNHA is a relatively large marsh area that is located north of the Avoca River on the perimeter of Arklow Town and is described as a good example of a relatively large wetland. A disused roadway from Shelton Abbey bisects the site from east to west. They also include a disused railway line.

Habitats within the pNHA that are overlapped by the planning boundary area include:

- Tidal rivers (CW2)/ Depositing lowland rivers (FW2)
- Treelines (WL2)
- Improved agricultural grassland (GA1)/ Wet grassland (GS4)
- Reed and large sedge swamps (FS1)
- Recolonising bare ground (ED3)
- Scrub (WS1)/ Wet grassland (GS4)
- Drainage ditch (FW4) and Canals (FW3)
- *Rhododendron ponticum* (RP)

Habitats within the pNHA outside of the planning boundary include:

- FS2 Tall-herb swamps FS2
- Wet grassland (GS4)
- Oak-birch-holly woodland (WN1)

Part of compound SC1 is located in the northeast corner of the pNHA. Habitats within compound SC1 are characterised as improved agricultural grassland (GA1) / Wet grassland (GS4).

Compound SC3 is located in the southeast of the pNHA and borders the Avoca River. Habitats with SC3 are Scrub (WS1), Recolonising bare ground (ED3), and Tidal rivers (CW2)/ Depositing lowland rivers (FW2).

The invasive species Butterfly-bush (*Buddleia davidii*) and Rhododendron were recorded at SC1 while Butterfly-bush was recorded at SC3. Further details of habitats within SC1 and SC3 is included in **Section 10.4.5.6** below.

Immediately upstream of Arklow Bridge, the river area includes a number of vegetated islands and a gravel bank area. This river area and features lie within the FRS planning boundary (see **Figure 10.1**).

What follows is a description of flora found within the pNHA.

The pNHA is a good example of a relatively large wetland and is the principal wetland area in Arklow.

The marsh area is dominated by Common Reed (*Phragmites australis*), with Creeping Bent (*Agrostis stolonifera*) and Common Valerian (*Valeriana officinalis*) common in places.

On the southern side, numerous scattered bushes of willow (*Salix spp.*) are growing among Common Reed, forming a scrub in places. Drier areas are characterised by large tussocks of Tufted Hair-grass (*Deschampsia caespitosa*). Other plants present include Soft Rush (*Juncus effusus*), Yellow Iris (*Iris pseudacorus*), Skullcap (*Scutellaria galericulata*), Lesser Pond-sedge (*Carex acutiformis*) and several other sedges (*Carex spp.*).

Wet grassy areas with extensive stands of Water Horsetail (*Equisetum fluviatile*) occur on the north-east margin, with Creeping Bent, Common Spike-rush (*Eleocharis palustris*), Meadowsweet (*Filipendula ulmaria*) and rushes (*Juncus articulatus* and *J. conglomeratus*) present.

Extensive areas of the marsh are dominated by Reeds (*Phragmites australis*) (see **Figure 10.6** below), with Creeping Bent Grass (*Agrostis stolonifera*) and Valerian (*Valeriana officinalis*) common in places. Other plants present include Soft Rush (*Juncus effusus*), Iris (*Iris pseudacorus*), Skullcap (*Scutellaria galericulata*), Lesser Pond-sedge (*Carex acutiformis*) and several other sedges (*Carex spp.*). The dominant aquatic plants include Branched Bur-reed (*Sparganium erectum*), Fool's-water-cress (*Apium nodiflorum*) and Reed Canary-grass (*Phalaris arundinacea*).



Figure 10.6: Reed beds and *Convolvulus* in Arklow Marsh pNHA.

On the south side of the marsh along the edge of the Avoca River, the river bank is densely colonised by mature trees including Ash (*Fraxinus excelsior*), Alder (*Alnus glutinosus*), Oak (*Quercus rober*), Pine (*Pinus sylvestris*), Sycamore (*Acer pseudoplatanus*), Birch (*Betula* spp.) and lower growing plants such as Gorse (*Ulex europaeus*), Hawthorn (*Crataegus monogyna*), Holly (*Ilex aequifolium*), Ferns (*Pteridium aquilinum*), Bramble (*Rubus fruticosus*), Ivy (*Hedera helix*) and Reeds (*Phragmites australis*) (see **Figure 10.7** below).



Figure 10.7: Tree line along the north bank of the Avoca River.

There are also numerous scattered specimens of Willow (*Salix* spp.) growing among reeds that form a dense scrub in places.

Drier areas of the site are characterized by large tussocks of Tufted Hair Grass (*Deschampsia caespitosa*). There are other plants found at the site including: include Soft Rush (*Juncus effusus*), Iris (*Iris pseudacorus*), Skullcap (*Scutellaria galericulata*), Lesser Pond Sedge (*Carex acutiformis*) and several other Sedges (*Carex* spp.).

The site also contains improved and wet grassland areas with extensive stands of Bulrush (*Typha latifolia*) and Water Horsetail (*Equisetum fluviatile*) that occur on the northeast margin (see **Figure 10.8** below), with Creeping Bent Grass (*Agrostis stolonifera*), Spike Rush (*Eleocharis palustris*), Meadowsweet (*Filipendula ulmaria*) and Rushes (*Juncus articulatus* and *J. conglomeratus*), Bulrush (*Typha latifolia*) and Iris (*Iris pseudacorus*) are also present.



Figure 10.8: Improved and wet grassland areas in the north-eastern area of the marsh area.

The northern part of this improved wet grassland has been recently cleared (see **Figure 10.9**).



Figure 10.9: Cleared ground at Site Compound 1 behind the Petrol Station on the Dublin Road with Willow and Pine.

Garden escapes in the marsh include Rhododendron, Dogwood, Buddleia and Lawson's Cypress (see **Figure 10.10** below showing Rhododendron within the marsh and **Figure 10.11** showing Lawson's Cypress). Further description of invasive species recorded is included **Section 10.4.5.8** below.



Figure 10.10: Rhododendron within the Arklow Marsh pNHA viewed from avenue and looking north.

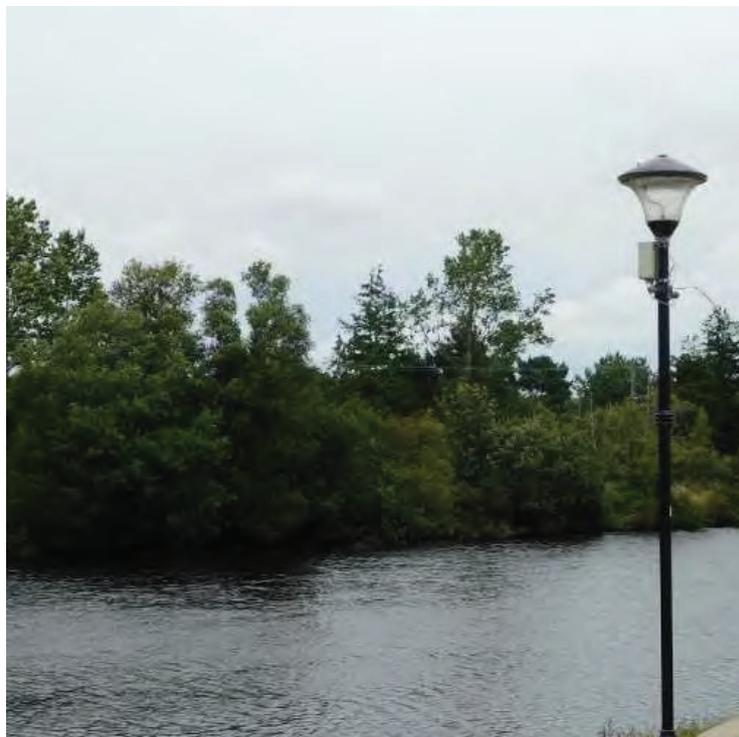


Figure 10.11: Lawson's Cypress on north bank of river within pNHA Arklow Marsh.

There have been recordings of Broad-leaved Cottongrass (*Eriophorum latifolium*) at the site but the NBDC website does not list the area for this species.

The Site Synopsis report for Arklow Town which was drafted in 1995, indicated that industrial air pollution was problematic in the Arklow area (NPWS 1995). At the time of writing the Site Synopsis, much of the willow at the site was defoliated. The effects of aerial pollution noted in the Site Synopsis are no longer apparent, with recovery and re-growth of willow within the marsh area and of trees on adjoining lands.

Existing impacts on the marsh include grazing and poaching by horses, periodic inundation by sea water during storm surge events, the presence of non-native garden escape plant species, historic impacts from both water and atmospheric pollution, infilling at its western end and historic drainage. Despite these impacts and its proximity to Arklow Town, it is a good example of a relatively large wetland.

10.4.5.3 River Walk

Habitats along this area and within the planning boundary include built areas, roads and foot paths (BL1 and BL3 *sensu* Fossitt), amenity grassland (GA2, *sensu* Fossitt, 2000), some planted mature trees *e.g.* Weeping Willow (*Salix babylonica*) and Sycamore (*Acer pseudoplatanus*) and tidal river/ lowland depositing river (CW2/FW2 *sensu* Fossitt, 2000). Refer also to **Table 10.1** and **Drawing No 001**. Japanese Knotweed (*Fallopia japonica*) and Buddleia were recorded along the River Walk area outside of the planning boundary.



Figure 10.12: Willow, Sycamore and Alder in the Riverbank area.



Figure 10.13: Habitats at the Riverbank location showing foot paths, roads, riverbank and trees. Feral geese, Mallard, Starling and Collard doves are also imaged.

10.4.5.4 South Bank

Habitats within the planning boundary along the western half of this area include built areas, roads and foot paths (BL1 and BL3 *sensu* Fossitt) and estuaries (MW4 *sensu* Fossitt, 2000) while the eastern half as far as the marina include built areas, roads and foot paths (BL1 and BL3 *sensu* Fossitt, estuaries (MW4 *sensu* Fossitt, 2000), amenity grassland planted with Sycamore, Cherry, Cordilines and Daffodils (GA2, *sensu* Fossitt, 2000) and sea walls (CC1 *sensu* Fossitt, 2000). No invasive species were recorded during walkover surveys in this location. Refer also to **Table 10.6** and **Drawing No 001**.

10.4.5.5 North Quay (downstream of bridge)

Habitats within the planning boundary on the North Quay (downstream of bridge) include estuaries (MW4 *sensu* Fossitt, 2000), buildings and artificial surfaces such as roads, footpaths (BL3 *sensu* Fossitt, 2000), a small marina and a works area for Arklow Harbour Commissioners at its eastern end (CC1 *sensu* Fossitt, 2000). Invasive species were not recorded during walkover surveys in this area. Refer also to **Table 10.6**.

10.4.5.6 Site Compounds

The location of the site compounds are shown on **Figures 10.2** and **10.3** above. Habitats listed with the site compounds are also listed in **Table 10.6** and shown *Site Compound 1*

This Site Compound is located behind the Circle Garage on the south side of the Dublin Road (R772). Part of the compound is located in the northeast of Arklow Town Marsh pNHA. The habitat is improved agricultural grassland (GA1) / wet grassland (GS4) (*sensu* Fossitt, 2000) and a part of it has been recently stripped of plants. Mature trees include Scots Pine and Willow. It is grazed and poached by horses. The invasive species Butterfly-bush (*Buddleia davidii*) and Rhododendron were recorded at SC1.

Site Compound 2

This Site Compound is located near the Leisure Centre at Ferrybank. The habitat is amenity grassland (GA2 *sensu* Fossitt, 2000).

Site Compound 3

This Site Compound is located in the southeast of Arklow Town Marsh pNHA to the northwest of the roundabout on the north side of the Arklow River. The habitats present are scrub (WS1), and tidal river/ depositing lowland river (CW2/FW2 *sensu* Fossitt, 2000). Species recorded in WS1 include Willow, Bramble, Buddleia, Apple and Ragwort.

Site Compound 4

This Site Compound is located on the south bank of the Avoca River and west of Arklow Bridge along River Walk. It is used for car parking (Main St car park) with no plant species present (BL3 *sensu* Fossitt, 2000).

Site Compound 5

This Site Compound is located at the eastern end of North Quay and is bounded to the south by the Avoca Estuary and to the north by the Irish Sea. It is used by Arklow Port as a storage area for port equipment. It falls under the definition of sea wall, piers and jetties (CC1 *sensu* Fossitt).

Site Compound 6

This is a narrow, triangular strip of grassland between South Beach and the Arklow Gold Club. It can be described as amenity grassland (GA2) *sensu* Fossitt, 2000). Curtis and Wilson (2007) recorded *Equisetum x moorei* in the area. In December 2020, AQUAFAC T re-surveyed the area for this species but no *Equisetum x moorei* plants were recorded. AQUAFAC T recorded *Equisetum telmateia* in the same area. Refer to **Appendix 10.1** for details. Following the December 2020 survey, the boundary of SC6 was reduced to avoid directly impacting on this area where *Equisetum x moorei* was recorded in 2007. Compound SC6 also comprised a car park (BL3 *sensu* Fossitt, 2000).

10.4.5.7 Bryophytes at Arklow Bridge

Denyer Ecology carried out a survey of bryophytes in the area around Arklow Bridge in November 2020. A total of 19 species was recorded and all were all mosses with no liverworts having been recorded. The full details of the survey are provided in **Appendix 10.7**.

Bryophyte diversity is relatively low for a large old stone bridge and lowland river in Ireland. Much of the stonework did not support bryophytes and it may be that either the bridge has been cleaned in the past or the stone is smooth and offers little hold potential for mosses. The top stonework of the bridge has been replaced with concrete and this was dominated by a few species typical of urban, calcareous, relatively smooth surfaces. There were few aquatic mosses, and this may be due to the tidal nature of the river in this location and slightly brackish water.

Four species were recorded from Arklow Bridge that have less than 10 records within Co. Wicklow (Vice County H20). These are *Didymodon nicholsonii*, *Leptodictyum riparium*, *Syntrichia laevipila* and *Syntrichia montana*. These are species of lowland urban or lowland river habitats, and all are widespread nationally and it is considered that they are under-recorded within Co. Wicklow, rather than genuinely rare. *Didymodon nicholsonii* was recorded upstream of the bridge; *Leptodictyum riparium* from both sides of the river downstream of the bridge and both *Syntrichia* species from side concrete at the very western end of the bridge, near the roundabout.

The main habitats for bryophytes within the survey area were the concrete on top of the bridge (above high tide level), stonework up and downstream of the bridge (at high tide level) and (to a lesser extent) the bridge stonework between high and low tide level (aquatic moss species). The bridge and adjacent habitats had relatively low bryophyte species diversity with a total of 19 mosses recorded.

None of these species are nationally rare or listed on the Flora (Protection) Order.

As noted above four species which have less than 10 records within County Wicklow were recorded. However, these are widespread and common species, which are likely to be under-recorded in Co. Wicklow. It is considered that the bridge does not support a bryophyte flora of conservation interest. However, it does support moderate to high bryophyte cover in some areas (e.g. the top concrete).

10.4.5.8 Invasive Alien Plant Species

Within the planning boundary two species of invasive plants have been recorded during walk-over surveys undertaken for the Arklow FRS development and Arklow WwTP project.

The species are Butterfly-bush (*Buddleia davidii*) and Rhododendron (*Rhododendron ponticum*). Butterfly-bush was recorded at SC1 and SC3. An extensive stand of Rhododendron was recorded in the eastern part of the pNHA and overlaps the planning boundary.

Outside of the planning boundary Himalayan balsam (*Impatiens glandulifera*) was recorded at three locations along the north bank of the Avoca River. Japanese Knotweed (*Fallopia japonica*) was also previously recorded, but its location was outside the planning boundary area.

The NBDC reports²⁵ the invasive plant species Japanese Knotweed (*Fallopia japonica*) and Rhododendron (*Rhododendron ponticum*) within reporting grid numbers T27G, T27H, T27L, T27M. The location of these records relative the Arklow FRS site boundary and Arklow Town pNHA boundary are shown in Figure 10.14.

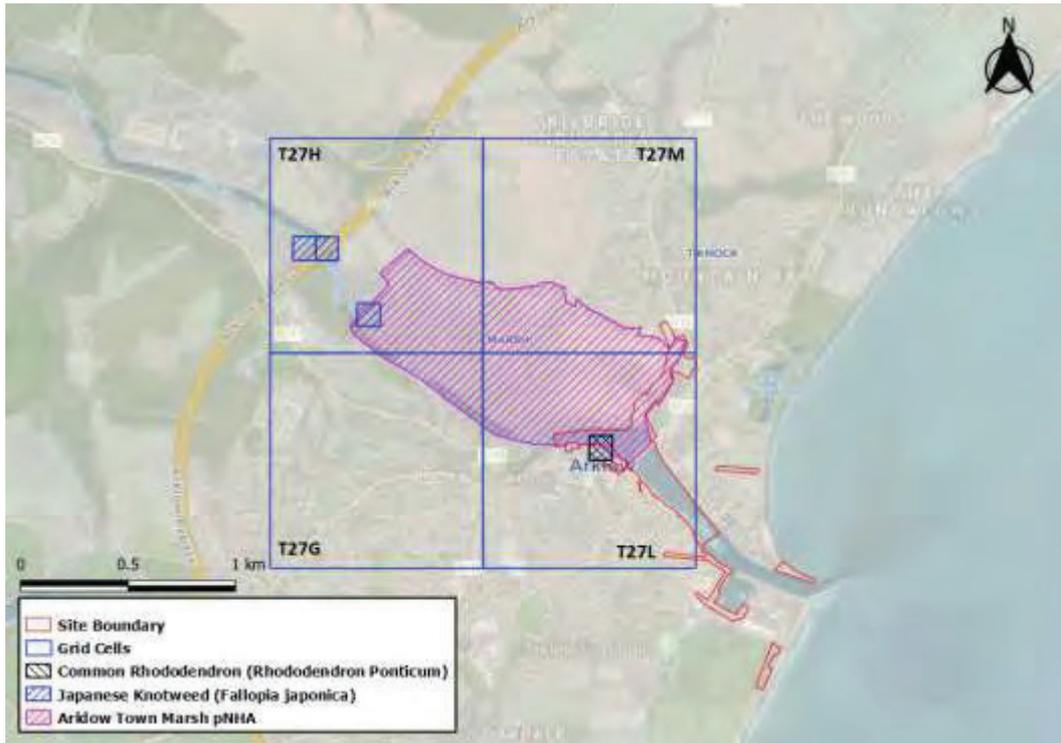


Figure 10.14: NBDC record of invasive species within grid squares T27G, T27H, T27L, and T27M, relative to Arklow FRS site boundary and Arklow Town pNHA

10.4.6 Birds

10.4.6.1 Bird Surveys at Arklow - 2016 – 2018

As part of the Arklow WwTP project, a series of 26 bird surveys were undertaken over 3 survey areas between September 2016 and February 2018 (Arup, 2018a, b). The survey areas were the Avoca River and Estuary, Arklow Pond, and nearby coastal waters. The surveys recorded a total of 22 waterbird species along the Avoca River and Estuary, at Arklow Pond, and in coastal waters, where one seabird species, Guillemot, was recorded.

²⁵ <http://maps.biodiversityireland.ie> (accessed 15/04/2021)

Gulls were the most numerous waterbirds and were recorded in all three survey areas (see **Table 10.7**).

Most of the gull use of the Avoca River and estuary was by birds roosting, bathing and preening; gulls use the gravel banks upstream of the Arklow Bridge to roost on, and bathe and preen in the fresh water of the river. Single Kingfishers, listed in Annex I of the Birds Directive, were recorded on three separate occasions, flying along the northern bank of the Avoca River upstream of Arklow Bridge. The riverbanks within the Arklow FRS planning area are not suitable for Kingfisher nesting as Kingfishers prefer vertical or near vertical banks at least 1-2m high²⁶.

House Sparrow, Starling, Magpie and Wood Pigeon were recorded as present along River Walk and South Bank, and as breeding in the general area. Grey Wagtail and Pied Wagtail were consistently present along the Avoca River banks and feeding on exposed gravels.

Breeding birds recorded include Meadow Pipit and Grey Wagtail, Red listed as breeding birds of Conservation Concern in Ireland, and Barn Swallow, Robin, Stonechat, Starling, House Sparrow and Linnet, which are Amber listed. With regard to Starling, Arklow Marsh is known to support a large roost for this species.

Of the species identified during the surveys, 17 species are listed as SCIs of Irish SPAs some of which are species for which neighbouring SPAs are designated. The 17 species are highlighted in bold text in **Table 10.4**. The stony gravel bank that exposes before the mid ebbing tide just upstream of the bridge is used as a roosting site by Herring Gulls, Black headed Gulls, Greater Black backed and Lesser Black backed Gulls and by Cormorant, Mute swan, Mallard, Heron and feral geese that are present in the estuary (see **Figure 10.15** below).

There are a number of tree stumps and low lying branches on the northern side of the river upstream of the bridge on which cormorant roost and downstream of the bridge, on the southern side of the river, there are a number of rocks that cormorant also use as perches (see **Figure 10.16** below).

²⁶ Cummins et al., 2010. Assessment of the distribution and abundance of Kingfisher *Alcedo atthis* and other riparian birds on six SAC river systems in Ireland. A report commissioned by the National Parks and Wildlife Service and prepared by BirdWatch Ireland.

Table 10.7: Peak numbers of waterbirds recorded during baseline surveys at Arklow. Special Conservation Interest species of Irish Special Protection Areas highlighted in bold

Species	Birds Directive Annex			Special Conservation Interest species of Irish Special Protection Areas	Birds of Conservation Concern in Ireland (BoCCI) ²⁷ . Breeding = b, wintering =w)	Shoreline and coastal waters ²⁸	Avoca River estuary	Arklow Pond ²⁹
	I	II	III					
Black Headed Gull (<i>Chroicocephalus ridibundus</i>)	-	Yes	-	Yes – 19 SPAs	Red (b)	67	512	101
Common or Mew Gull (<i>Larus canus</i>)	-	Yes	-	Yes – 21 SPAs	Amber (b)	21	50	-
Common Sandpiper (<i>Actitis hypoleucos</i>)	-	-	-	-	Amber (b)	-	1	-
Coot (<i>Fulica atra</i>)	-	Yes	Yes	Yes – 12 SPAs	Amber (b/w)	-	-	1
Cormorant <i>Phalacrocorax carbo</i>	Yes	-	-	Yes – 22 SPAs	Amber (b/w)	13	9	-
Great Black-backed (Gull <i>Larus marinus</i>)	-	Yes	-	-	Amber (b)	4	40	-
Greenland White-fronted (Goose <i>Anser albifrons flavirostris</i>)	-	-	-	Yes – 29 SPAs	Amber (w)	-	1	1
Grey Heron <i>Ardea cinerea</i>	-	-	-	Yes – 4 SPAs	-	-	3	-
Greylag Goose (feral) (<i>Anser anser</i>)	-	Yes	-	Yes – 8 SPAs	-	-	43	29
Black Guillemot (<i>Cephus grylle</i>)	-	-	-	-	-	4	-	-
Herring Gull (<i>Larus argentatus</i>)	-	Yes	-	Yes – 18 SPAs	Red (b)	150	390	2
Kingfisher (<i>Alcedo atthis</i>)	Yes	-	-	Yes – 2 SPAs	Amber (b)	-	1	-

²⁷ Colhoun K. and Cummins, S. 2013 Birds of Conservation Concern in Ireland 2014-19. Irish Birds 9:523-544

²⁸ Shoreline and coastal waters lie outside of the FRS planning boundary. No impacts predicted.

²⁹ Arklow Pond lies outside of the FRS planning boundary. No impacts are predicted.

Species	Birds Directive Annex			Special Conservation Interest species of Irish Special Protection Areas	Birds of Conservation Concern in Ireland (BoCCI) ²⁷ . Breeding = b, wintering =w)	Shoreline and coastal waters ²⁸	Avoca River estuary	Arklow Pond ²⁹
	I	II	III					
Lesser Black-backed Gull (<i>Larus fuscus</i>)	-	Yes	-	Yes – 14 SPAs	Amber (b)	3	10	-
Little Grebe (<i>Tachybaptus ruficollis</i>)	-	-	-	Yes – 6 SPAs	Amber (b/w)	-	-	4
Mallard (<i>Anas platyrhynchos</i>)	-	Yes	Yes	Yes – 9 SPAs	-	-	49	51
Mediterranean Gull (<i>Larus melanocephalus</i>)	Yes	-	-	-	Amber (b)	3	-	-
Moorhen (<i>Gallinula chloropus</i>)	-	Yes	-	-	-	-	4	5
Mute Swan (<i>Cygnus olor</i>)	-	-	-	-	Amber (b/w)	-	2	6
Oystercatcher (<i>Haematopus ostralegus</i>)	-	Yes	-	Yes – 16 SPAs	Amber (b/w)	3	-	-
Red-throated Diver (<i>Gavia stellata</i>)	Yes	-	-	Yes – 6 SPAs	Amber (b)	1	-	-
Ringed Plover (<i>Charadrius hiaticula</i>)	-	-	-	Yes – 15 SPAs	-	1	-	-
Teal (<i>Anas crecca</i>)	-	Yes	Yes	Yes – 21 SPAs	Amber (b/w)	-	-	1
Turnstone (<i>Arenaria interpres</i>)	-	-	-	Yes – 11 SPAs	-	12	12	-



Figure 10.15: Exposed gravel bank with roosting gulls.

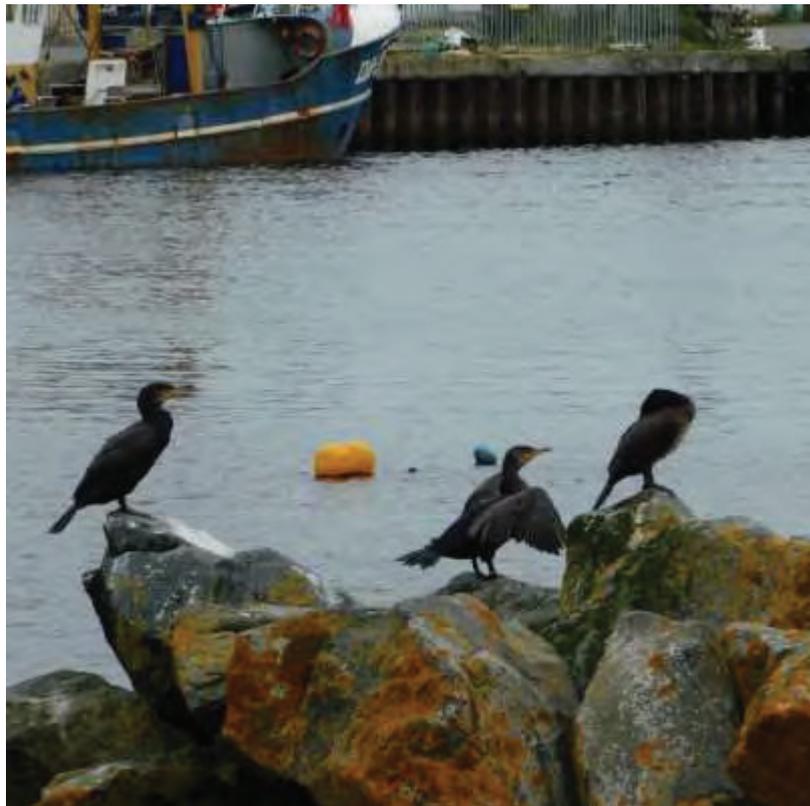


Figure 10.16: Perching cormorant east of the Arklow Bridge.

10.4.6.2 NBDC Bird Records

The planning boundary for the proposed FRS overlaps part of the Arklow Marsh pNHA (see **Figure 10.17**).

The Arklow Marsh pNHA lies within four NBDC 2km² reporting grid squares (T27G, T27H, T27L and T27M) (see **Figure 10.17**).

The NBDC reports³⁰ a total of 83 species of bird within T27G, T27H, T27L, T27M (see **Table 10.8**) of which 19 are listed as SCIs of Irish SPAs (see

Table 10.9).

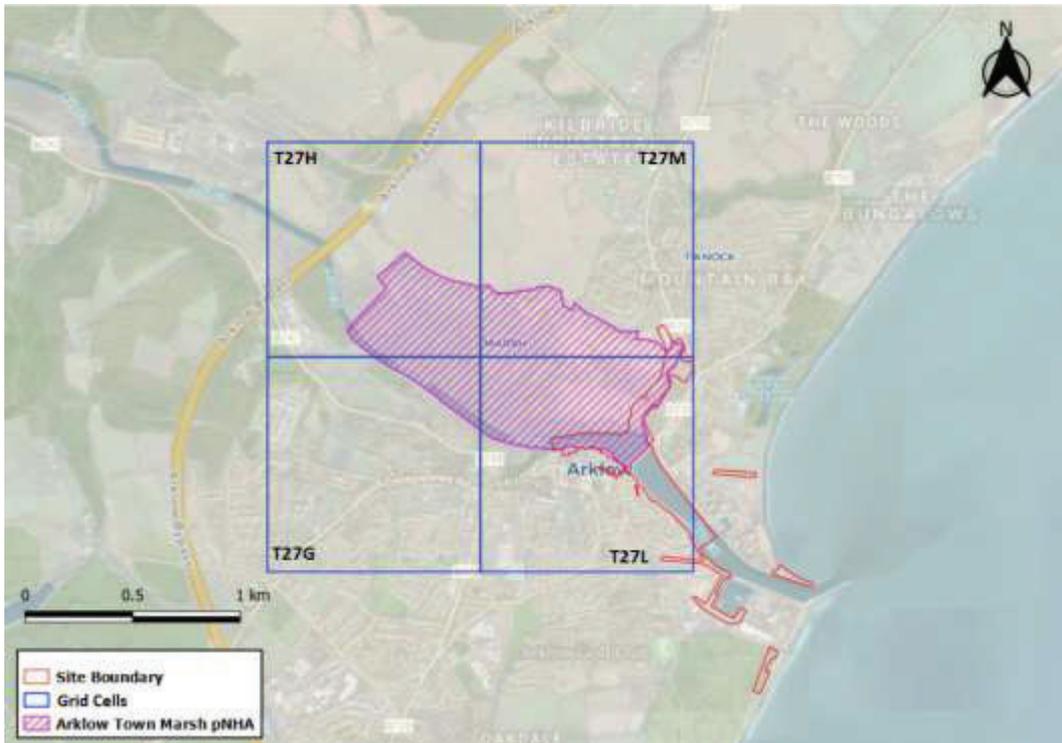


Figure 10.17: Planning boundary relative to grid squares T27G, T27H, T27L, and T27M and Arklow Town pNHA.

³⁰ <http://maps.biodiversityireland.ie> (accessed 15/04/2021)

Table 10.8: Bird species recorded with grid squares T27G, T27H, T27L, and T27M

Species – (Special Conservation Interest species of Irish Special Protection Areas highlighted in bold)		
Barn Swallow (<i>Hirundo rustica</i>)	Hedge Accentor (<i>Prunella modularis</i>)	Red Kite (<i>Milvus milvus</i>)
Black Kite (<i>Milvus migrans</i>)	Herring Gull (<i>Larus argentatus</i>)	Red-rumped Swallow (<i>Cecropis daurica</i>)
Black-billed Magpie (<i>Pica pica</i>)	Hooded Crow (<i>Corvus cornix</i>)	Reed Bunting (<i>Emberiza schoeniclus</i>)
Blackbird (<i>Turdus merula</i>)	House Martin (<i>Delichon urbicum</i>)	Reed Warbler (<i>Acrocephalus scirpaceus</i>)
Blackcap (<i>Sylvia atricapilla</i>)	House Sparrow (<i>Passer domesticus</i>)	Robin (<i>Erithacus rubecula</i>)
Black-headed Gull (<i>Larus ridibundus</i>)	Iceland Gull (<i>Larus glaucoides</i>)	Rook (<i>Corvus frugilegus</i>)
Blue Tit (<i>Cyanistes caeruleus</i>)	Jackdaw (<i>Corvus monedula</i>)	Rosy Starling (<i>Sturnus roseus</i>)
Bullfinch (<i>Pyrrhula pyrrhula</i>)	Kingfisher (<i>Alcedo atthis</i>)	Sand Martin (<i>Riparia riparia</i>)
Buzzard (<i>Buteo buteo</i>)	Laughing Gull (<i>Larus atricilla</i>)	Sedge Warbler (<i>Acrocephalus schoenobaenus</i>)
Chaffinch (<i>Fringilla coelebs</i>)	Lesser Black-backed Gull (<i>Larus fuscus</i>)	Siskin (<i>Carduelis spinus</i>)
Chiffchaff (<i>Phylloscopus collybita</i>)	Lesser Redpoll (<i>Carduelis cabaret</i>)	Sky Lark (<i>Alauda arvensis</i>)
Coal Tit (<i>Periparus ater</i>)	Lesser Whitethroat (<i>Sylvia curruca</i>)	Snipe (<i>Gallinago gallinago</i>)
Collared Dove (<i>Streptopelia decaocto</i>)	Linnet (<i>Carduelis cannabina</i>)	Song Thrush (<i>Turdus philomelos</i>)
Coot (<i>Fulica atra</i>)	Little Egret (<i>Egretta garzetta</i>)	Sparrowhawk (<i>Accipiter nisus</i>)
Curlew (<i>Numenius arquata</i>)	Little Grebe (<i>Tachybaptus ruficollis</i>)	Starling (<i>Sturnus vulgaris</i>)
Goldcrest (<i>Regulus regulus</i>)	Long-tailed Tit (<i>Aegithalos caudatus</i>)	Stonechat (<i>Saxicola torquata</i>)
Golden Oriole (<i>Oriolus oriolus</i>)	Mallard (<i>Anas platyrhynchos</i>)	Swift (<i>Apus apus</i>)
Golden Plover (<i>Pluvialis apricaria</i>)	Meadow Pipit (<i>Anthus pratensis</i>)	Treecreeper (<i>Certhia familiaris</i>)
Goldeneye (<i>Bucephala clangula</i>)	Common (or Mew) Gull (<i>Larus canus</i>)	Tufted Duck (<i>Aythya fuligula</i>)
Goldfinch (<i>Carduelis carduelis</i>)	Mistle Thrush (<i>Turdus viscivorus</i>)	Water Rail (<i>Rallus aquaticus</i>)

Species – (Special Conservation Interest species of Irish Special Protection Areas highlighted in bold)		
Grasshopper Warbler (<i>Locustella naevia</i>)	Montagu's Harrier (<i>Circus pygargus</i>)	White Wagtail (<i>Motacilla alba</i>)
Great Black-backed Gull (<i>Larus marinus</i>)	Moorhen (<i>Gallinula chloropus</i>)	Whitethroat (<i>Sylvia communis</i>)
Great Cormorant (<i>Phalacrocorax carbo</i>)	Mute Swan (<i>Cygnus olor</i>)	Wigeon (<i>Anas penelope</i>)
Great Spotted Woodpecker (<i>Dendrocopos major</i>)	Northern Lapwing (<i>Vanellus vanellus</i>)	Willow Warbler (<i>Phylloscopus trochilus</i>)
Great Tit (<i>Parus major</i>)	Oystercatcher (<i>Haematopus ostralegus</i>)	Winter Wren (<i>Troglodytes troglodytes</i>)
Greenfinch (<i>Carduelis chloris</i>)	Pheasant (<i>Phasianus colchicus</i>)	Wood Pigeon (<i>Columba palumbus</i>)
Grey Heron (<i>Ardea cinerea</i>)	Pochard (<i>Aythya ferina</i>)	Woodcock (<i>Scolopax rusticola</i>)
Greylag Goose (<i>Anser anser</i>)	Raven (<i>Corvus corax</i>)	-

Table 10.9: SCI bird species recorded with grid squares T27G, T27H, T27L, and T27M

Species	Birds Directive Annex			Special Conservation Interest species of Irish Special Protection Areas	Birds of Conservation Concern in Ireland (BoCCI) ³¹ . Breeding = b, wintering =w)
	I	II	III		
Black Headed Gull (<i>Chroicocephalus ridibundus</i>)	-	Yes	-	Yes – 19 SPAs	Red (b)
Coot (<i>Fulica atra</i>)	-	Yes	Yes	Yes – 12 SPAs	Amber (b/w)
Curlew (<i>Numenius arquata</i>)	-	Yes	-	Yes – 19 SPAs	-
Golden Plover (<i>Pluvialis apricaria</i>)	Yes	Yes	Yes	Yes – 10 SPAs	-
Goldeneye (<i>Bucephala clangula</i>)	-	Yes	-	Yes – 6 SPAs	-
Cormorant (<i>Phalacrocorax carbo</i>)	Yes	Yes	-	Yes – 22 SPAs	Amber (b/w)
Grey Heron (<i>Ardea cinerea</i>)	-	-	-	Yes – 4 SPAs	-

³¹ Colhoun K. and Cummins, S. 2013 Birds of Conservation Concern in Ireland 2014-19. Irish Birds 9:523-544

Species	Birds Directive Annex			Special Conservation Interest species of Irish Special Protection Areas	Birds of Conservation Concern in Ireland (BoCCI) ³¹ . Breeding = b, wintering =w)
	I	II	III		
Greylag Goose (<i>Anser anser</i>)	-	Yes	-	Yes – 8 SPAs	-
Herring Gull (<i>Larus argentatus</i>)	-	Yes	-	Yes – 18 SPAs	Red 9b)
Kingfisher (<i>Alcedo atthis</i>)	Yes	-	-	Yes – 2 SPAs	Amber (b)
Lesser Black-backed Gull (<i>Larus fuscus</i>)	-	Yes	-	Yes – 14 SPAs	Amber (b)
Little Grebe (<i>Tachybaptus ruficollis</i>)	-	-	-	Yes – 6 SPAs	Amber (b/w)
Mallard (<i>Anas platyrhynchos</i>)	-	Yes	Yes	Yes – 9 SPAs	-
Common or Mew Gull (<i>Larus canus</i>)	-	Yes	-	Yes – 21 SPAs	Amber (b)
Northern Lapwing (<i>Vanellus vanellus</i>)	-	Yes	-	Yes – 23 SPAs	Amber (b/w)
Oystercatcher (<i>Haematopus ostralegus</i>)	-	Yes	-	Yes – 16 SPAs	Amber (b/w)
Pochard (<i>Aythya ferina</i>)	-	Yes	Yes	Yes – SPAs	Red (w)
Tufted Duck (<i>Aythya fuligula</i>)	-	Yes	Yes	Yes – 11 SPAs	Red (w)
Wigeon (<i>Anas penelope</i>)	-	Yes	Yes	Yes – 25 SPAs	Red (w)

10.4.6.3 Bird Survey at Arklow Town Marsh pNHA - 2017

The bird survey Arklow Town March pNHA comprised three early morning surveys carried out between April and May 2017. Birds present were recorded based on a combination of visual sightings and identification of calls. The results of the surveys are given in **Table 10.10**.

Table 10.10: Bird species recorded

Species	Breeding status ¹	Frequency in site ²
Blackbird	Probable breeding	Frequent
Blackcap	Probable breeding	Occasional
Blue Tit	Probable breeding	Occasional
Chaffinch	Probable breeding	Occasional
Chiffchaff	Probable breeding	Occasional
Collared Dove	Probable breeding	Occasional
Dunnock	Probable breeding	Infrequent
Goldcrest	Probable breeding	Infrequent
Goldfinch	Probable breeding	Occasional
Great Tit	Probable breeding	Occasional
Grey Heron	Non-breeding	Occasional
House Sparrow	Probable breeding	Infrequent
Jackdaw	Probable breeding	Infrequent
Magpie	Probable breeding	Occasional
Mallard	Probable breeding	Occasional
Moorhen	Probable breeding	Occasional
Pheasant	Probable breeding	Occasional
Robin	Probable breeding	Occasional
Sedge Warbler	Probable breeding	Frequent
Snipe	Probable breeding	Occasional
Song Thrush	Probable breeding	Infrequent
Teal	Probable breeding	Infrequent
Willow Warbler	Probable breeding	Occasional
Woodpigeon	Probable breeding	Frequent
Wren	Probable breeding	Frequent
Starling	Probable breeding	Infrequent

1. Breeding status is based on the categories in the Bird Atlas 2007-11 (Balmer et al. 2013)

2. Frequency is based on the number of registrations recorded in all visits

10.4.7 Amphibians

The NBDC has records of the Common Frog (*Rana temporaria*) for within the Arklow Town area while records of Newt (*Lissotriton vulgaris*) are from *ca* 8km up river of the town. While Common Frog and Newt were not observed during the walkover survey, it is highly likely that the species are present in the area. In particular, vegetation and marsh habitats adjacent to the Avoca River and within the Arklow Town Marsh pNHA are likely to support these species. As the species are fairly widespread in Ireland and the potential for impact on both species is considered to be low, neither species are considered further.

10.4.8 Bats

Bat surveys undertaken in 2016 and 2017 as part of the Arklow WwTP project recorded four Habitats Directive Annex IV species bat species along the Arklow Bridge, Avoca River corridor, Arklow Town Marsh pNHA, and at Arklow Pond. The species recorded are:

- Common Pipistrelle (*Pipistrellus pipistrellus*)
- Soprano Pipistrelle (*Pipistrellus pygmaeus*)
- Leisler's Bat (*Nyctalus leisleri*)
- Daubenton's Bat (*Myotis daubentonii*)

In 2020 a bat survey undertaken to inform the application to NPWS for a bat derogation licence required for the proposed works at Arklow Bridge identified Daubenton's bat at the Bridge.

The full details of the surveys are provided in **Appendix 10.2** and **Appendix 10.3**. A summary of the survey results are provided below.

10.4.8.1 Bat roosts affected by the Arklow Flood Relief Scheme proposal

A roost site of Daubenton's bat (*Myotis daubentonii*) is located within Arklow Bridge arches.

Bats are using Arklow Bridge as a roost site (western side of the southern end of the bridge). This is likely to be most often individuals roosting rather than a maternity roost and it is a transitional roost.

On 17th November 2020, a single Daubenton's bat was noted resting on the wing wall of the older bridge section at the most southern arch of the bridge (closest to the town centre) close to the bridge expansion (western side of bridge) on November 17th, 2020. This bat was not seen to become active as it was not visible from the riverbank but signals on both detectors indicate that a Daubenton's bat flew past at approximately 10.20 hours. There was evidence gathered in August 2017 that bats were availing of crevices in the upriver side of the bridge (west) to roost at the southern end of the bridge. This was in the form of clusters and individual droppings below the crevices.

The northern end offers very suitable roosting conditions, but no bat signs or bats were present within this section either in 2017 or 2020.

10.4.8.2 Bat fauna feeding and commuting within and through the FRS site

Common pipistrelles were noted at all times throughout the survey period and throughout Arklow town. This is the most widespread species in Europe and is most often the most commonly encountered bat species. Common pipistrelles were widespread in Arklow in summer in 2016 and 2017. In October 2016, males of this species were noted calling along the riverbank south of the river. Common pipistrelles were also noted along the lands that would flank the proposed embankment, north of the river. This species was heard within the fields adjacent to Brigg's Lane behind Ferrybank around a derelict house and along the disused "railway line" (The marsh is traversed by an elevated pathway leading from the Dublin Road at Ferrybank to Shelton Abbey over 3.0km to the west and upstream of Ferrybank -reference in this section to the *railway line* is interpreted to be the *elevated pathway*).

Soprano pipistrelles were more numerous along the river and in marshy areas close to the river. This was the first bat to be noted around the mature trees along the river and one individual was present along the disused railway line for several minutes as well as feeding and calling around the derelict house.

Soprano pipistrelles were seen and heard along the southern riverbank west of Arklow Bridge and were the only species noted prior to dawn on 18th October 2016. Similarly, in August 2017, soprano pipistrelles were the most commonly encountered bat species prior to dawn.

The SM2 north of the river on 19th October 2016 revealed the presence of three species of bat; Leisler's bat, common and soprano pipistrelle. Each bat only occurred on one occasion between 18.15 hours and 21.30 hours.

Daubenton's bats were heard over several hours along the river and were also noted flying from the rear of the houses north of the river towards the river. Daubenton's bats were not roosting in any of the trees that will be removed by the proposed FRS embankment. Daubenton's bat activity was noted along the river from the Ferrybank Bridge to Arklow Castle and onwards to the M11 motorway bridge.

Ireland is considered to be a stronghold for Leisler's bats and this species is encountered throughout Leinster and the east coast. This bat fed throughout Arklow while moving to and from a roost site that was not within the FRS land take itself in June 2016.

The final bat observed prior to dawn was last noted flying towards the Avoca River in a south-westerly direction and it is probable that this individual was crossing towards the town over the river.

Leisler's bats were very briefly present on October 19th, 2016 at 19.31 hours and otherwise there was very little activity. This species was present in August 2017 but was less in evidence than all other species.

A Leisler's bat was seen and heard flying over the Main Road, Arklow close to the Castle ruins area prior to dawn away from any areas within the FRS scheme. The Castle ruins lies outside of the FRS planning boundary.

Common pipistrelle activity was the first noted at the ruins of Arklow Castle (19.08 hours) in the survey undertaken in October and this was followed 12 minutes later by soprano pipistrelle activity. Neither species was seen to return to Arklow Castle prior to dawn. However, on cold mornings, it is possible that bats have returned during the night and have not re-emerged to feed.

In August, no bats emerged or returned to the Castle. A number of bats were noted returning towards the town from the area west of Arklow Bridge prior to dawn but not to the Castle. Pipistrelle activity was noted heading to the southwest of the river. A Leisler's bat was noted flying to the south as discussed earlier in these results in the vicinity of the Castle (but clearly flying beyond the Castle). The roost that was present within the Castle would appear to be absent in August and October and given that the emergence area is more overgrown than when bats were present previously, it is probable that bats are either scarce or absent from the building.

Daubenton's bats were present close to water in almost all encounters with some Daubenton's bat activity in Arklow Marsh behind the houses at Ferrybank being the only exception.

Bat activity was predominantly soprano pipistrelle along the river with Daubenton's bat activity in various sections including at the northern end (west of the bridge) and up as far as the survey followed to the M11 bridge.

Common pipistrelle activity was present both west and east of the southern end of the bridge as well as along the river walk, west of Arklow Bridge towards Arklow Castle and up as far as the M11. Common pipistrelles were second to soprano pipistrelles in frequency of encounter.

Leisler's bats were noted on occasion throughout the site but were much less common than all other species.

Trees at the northern end of the town bridge offered low roost potential. Some of these had been removed by November 2020. Trees within the hedgerows north of this point have higher roost potential.

No roosts were noted in any of the trees examined prior to dawn and it was considered most probable from pre-dawn activity that bats were heading towards the houses at Ferrybank or further afield.

There is historic evidence of use of the Castle including information provided by the resident of the house adjacent to the Castle from childhood and up to recent years. The Castle ruins lie outside of the FRS planning boundary.

None of the bat boxes along the riverbank had been occupied by bats. These bat boxes were in clutter and ivy was blocking a number of the box entrances. A bat box at the Arklow Ponds was examined from ground level with a torch (not checked from a ladder) and no droppings or bat was visible.

Bat activity over the Arklow Ponds during an evaluation in 2017 was high and included Daubenton's bats, Leisler's bat, soprano and common pipistrelle. Several bat boxes around the Ponds are known to be in use (Enda Mullen, NPWS pers. Comm.). Ms Mullen provided the following additional information: there is a pipistrelle roost in a building near Arklow Bay Hotel (west of Arklow Pond), and another bat roost in the OPW building in Arklow town. The Arklow Ponds lie outside of the FRS planning boundary.

10.4.9 Other Terrestrial Mammals

Badger (Meles meles)

The NBDC data sets contains records of badger in the northern section of Arklow Town. Measures to mitigate potential construction impacts on are detailed in **Section 10.6.7**

Red Squirrel (Sciurus vulgaris), Grey squirrel (Sciurus carolinensis) and Pine marten (Martes martes)

With regard to Red squirrel (*Sciurus vulgaris*), though not observed during the course of the present survey, records held by the NBDC for the area come from 1984. More recently, Lawton et al. (2019) carried out an all-Ireland survey of red squirrel and also, Grey squirrel (*Sciurus carolinensis*) and Pine marten (*Martes martes*) and note that Nationally, records of Red squirrel have continued to increase since previous surveys in 2007 and 2012.

As neither Red Squirrel nor Pine Martin occur within the works area, no mitigation measures are neither required nor proposed.

Other terrestrial mammals likely to occur include Fox (*Vulpes vulpes*) Pygmy shrew (*Sorex minutes*) and the rodent species Wood Mouse (*Apodemus sylvaticus*), House Mouse (*Mus domesticus*) and Brown Rat (*Rattus norvegicus*) are likely to occur. As all of these species are common throughout the area and no significant impact is considered likely on their populations, no mitigation measures are required.

10.4.10 Aquatic Ecology

10.4.10.1 General

The Avoca River continues to be one of the most seriously polluted rivers in Ireland due to acid mine drainage at Avoca Mines, just upstream of the village of Avoca³². This pollution has had, and continues to have, serious impacts on the macroinvertebrate and fish populations of the river.

³² Fanning, A. Craig, M., Webster, P., Bradley, C., Tierney, D., Wilkes, R., Mannix, A., Treacy, P., Kelly, F., Geoghegan, R., Kent, T. and Mageean, M. (2017) Water Quality in Ireland 2010-2015. Environmental Protection Agency, Johnstown Castle, Co. Wexford

These impacts are most severe closest to the Avoca Mines site and are having a lesser effect downstream; an effect that appears to be diminishing over time³³.

The effects of the acid mine drainage from the Avoca Mines extends all the way to the estuary of the Avoca River. The Avoca River Estuary is the only transitional or coastal waterbody in Ireland to fail for chemical status under the Water Framework Directive (WFD) assessment due to the levels of substances that are not ubiquitous in the water environment¹⁵.

In addition to the acid mine drainage impacting on the Avoca River for much of its length, the lack of a wastewater treatment plant for Arklow and its environs has resulted in untreated wastewater being discharged into the Avoca River Estuary. This is impacting water and sediment quality within the estuary.

10.4.10.2 Fish

Despite the negative impacts on the Avoca River from the acid mine drainage and the release of untreated wastewater, the river and estuary continue to support a diverse fish population.

Surveys of the Avoca River Estuary carried out under the WFD classed this waterbody as ‘Moderate’ status for the fish populations in both the 2008 and 2010 sampling periods (Kelly et al, 2009³⁴, Kelly et al, 2011³⁵).

The Avoca River Estuary was classified as ‘Good’ status for fish populations in 2015 (Ryan et al, 2015). The overall WFD status of the Avoca Estuary for the period 2010 to 2015 is ‘Moderate’ (EPA data, Site Code IE_EA_150_0100). The Avoca River was classified by the Eastern River Basin District (ERBD 2008) as “Poor” in status partly on the basis of discharges from mines.

This “Poor” status is reflected in the low numbers of species and numbers of individuals of invertebrates that are present in estuarine and tidal river sediments as recorded above. These characteristics make it an unsuitable foraging area for fish.

The river and estuary provide a migration corridor for Habitats Directive Annex II listed diadromous fish species Atlantic Salmon *Salmo salar*, River Lamprey *Lampetra fluviatilis* and Sea Lamprey *Petromyzon marinus*.

³³ Gray, N.F. and Delaney, E. (2010) Measuring community response of benthic macroinvertebrates in an erosional river impacted by acid mine drainage by use of a simple model. *Ecological Indicators* 10: 668-675.

³⁴ Kelly, F., Harrison, A., Connor, L., Wightman, G., Matson, R., Morrissey, E., O’Callaghan, R., Feeney, R., Hanna, G., Lordan, M. and Rocks, K. (2009). Sampling Fish for the Water Framework Directive – Transitional Waters 2008. Avoca Estuary. The Central and Regional Fisheries Boards.

³⁵ Kelly, F., Harrison, A., Connor, L., Matson, R., Morrissey, E., O’Callaghan, R., Feeney, R., Wögerbauer, C., Hanna, G., Gallagher, K. and Rocks, K. (2011). Sampling Fish for the Water Framework Directive – Transitional Waters 2010. Avoca Estuary. Inland Fisheries Ireland.

The deep and slow flowing nature of the Avoca River immediately upstream, and the estuarine area within the Arklow FRS planning boundary do not provide suitable spawning habitat for salmon or lamprey species, which require shallower, faster flowing water over suitable spawning gravel (O'Reilly, 2009³⁶). In addition, it should be noted that as result of the impact of both historical mining and the disposal of untreated sewage effluent on water quality and sediment chemistry and the tidal nature of the Avoca River upstream of the bridge, habitat quality of the lower reaches of the river makes the area unsuitable for fish egg laying/development.

The closest SAC to the development area designated for these species is the Slaney River Valley SAC (Site Code 000781). There are no rivers connecting the SAC to the development area. By sea, the shortest distance of the SAC from the development area is over 50km.

O'Reilly (2009) notes that due to run-off from disused sulphur and copper mines, the water of the river is polluted. He does however mention that migratory fish hold up in the tidal waters before running up into the clear water above on a flood. He also comments that in the upper reaches in the Avonmore and Avonbeg, the rivers hold big stocks of small brown trout and also larger specimens of up to 2.5 kg noting that these bigger fish are probably seatrout.

The Central and Regional Fisheries Boards carried out a fish stock survey of the lower Avoca Estuary in 2008 (CFRB, 2009) and recorded the following 11 species of fish (with the number of specimens for each in brackets): River lamprey (5), Whiting (2), 3 spined stickleback (5), Salmon,(1), Sea trout (2), Brown trout (1), 5 bearded rockling (6), Sand goby (1), Eel (20), Spratt (1), Flounder (225) and Mullet (36).

Inland Fisheries Ireland (2012) carried out an electrofishing survey of a part of the upper Avoca River near Woodenbridge and recorded 6 juvenile salmon and eels at the site.

Inland Fisheries Ireland (2016) carried out a survey of River Lamprey between 2015 and 2016 in the upper reaches of the Avoca catchment in the Aughrim and Avonmore Rivers. A total 8 lamprey were trapped over that time period. River lamprey spawning sites were recorded at 3 locations and spawning was first noted in March 31st and continued in to mid – April.

The life cycle of the sea lamprey (*Petromyzon marinus*) contains both a marine phase and a freshwater phase.

Adult sea lamprey living as external parasites on host fish or marine mammals at sea grow in length from 60 to 100cm before migrating in spring into freshwater to excavate redds or spawning nests in gravelled areas of large rivers. Upriver migration occurs at a time of falling water levels and substantial spawning activity has been recorded in gravelled areas downstream of large weirs in the major Irish rivers.

³⁶ O'Reilly, P. (2009) Rivers of Ireland, a Flyfisher's Guide (7th Edition). Merlin Unwin Books, Shropshire, UK

Sea lamprey spawning has been recorded in the upper reaches of the Avoca River, where there are no barriers to upstream migration.

Egg laying follows nest excavation and the resulting larvae, called ammocoetes, hatch out within days. These swim or drift downstream to areas of fine sediment into which they can burrow. The ammocoete retains its burrowing habit in fine-grained sediment over a period of years. Transformation to the young adult stage occurs in late summer and the juvenile sea lamprey can be found migrating downriver to estuarine waters and the open sea in late autumn-winter. The sea lamprey is listed in the most recent Irish Red Data Book as Near Threatened. Barriers to upstream migration (*e.g.* weirs) are considered the major impediment to good conservation status for sea lamprey as these limit access to spawning beds and juvenile habitat. The Overall Status of this species is assessed as Bad with a stable trend, unchanged since the last 2013 assessment.

The sea lamprey which grows to maturity in the sea and migrates to freshwater to spawn. They migrate through the estuary from the sea in April and May (Hardisty, 1969) and spawn in rivers in late May or June and then return to sea.

The river lamprey (*Lampetra fluviatilis*) is a migratory species which grows to maturity in estuaries and migrates to freshwater to spawn from October to December (Maitland, 2003). Spawning occurs in the rivers in March and April. Between July and September young adults at 3-5 years of age migrate during darkness to the estuary. Salmon is a QI of the Slaney River Valley SAC. Salmon migrates through outer Wexford harbour into the Slaney River Valley SAC.

The river lamprey breeds in freshwater rivers and streams. Adults spawn in spring, excavating shallow nests in riverine sections comprising fine gravels and small stones. After hatching, the larvae or 'ammocoetes' drift or swim downstream to areas of river bed or margins with fine silt deposits.

They burrow into this bed material where they live as filter feeders over a period of years before transforming into young adult fish and migrating downriver to estuarine and marine habitats.

Following metamorphosis to adults, River Lamprey migrate to estuaries and the sea, where they spend one to two years feeding. As adults they are parasitic, attaching to and feeding on larger fish in coastal waters. They can grow up to 25-30cm at maturity, at which stage they return to freshwater habitats to spawn. The adult fish die after spawning. River and brook lamprey are indistinguishable as larvae. The mature adult forms are, however, clearly distinguishable based on body size. The two types of lamprey are considered by many in the same context as the brown trout / sea trout pairing, with a similar absence of genetic discriminators. The inability to distinguish between river lamprey and brook lamprey larvae, and the challenges associated with sampling for adult river lamprey, means that an evaluation of their actual range and population size cannot be undertaken.

The Overall Status for river lamprey is therefore assessed as Unknown. The previous reporting period used primarily juvenile *Lampetra* sp. distribution data for this species.

In Ireland, migration of adults back upstream for spawning takes place over a protracted period from late summer to autumn (Kelly & King, 2001³⁷), while downstream movement of newly metamorphosed adults peaks in March-April (Hardisty et al., 1970³⁸).

The Slaney is primarily a spring salmon fishery and is regarded as one of the top rivers in Ireland for early spring fishing (NPWS 2015). The upper Slaney and tributary headwaters are very important for spawning. Smolts typically head out to sea between March and June and adults return to the river between March and August.

Atlantic salmon is indigenous to the North Atlantic. The Irish population generally comprises fish that usually spend two years as sub-adults in freshwater before going to sea as smolts. The majority of fish spend one winter at sea before returning to their natal rivers, mainly during the summer, as grilse. Smaller numbers spend two winters at sea, returning mainly in spring, hence “spring” salmon. A small proportion of the adult population returns to the sea post-spawning and can return to spawn again. The survival of salmon during the marine phase of its lifecycle has been identified as the key determinant of trends in population size in natal rivers. Known pressures include exploitation at sea in commercial fisheries, interceptory fisheries in coastal waters, aquaculture and predation. In addition, the negative influence of climate change on food prey structure and abundance has increasingly been attributed to the declines observed in stocks at sea. Within river systems, variation in individual stock abundance can be influenced by a variety of factors, notably alterations in physical habitat, water quality, environmental factors, predation, and angling and commercial fisheries exploitation pressure.

Salmon require passage through the estuary and lower reaches of the Avoca River and estuary to reach spawning grounds further up the system and the area may also support smolts and adults for a period of time on their way to sea or upriver, respectively. The Avoca River supports a spring and summer salmon run, with adults returning from sea, passing through the estuary and moving upstream during this period. Following hatching, salmon develop through a number of stages over the course of a number of years before undergoing physiological change (smoltification) to become smolts and be ready to go to sea.

³⁷ Kelly, F.L. and King, J.J. (2001) A review of the ecology and distribution of three lamprey species, *Lampetra fluviatilis* (L.), *Lampetra planeri* (Bloch) and *Petromyzon marinus* (L.): a context for conservation and biodiversity considerations in Ireland. *Biology and Environment: Proceedings of the Royal Irish Academy* 101B(3): 165 – 185.

³⁸ Hardisty, M.W., Potter, I.C. and Sturge, R. (1970) A comparison of the metamorphosing and macrophthalmia stages of the lampreys, *Lampetra fluviatilis* and *Lampetra planeri*. *Journal of Zoology* (London) 162: 383–400.

There are a range of factors that determine the exact timing of the movement of smolts to sea, including water temperature and photoperiod (McCormick et al., 1998³⁹, Byrne et al., 2004⁴⁰); however, the seaward migration takes place over the spring to summer period.

European Eels also require passage through the lower reaches of the Avoca River on their migration from spawning grounds at sea to rivers where they spend most of their lives. Adult European Eels move to sea in the autumn⁴¹, while glass eels (young eels migrating from the spawning grounds to rivers) move upstream in spring⁴².

As noted above in the description of the estuary and in the tidal section of the Avoca and the impact of both historical mining and the disposal of untreated sewage effluent on sediment chemistry, habitat quality of the river bed makes it an unsuitable area for fish to lay eggs.

Marine fish in the coastal waters off Arklow include dogfish, ray, codling, whiting and tope, bass, dab, sole, flounder, plaice, sea trout and mackerel further south off Clogga. Commercial pot fishing by boats based in Arklow Harbour is mainly for whelk.

10.4.10.3 Marine mammals

Marine mammals listed on Annex II of the Habitats Directive generally occur in coastal and marine waters off Arklow.

The NBDC database includes a single sighting of Common Seal (*Phoca vitulina*) in the outer estuary in July 2016. Site investigation works have been carried out in the Avoca River estuary and in Arklow Bay to inform the Arklow WwTP project. As part of the work the contractor was required to appoint a qualified Marine Mammal Observer (MMO) to monitor for marine mammals and to log all relevant events during the intrusive ground investigations. A total of 30 MMO watches, with a total duration of 268 hours of observations, was carried out during the 30 minutes prior to, and during site investigation works⁴³. During the watches no marine mammals were recorded.

³⁹ McCormick, S.D., Hansen, L.P., Quinn, T.P. and Saunders, R.L (1998) Movement, migration, and smolting of Atlantic salmon (*Salmo salar*). Canadian Journal of Fisheries and Aquatic Sciences 55(suppl. 1): 77-92.

⁴⁰ Byrne, C.J., Poole, R., Dillane, M., Rogan, G. and Whelan, K.F (2004) Temporal and environmental influences on the variation in sea trout (*Salmo trutta* L.) smolt migration in the Burrishoole system in the west of Ireland from 1971 to 2000. Fisheries Research 66(1): 85-94.

⁴¹ Sandlund, O.T., Diserud, O.H., Poole, R., Bergesen, K., Dillane, M., Rogan, R., Durif, C., Thorstad, E.B., Asbjørn Vøllestad, L. (2017) Timing and pattern of annual silver eel migration in two European watersheds are determined by similar cues. Ecology and Evolution 7:5956–5966

⁴² Anonymous (2008) National Report for Ireland on Eel Stock Recovery Plan Including River Basin District Eel Management Plans. Report prepared by the Inland Fisheries Division of The Department of Communications, Energy and Natural Resources, Dublin

⁴³ Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters January 2014

In addition, as part of the Arklow WwTP project a series of 6 bird surveys of coastal waters were undertaken between Nov 2016 and Feb 2018. During these surveys, a single Common Seal was observed on one occasion.

The above clearly indicates that the Avoca River and Arklow FRS development area does not represent an important foraging area for the species.

10.4.10.4 Otter

Otter occur within the study area. During walkover survey undertaken as part of the Arklow WwTP project evidence of otter spraint was recorded at two locations along the south bank of the Avoca River between the M11 Bridge and the start of the built-up banks in Arklow Town upstream of the FRS planning boundary. It should be noted that it is likely that the vegetation at the banks of the Avoca River provide suitable habitat for the species, habitat surveys undertaken did not report evidence of otter holts, runs or slides in the area. The NBDC database includes a single sighting in 2015⁴⁴ of the Habitats Directive Annex II species Otter (*Lutra lutra*) in the Avoca River at Arklow Bridge. Two individuals (1 adult and 1 juvenile) were observed feeding along the southern bank in the early morning during the course of fieldwork carried out by AQUAFACT in summer of 2020.

Otter is a QI species of the Slaney River Valley SAC (Site code: 000781) which is located 13.3km as the 'crow-flies' west of the proposed development. There are no rivers connecting the SAC to the development area. Otter *Lutra lutra* is also listed as a QI for Wicklow Mountains SAC (Site Code 002122). This SAC is located over 40km upstream of the FRS via the Avonmore, Avonbeg and Avoca rivers. Given the location and distances of the SACs from the FRS area, it is highly unlikely that individuals from the sites would be found in the development area.

10.4.10.5 Marine and Freshwater Macroinvertebrates

The lower reaches of the Avoca River have been highly modified by human activity through the construction of retaining walls and harbour breakwaters. As noted above, river water quality has been impacted by acid mine drainage from the Avoca Mines upstream. The estuary is also influenced by the input of untreated sewage below the bridge. Because of these impacts, the intertidal and estuarine habitats of the study area are depressed in species numbers and this in turn decreases the species richness and therefore are of low ecological value.

Concerning marine invertebrates, a benthic survey of the lower part of the Avoca Estuary was carried out by AQUAFACT in August 2020 to document the conditions in terms of sediment quality and infauna present (see Figure 10.18 below for positions of the sampling sites).

https://www.npws.ie/sites/default/files/general/Underwater%20sound%20guidance_Jan%202014.pdf

⁴⁴ <https://maps.biodiversityireland.ie/> (accessed 15/04/2021)

Duplicate faunal samples were taken at each location and positions were recorded using a hand held GPS device. A 0.025m² grab was deployed from an inflatable and on recovery, the sediment type, colour and smell was recorded, and the sample was placed for later washing through a 1mm mesh sieve and preserving in 5% formalin on land. The samples were returned to the laboratory for sorting, identification and enumeration of macrofauna under a microscope. Faunal returns for each sample at each site are presented in **Table 10.11** below. The examination of the sediments showed them all to be black, muddy sands with small amounts of shell and gravel and strongly smelling of hydrogen sulphide.

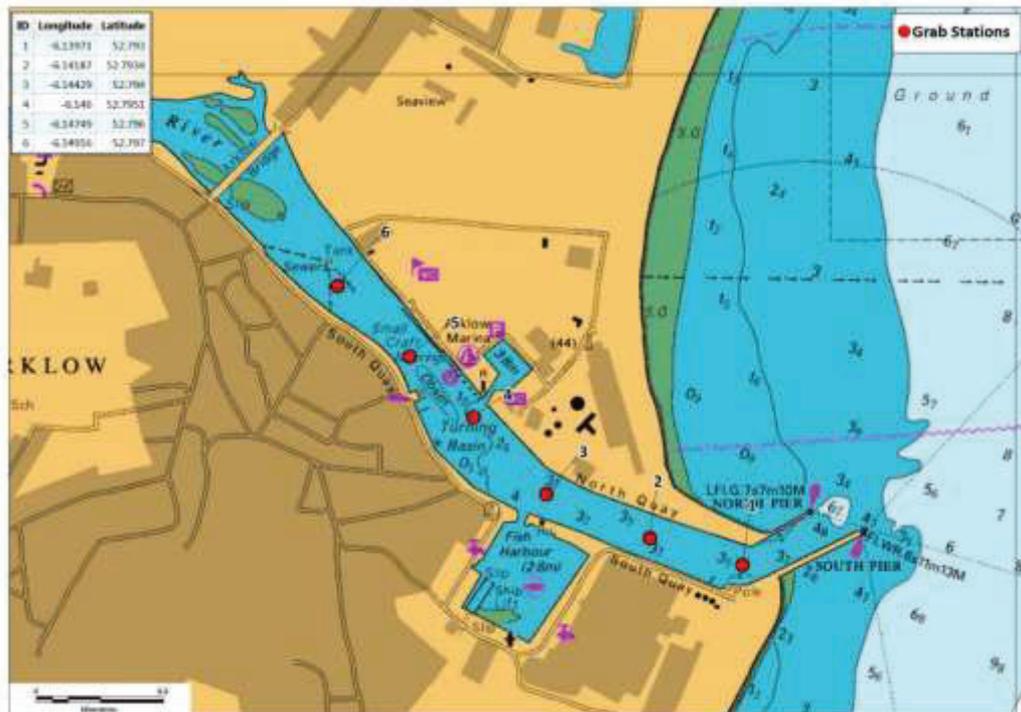


Figure 10.18: Location of 6 sampling sites in the Avoca Estuary, 13 August 2020.

Table 10.11: Taxa and number of specimens recorded in the lower Avoca Estuary

Station	Species		
St. 1a	<i>Tubificoides benedii</i> 5	<i>Capitella capitata</i> 2	<i>Owenia fusiformis</i> 1
St.1b	<i>Tubificoides benedii</i> 7	<i>Capitella capitata</i> 1	<i>Hediste diversicolor</i> 2
St.2a	<i>Tubificoides benedii</i> 4 <i>T. pseudogaster</i> 2	<i>Capitella capitata</i> 3	<i>Amphictene auricoma</i> 1
St. 2b	<i>Tubificoides benedii</i> 2	<i>Capitella capitata</i> 5	
St. 3a	<i>Tubificoides benedii</i> 9	<i>Capitella capitata</i> 4	
St. 3b	<i>Tubificoides benedii</i> 6 <i>T. pseudogaster</i> 3	<i>Capitella capitata</i> 1	<i>Nephtys hombergii</i> 1
St. 4a	<i>Tubificoides benedii</i> 12	<i>Capitella capitata</i> 6	<i>Hediste diversicolor</i> 3

Station	Species		
St. 4b	<i>Tubificoides benedii</i> 3		
St. 5a		<i>Capitella capitata</i> 1	
St. 5b	<i>Tubificoides benedii</i> 3	<i>Capitella capitata</i> 2	
St. 6a	No fauna		
St. 6b	No fauna		

The marine benthic community immediately outside the Avoca Estuary in the Irish Sea has a depressed species richness compared to what might be expected from the habitat present. It is likely that the discharge of untreated wastewater and acid mine drainage to the Avoca River is having an influence in terms of contaminant load, as suggested in previous benthic surveys by BEC in 2017. The area is dominated by a single biotope *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment. This biotope is common and widespread along the east coast of Ireland.

With regard to assessing water quality in the Avoca River, the standard method is known as the Q index. In aquatic systems, as levels of pollution increase, so invertebrates react to this variable. Taxa are either highly intolerant, moderately tolerant or very tolerant to different levels of pollution and those that fall into the highly intolerant group *e.g.* many May flies and Stone flies, are never found in even moderately polluted water while highly tolerant taxa include such groups as tubificid oligochaetes, asellids and *Chironomus* sp.

By taking a sample of the benthic invertebrates and identifying the biological material even to as high a taxonomic level of family, from these results, it is possible to determine the likely quality of the water in terms of pollution. This is known as the Biological River Quality Classification System or Q value (Q-Scheme) and it has been in use in Ireland since 1971. It has undergone a number of modifications since then and has been included in the Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorus) Regulations, 1998. It is routinely employed by the EPA. For the purpose of this assessment benthic invertebrates have been divided into five indicator groups according to tolerance of pollution, particularly organic pollution.

In order to determine the biological quality of the river, the Q-scheme index is used whereby the analyst assigns a Biotic Index value (Q-Value) based on the results of the identification and enumeration of macroinvertebrate samples collected in different parts of the aquatic system. The Biotic Index is a quality measurement for freshwater bodies that range from Q1 – Q5 with Q1 being of poorest quality and Q5 being pristine/unpolluted (see **Table 10.12** below).

Table 10.12: Biotic Index scoring system for the Q-Scheme (Lucey *et al.*, 1999)

Biotic Index	Quality Status	Quality Class
Q5, 4-5, 4	Unpolluted	Class A

Biotic Index	Quality Status	Quality Class
Q3-4,	Slightly Polluted	Class B
Q3, 2-3	Moderately Polluted	Class C
Q2, 1-2, 1	Seriously Polluted	Class D

With regard to Q values of the Avoca River, the ERU (1992) record very low values of 1 – 0 at Arklow Bridge for 1986 and 1990 indicating a quality status of Seriously Polluted. The most recent review (EPA 2020) noted that the lack of pollution sensitive taxa and the low abundances of pollution tolerant species continued to indicate significant ecological disruption at Avoca Bridge in July 2019.

As noted previously, the freshwater macroinvertebrate community of the Avoca River was sampled at six locations on the main channel and at one location (S7), close to the M11 Bridge on the channel that runs in a south-easterly direction through Arklow Town Marsh by BEC on 26 September 2017. The survey was carried out by BEC to inform both the FRS and WwTP. Two of the locations (S1, S2) were situated within the planning boundary of the FRS. S1 was located just downstream of Arklow Bridge. S2 was located upstream of Arklow Bridge. The remaining five locations were situated further upstream.

At S1 which is located just downstream of Arklow Bridge shows the estuarine influence on the macroinvertebrate community with a high abundance of the shrimp *Gammarus chevreuxi*, while the high numbers of the worm *Lumbriculus variegatus* present at this site point towards issues of organic pollution. This site also had the lowest species richness, with eight species or higher taxa recorded.

At S2, which is located approximately 250m upstream of the Arklow Bridge, a single *G. chevreuxi* individual was recorded, possibly reflecting the decreasing estuarine influence.

The community at S2 also included two crustacean species typically associated with freshwater environments, *Crangonyx pseudogracilis* and *Asellus aquaticus*. The relative abundance of these species at the sampled site increased with increasing distance upstream.

Conversely, (S6), the most upstream site on the Avoca River upstream of the M11 Bridge had higher species richness with 21 species or higher taxa recorded. Fauna of the channel that flows through Arklow Town Marsh (S7), was dominated by mollusc species including *Radix peregra* and *Physa fontinalis*. This reflects the very slow-flowing or still nature of the water at this site.

There are no records of the protected White-clawed Crayfish (*Austropotamobius pallipes*) from the Avoca River catchment, due to the low pH and alkalinity conditions created by the underlying geology⁴⁵.

Three Margaritifera Sensitive Areas lie upstream of the proposed FRS:

- Avoca - Aughrim; catchment of extant population;
- Avoca – Upper Avonmore; catchment of extant population; and
- Avoca – Lower Avonmore; catchments with previous records of Margaritifera, but current status unknown.

The Freshwater Pearl Mussel *Margaritifera margaritifera* is listed in Annex II of the Habitats Directive and has been recorded in the Aughrim and Avonmore tributaries as noted above, but not in the Avoca River.

10.4.10.6 Conclusion on Aquatic Ecology

The freshwater, estuarine and marine ecology in the vicinity of the proposed development has been described through field survey and desk study. The river has been impacted by acid mine drainage from the Avoca Mines upstream and the estuary also influenced by the input of untreated wastewater. The Avoca River Estuary is the only transitional or coastal waterbody in Ireland to fail for chemical status under the Water Framework Directive (WFD) assessment due to the levels of substances that are not ubiquitous in the water environment⁴⁶.

Despite the negative impacts on the Avoca River from the acid mine drainage and the release of untreated wastewater, the river and estuary continue to support a diverse fish population.

The river and estuary provide a migration corridor for Habitats Directive Annex II listed diadromous fish species Atlantic Salmon *Salmo salar*, River Lamprey *Lampetra fluviatilis* and Sea Lamprey *Petromyzon marinus*.

The deep and slow flowing nature of the Avoca River immediately upstream, and the estuarine area within the Arklow FRS planning boundary do not provide suitable spawning habitat for salmon or lamprey species, which require shallower, faster flowing water over suitable spawning gravel.

Otters occur within the study area and are likely to make use of both banks of the river.

The Avoca River does not represent an important foraging area for seal species.

The species richness of the macroinvertebrate community is somewhat reduced compared to what might be expected in a river such as the Avoca.

⁴⁵ Lucey, J. and McGarrigle, M.L. (1987) The distribution of the crayfish *Austropotamobius pallipes* (Lereboullet) in Ireland. Irish Fisheries Investigations Series A (Freshwater). No. 29.

⁴⁶ Fanning, A. Craig, M., Webster, P., Bradley, C., Tierney, D., Wilkes, R., Mannix, A., Treacy, P., Kelly, F., Geoghegan, R., Kent, T. and Mageean, M. (2017) Water Quality in Ireland 2010-2015. Environmental Protection Agency, Johnstown Castle, Co. Wexford.

This is due to the fact that the Avoca River is still recovering from the effects of acid mine drainage, which continues to have an influence on water quality. No rare or protected macroinvertebrates were recorded in the course of the surveys or desk study.

The low salinity of the estuary would likely play a factor in the low species richness and abundance, but the pollution caused by metals washed down from the Avoca mines upstream and the input of untreated wastewater into the estuary from Arklow Town are likely to be combining to cause the depauperate character of the benthic community in the Avoca River estuary, with the effect extending out to sea.

10.5 Likely Significant Effects

10.5.1 Do-Nothing Scenario

If the proposed flood relief scheme were not carried out, the habitats, flora and fauna would remain the same as reported above.

10.5.2 Impact Assessment Methodology

A detailed description of the proposed development is provided in **Chapter 4**.

In summary, the proposed development will involve the construction of flood defences and an embankment, as well as conveyance improvements in the Avoca River; including deepening of the river channel, the introduction of new debris and gravel traps and strengthening works to the existing quay walls and Arklow Bridge. The altered channel profile along with the provision of a gravel trap upstream of Arklow Bridge will reduce significantly the level of maintenance required for the river channel. It is expected however that there will be some level of sediment settling along the channel related to the flood scheme. As such, some dredging of the channel will be required from time to time (approximately once every 10 years). This will follow a similar methodology as the channel dredging and will be dependent on where deposition occurs. This is estimated as every ten years but will be based on periodic surveys of the riverbed levels.

Wicklow County Council considers Arklow FRS to be a key strategic asset in the protection of Arklow Town from flooding and it will have a minimum of a 50 year design life. As such it is anticipated that the proposed development will be maintained by Wicklow County Council in the long term. In the event of decommissioning, measures will be undertaken by Wicklow County Council to ensure that there will be no likely significant effects associated with the decommissioning of the proposed development.

The potential impact mechanisms (sources of impact) of concern with regard to effects to biological receptors of the environment are associated with the activities proposed for the construction and operational phases of the development.

The assessment of likely significant direct and indirect effects of impact mechanisms on biodiversity (plants, animals, and habitats) within the zone of influence of the project (*in situ* effects).

As well as considering potential *in situ* effects to biodiversity, consideration has been given to potential effect to highly mobile protected conservation features species of more distant European sites that may occur in the development area and thereby be affected (*ex situ* effects to European sites).

10.5.3 Impact Mechanisms

The impact mechanisms associated with the development, which have been identified based on the location, nature and scale of the activities proposed for the construction and operation phases, take into account the sensitivities of the biological receptors recorded in the project area.

10.5.3.1 Impact Mechanism 1 Discharges

As with any construction activity there is a risk potential that activities proposed for construction and operational phases of the development (including construction, excavation work, capital dredging and occasional channel dredging operations, installation of permanent river side ramps, installation/ removal of temporary river access points, haul roads and causeways, maintenance of debris and gravel traps) may result in the release of sediments to nearby habitats and watercourses including the river. There is also potential that water quality may be affected by the accidental release of concrete materials.

There is risk that activities associated with the construction phase may result in the accidental release of chemicals or other waste material pollution. Potential pollutants associated with construction plant equipment include fuels, oils, greases hydraulic fluids (hydrocarbons).

As noted in Section 5.5.2 of **Chapter 5 Construction Activities**, a dredge material management study has been undertaken, the results of which are presented in **Appendix 15.2** of the EIAR.

The results of the study as presented in **Table 5.5** of **Chapter 5 Construction Activities**, indicate that bulk of the proposed dredge material (estuarine material) will comprise of inert natural sands and gravels, with a small proportion of the dredge material comprising of a surface layer of fill (silty riverbed with fill material containing anthropogenic material). The natural sands and gravels will be suitable for reuse within the scheme and/or offsite. The fill material was identified on the south bank upstream of Arklow Bridge. Some of this fill material will require disposal to a hazardous licenced facility and the remainder of the fill material will require disposal to a non-hazardous licenced landfill. Some of the dredged material sampled downstream of Arklow Bridge had natural slightly elevated chloride concentrations, likely due to saline intrusion given the tidal influence on this section of river. Temporary stockpiling of this material is likely to allow natural reduction in chloride concentrations sufficiently so this material could be deemed to be inert (subject to verification testing).

As noted in **Table 5.5** of **Chapter 5 Construction Activities**, some of the dredge material excavated will require archaeological examination at the site compounds prior to removal offsite. Inert dredge (sands and gravels) will be archaeologically examined at SC1 and SC6.

Material with slightly elevated chloride concentrations will be archaeologically examined at SC1 and reused for construction of the embankment. Material with slightly elevated chloride concentrations will also be archaeologically examined at SC5 before removal offsite. Hazardous and non-hazardous contaminated material will be archaeologically examined at SC2 before removal offsite.

In the absence of mitigation measures, there is a potential risk of discharges into the river during the excavation of the contaminated fill material on the south bank upstream of Arklow Bridge. There is a potential risk of discharges into the ground

In the absence of mitigation measures, there is potential that runoff from the stockpiles of excavated dredge material at the site compounds may result in the introduction of sediment and, hazardous and non-hazardous contaminants and slightly elevated chloride concentrations to the adjacent habitats, marsh and river, potentially impacting habitat and water quality. Following construction of the embankment adjacent to the marsh, it is likely that runoff from the dredge with the slightly elevated chloride concentrations will percolate into the ground.

During bridge masonry repair works, plant roots attached to the bridge will be treated using herbicide; accidental release of herbicides to the river may impact water quality. Water quality may also be affected by the accidental release of concrete and grouting materials.

An assessment of potential effects associated with discharges is presented in **Section 10.5.4.1**. Relevant measures necessary to avoid the risk of impact associated with discharges are referenced in **Section 10.6**.

10.5.3.2 Impact Mechanism 2 Loss of in-river habitat

Elements that will result in loss of in-river habitat include the construction of river access points, temporary causeways, the installation of the debris and gravel traps and riprap within the river channel, in-stream capital dredging including the removal of the in-stream vegetated islands and gravel bank located upstream of the Arklow bridge, occasional channel dredging (during maintenance), installation and removal of temporary in-stream access ramps to allow access to and maintenance of debris and gravel traps (**Figure 10.14**). The construction of flood walls along River Walk, South Quay and around the dock on the south (right) bank, will result in in-river habitat loss at two locations, one upstream and one downstream of the Bridge.

An assessment of potential effects associated with loss of habitat is presented in **Section 10.5.4.1**. Relevant measures necessary to avoid the risk of impact associated with loss of habitat are detailed in **Section 10.6**.

10.5.3.3 Impact Mechanism 3 Noise disturbance

Construction activity including the construction and demolition works, piling operations, capital dredging and occasional channel dredging (during maintenance) and, the installation and removal of temporary in-stream access ramps for debris and gravel trap maintenance will result in noise emissions with potential disturbance to fish species.

An assessment of potential effects associated with noise disturbance is presented in **Section 10.5.4.3**.

10.5.3.4 Impact Mechanism 4 Loss of Terrestrial Habitat

Elements of the development that will result in the loss of habitats and vegetation of the Arklow Town Marsh pNHA are the construction of the flood wall along the north bank immediately upstream of the Arklow Bridge and the installation of the embankment at the marsh area. The location of the embankment is shown in drawings 1033 and 1032 presented in **Appendix 4.1**.

Works at SC1 and SC3, and the installation of the embankment will result in the loss of habitat in the marsh used by bird species for foraging, roosting and nesting. In addition the proposed works involve the removal of trees marsh used by bird species for foraging, roosting and nesting. The plans for tree removal for construction of the proposed scheme are shown in the landscape drawings in **Appendix 4.2**.

An assessment of potential effects associated with loss of habitat is presented in **Section 10.5.4.1**. Relevant measures necessary to avoid the risk of impact are detailed in **Section 10.6**.

10.5.3.5 Invasive Species

In **Section 10.3.3.1** it is noted that activities proposed for the construction phase will be undertaken in the vicinity of invasive plant species. Consequently, there is a risk of the spread of invasive species and impacts to terrestrial biodiversity. The Arklow FRS Construction Environmental Management Plan (CEMP) is provided in **Appendix 5.1** includes an invasive species management plan (see **Section 10.6.2.5** for further details). Within construction Compound SC1 and SC3 Butterfly Bush (*Buddleia davidii*) has been recorded (see **Section 10.4.5.6**, **Section 10.4.5.8**). There is also an area of mixed native and introduced shrubs and trees including the invasive species *Rhododendron* running across the marsh area (see **Section 10.4.5.6**, **Section 10.4.5.8**). This area coincides with the proposed flood defence embankment area (see **Figure 10.14**). *Rhododendron* has also been recorded within SC1.

Management measures for the species are given in **Section 10.6**.

10.5.4 Impact Assessment

10.5.4.1 Impact Mechanism 1 Discharges

The biological receptors of concern with regards to Impact Mechanism 1 Discharges are:

- Fish
- Otter
- Benthic Habitats

- Birds

Sediment Release

As with any construction activity, the activities proposed for this development including construction, excavation/ dredging operations and the installation/ removal of temporary river access points, haul roads and causeways and the annual removal of debris from the debris and silt traps will result in the release of sediment to the river adjacent to, and downstream of, the development site. Excessive suspended sediment loads can negatively impact riverine and estuarine flora and fauna.

Excessive deposition of suspended sediments can cause stress and affecting the gills, resulting in injury or mortality and the loss of suitable fish spawning habitat and declines in egg and early life stage success rates.

As noted above in the section on fish and on the description of the estuary, the tidal section of the Avoca River and the impact of both historical mining and the disposal of untreated sewage effluent on sediment chemistry, habitat quality of the lower reaches of the river bed make it an unsuitable area for fish to lay eggs. Increased turbidity can reduce feeding rates and affect prey abundance and predation efficacy in visual feeders such as salmon and otter.

As the Avoca River will for the great majority of the tidal cycle be flowing in an easterly direction (*ca* 10 hours), sediment laden water will be washed downstream and out to sea and as described above, as this section of the river is poor in fauna, the impact of this sediment laden water on biota is considered to be low. It should also be noted that species such as Lamprey, Salmon, Seatrout evolved over geological time to migrate through estuaries on their way to spawning grounds and as many estuaries are naturally high in turbidity, these species evolved mechanisms to deal with high suspended sediment loads.

It is also considered that when tidal forcing is affecting the Avoca River upstream of the bridge, due to the low tidal exchange rate brought about by the near-by tidal node, velocities will be very weak and will not transport sediment particles far from the dredge site and that they will fall out to the river bed within a short distance. Furthermore, it is planned that the dredging activity will last on average 10 hours per day after which it will stop. This will allow the sediment laden water to be effectively flushed out of the river completely.

Levels of back ground suspended solids vary from river to river: McMahon and Quirke (1992) record values in the Shannon ranging from 1 mg/l up to 86 mg while Walsh *et al.* (2012) record values of 1 mg/l – 2 mg/l, 1 mg/l – 6 mg/l and 1 mg/l – 20 mg/l in different parts of the Nore River. AQUAFAC recorded a value of 200 mg/l in Cork Harbour *ca* 10 m away from a dredger excavating sediments as part of the construction of the Lee Tunnel and a value of 4,000 mg/l in Galway Bay in 2011 during a severe storm event.

Figure 10.19 below shows the sediment plume from the Avoca River dispersing northwards into the Irish Sea. This image suggests that the Avoca River is naturally quite turbid.

While the Avoca naturally turbid conditions there remains potential that dredging activity may result in effects to Lamprey, Salmon. In order to further reduce any potential effect of the dredging on migrating fish species *e.g.* Lamprey and Salmon, dredging shall not be carried out between October to April.

Otter are visual hunters with good eyesight both above and below the water. The release of sediments in the water column during excavation and construction and the resuspension of sediments during dredging has the potential to significantly affect turbidity levels. Otter is a highly mobile species and while their eyes are adapted for seeing food item in murky or dark water, they will avoid areas of excessive turbidity. While local increases in turbidity may result in the temporary displacement of the species, there are extensive alternative areas of otter habitat available to the species away from the project area. Consequently, there is no risk of significant effects from discharges to otter.

The increase in turbidity could result in increased siltation, smothering of organisms and a reduction of light for phytoplankton following construction activities and dredging. High levels of suspended solids settling on the seabed can alter habitats resulting in a potential loss of feeding and spawning grounds. Mobile species may move away from unfavourable conditions, however sessile, benthic fauna may be smothered and lost.

It should be noted that the effect of increased turbidity, if realised, will be short lived. In addition, any effects are not likely to be significant for local sedimentary habitats and fauna, as the area is naturally turbid (see above) and hydrodynamically active and likely experiences a high degree of natural suspended solids due to the current tidal regime and sedimentary nature of the area. Consequently, there is no risk of significant effects to benthic habitats.

Without the implementation of construction best practice and mitigation measures, activities during the construction of the embankment at Arklow Town Marsh pNHA could result in the uncontrolled release of sediment material to the nearby river and habitat types likely to be used by the SCI species, affecting the availability of food items targeted by foraging birds. Similarly water runoff from stockpiles of excavated material could impact SCI bird foraging at the habitats through the introduction of sediment and chemical pollutants. Mitigation measures and the general construction practices required to prevent adverse effects are detailed in **Section 10.6**.



Figure 10.19: Sediment plume from the Avoca River dispersing into the Irish Sea.

Release of contaminants and elevated chloride concentrations from excavated dredge material

There is a risk runoff from stockpiles of excavated dredge material, in particular during dewatering, may result in the introduction of hazardous and non-hazardous material, and elevated chloride concentrations water to the nearby river channel, impacting water quality.

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

Mitigation measures specifically designed to avoid the introduction of sediment and contaminants in runoff to the river channel are detailed in **Section 10.6**. Mitigation measures are not necessary to address the introduction of slightly elevated chloride concentrations run off into the river during excavation given the tidal influence on this section of river.

Mitigation measures to address runoff from contaminants at the site compounds are detailed in **Section 10.6** At SC5 runoff with elevated chloride concentrations will be directed to the Irish sea; given the relatively small volume of runoff from the dredge material and the full marine salinity of the receiving waters (~35ppt) there will be no effect local salinity levels.

Chemical contamination of river channel and sediment could also occur from accidental spillages, such as oil and other chemicals through poor operational management, the non-removal of spillages, poor storage, handling and transfer of oil and chemicals.

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

Mitigation measures specifically designed to avoid the introduction of runoff and contaminants to the river channel are detailed in **Section 10.6**.

Accidental spillages will be contained and cleaned up immediately. Remediation measures will be carried out in the unlikely event of pollution of the marine environment (see **Section 10.6**).

Seepage of runoff with elevated chloride concentrations

As outlined above, runoff with elevated chloride concentrations will arise during the placement of excavated dredge material at SC1 for archaeological examination and stockpiling. This material will also be reused in the flood embankment and runoff will percolate into the ground. The runoff will disperse in the generally vicinity of the percolation and be ultimately diluted by groundwater. The maximum depth of dredging will be approximately 1.0m. Median salinity levels of sediments 1m below river bed is approximately 62mg/l.

The median salinity level of groundwater at the marsh area is 50mg/l, while the EPA reports salinity levels in the Avoca River (around the bridge) at approximately 1500mg/l (*i.e.* 1.5ppt). At SC1 any effect of runoff with elevated chloride concentrations on the salinity levels of groundwater would be negligible and significantly less than the current natural periodic flooding of the marsh area by the Avoca.

10.5.4.2 Impact Mechanism 2 Loss of In-River Habitats and Impact Mechanism 4 Loss of Terrestrial

The biological receptors of concern are:

- Benthic Habitats
- Birds - Potential *ex-situ* effects to SPAs
- Birds - Potential *in-situ* effects to resident bird species
- Otter

Benthic Habitats

The proposed dredging of river sediments will result in the loss of river bed including the construction of river access points, temporary causeways and the installation of the debris and gravel trap and riprap within the river channel. As noted above however, the biological diversity of in-river sediments is low, and the conservation significance of the loss is considered therefore to be low.

Loss of species due to dredging will be temporary as larvae, whether from fresh water or marine sources will quickly re-colonise to newly exposed sediments post-dredging. Consequently, there is no risk of significant effects to benthic habitats.

Potential ex-situ effects to SPAs

As shown in **Section 10.4.6** a total of 24 SCI bird species of SPAs have been recorded in the proposed development area and adjacent pNHA. The species are listed in **Table 10.13** alongside species ecology (feeding guilds, habitat preference typical diet, foraging behaviour *etc.*) and maximum recorded foraging ranges.

As outlined in **Section 10.4.3**, of the 24 SCI species, 17 SCI species were screened out while 7 SCI species were brought forward to the NIS for further assessment of *ex situ* effects due to the loss of marsh habitat and in-river habitat. The 7 SCI species brought forward to the NIS are highlighted in **bold** in **Table 10.13**. The SPAs designated for the species considered in the NIS are listed in **Section 10.4.3**.

The construction of the flood wall and installation of the embankment upstream of the river at Arklow Town Marsh pNHA will result in loss of river habitat and habitats within the Arklow Town Marsh pNHA; estimates of the extent of habitats lost due to installation of flood walls and embankment is presented in **Table 10.14**.

Based on the SCI species feeding guilds, habitat preference and typical diet (described in **Table 10.13**) six habitat types are likely to be suitable to the SCI species possibly used by the species for foraging are highlighted in **bold** in **Table 10.14**. The habitats possibly used by the species are:

- FS1 Reed and tall sedge swamp
- FS2 Tall-herb swamp
- GA1 Improved agricultural grassland / GS4 Wet grassland
- GS4 Wet grassland
- WL2 Treelines
- WS1 Scrub

In addition to the terrestrial habitats listed above, the aquatic habitat CW2 Tidal Rivers / FW2 Depositing Lowland Rivers, which includes the in-stream vegetated islands and gravel bank located upstream of the Arklow bridge, is of importance to the SCI species.

While the proposed development will result in the loss of parts of terrestrial habitat types within the Arklow Town pNHA likely to be used by SCI species, in each case, the area of habitat lost relative to the total area of the habitats area within the Arklow Town March pNHA is small. As the area of terrestrial habitats lost is small relative to the area available to the species, there is **no risk of significant adverse** of *ex situ* effects to the SCIs.

Within the aquatic habitat CW2 Tidal Rivers / FW2 Depositing Lowland Rivers, the vegetated islands provide roosting for bird species while birds, in particular gulls, use the gravel banks to roost on, and bathe and preen in the water of the river. The removal of the vegetated islands and gravel bank will result in the loss of approximately 0.2 ha of habitat potentially used by the SCI bird species.

The area lost is extremely small relative to the extent of habitat used by the SCI bird species in the area and within SPA sites designated for the species. Consequently, it is concluded that there will be **no risk of significant** *ex-situ* effects to SCI species due to habitat loss.

Table 10.13: Special Conservation Interest Species of SPA. SCI species brought forward to the NIS are highlighted in bold.

Foraging Guild (Weller 1999)	Special Conservation Interest Species	Habitat Preference and Diet (IUCN and Bird Watch Ireland)
Surface swimmer	A053 Mallard (<i>Anas platyrhynchos</i>)	The species occurs in almost every wetland type although it generally avoids fast-flowing, oligotrophic deep, exposed, rough, rockbound waters and hard unvegetated areas such as rocky ground, sand dunes and artificial surfacing. It requires water less than 1 m deep for foraging and shows a preference for freshwater habitats although it may frequent shallow brackish waters as long as they provide the cover of submerged, floating, emergent or riparian vegetation, dense reedbeds or overhanging branches. Its diet consists of seeds and the vegetative parts of aquatic and terrestrial plants (<i>e.g.</i> crops) as well as terrestrial and aquatic invertebrates (especially in the spring and summer) such as insects, molluscs, crustaceans, worms and occasionally amphibians and fish.
	A052 Teal (<i>Anas crecca</i>)	They usually nest near small freshwater lakes or pools and small upland streams away from the coast, and also in thick cover. During winter species is widespread on wetlands with good cover, such as reedbeds. Wide variety of habitats, both coastal and inland, and usually below an altitude of 200 metres, including coastal lagoons and estuaries and inland marshes, lakes, ponds and turloughs. Small seeds predominate, but <i>Enteromorpha</i> sp. and molluscs are also frequently taken. Occasionally feed on chironomid larvae where available, though usually during the summer months. They feed by day where they are safe from shooting.
	A059 Pochard (<i>Aythya ferina</i>)	Its diet consisting of seeds, roots, rhizomes, the vegetative parts of grasses, sedges and aquatic plants as well as aquatic insects and larvae, molluscs, crustaceans, worms, amphibians and small fish. This species requires well-vegetated eutrophic to neutral swamps, marshes, lakes and

Foraging Guild (Weller 1999)	Special Conservation Interest Species	Habitat Preference and Diet (IUCN and Bird Watch Ireland)
		slow-flowing rivers with areas of open water and abundant emergent fringing vegetation.
	A061 Tufted Duck (<i>Aythya fuligula</i>)	The species is omnivorous feeding mainly on molluscs, gastropods, crustaceans and aquatic insects, as well as seeds and vegetative parts of aquatic plants. It is common on large, freshwater lakes, ponds, reservoirs, gravel-pits and quiet stretches of wide slow-flowing rivers during this season
Water column diver (shallow)	A067 Goldeneye (<i>Bucephala clangula</i>)	Suitable habitats include freshwater lakes, pools, rivers and deep marshes surrounded by coniferous forest Nests in hollows of mature trees. The species will preferentially nest in trees in open stands near water or solitary trees on the edges of marshes, rather than in trees in dense stands in order to increase the ease of entry by flying. The species will also nest in artificial nest-boxes.
	A229 Kingfisher (<i>Alcedo atthis</i>)	Suitable habitats include freshwater lakes, pools, rivers and deep marshes surrounded by coniferous forest Found by still or slow flowing water such as lakes, canals and rivers. Typically observed on branches beside streams or river. Lays egg in nest at the end of riverbank burrows. Main prey is fish but will also consume aquatic insects, flies (Diptera), butterflies and moths (Lepidoptera), amphibians (Rana), crayfish (<i>Astacus</i>), prawns (<i>Palaemon</i>), amphipods (<i>Gammarus</i>) and isopods in winter. Very occasionally it feeds on berries (<i>Rubus</i> , <i>Sambucus</i>) and stems of reed (<i>Phragmites</i>). In areas where freezing conditions occur in winter, it regularly migrates south, but generally stays within the species' breeding range. Southern populations are usually sedentary (Woodall 2016).
Water column diver (deeper)	A017 Cormorant (<i>Phalacrocorax carbo</i>)	Found in coastal/ marine waters. Diet consists predominantly of fish, including sculpins, Capelin, gadoids and flatfish as well as crustaceans, amphibians, molluscs and nestlings. At sea, the species preys mostly on bottom-dwelling fish, occasionally also taking shoaling fish in deeper waters. It is a generalist, known to feed on at least 22 different fish species.
	A001 Red-throated Diver (<i>Gavia stellata</i>)	Species breeds on freshwater pools or lakes in open moorland, blanket bogs or open and wet peatland habitats. It will nest on pools as small as 10-20 m long or on lakes up to 5 ha in area, showing a preference for those in treeless areas that have well-vegetated margins and low islets or promontories on which to nest. It generally avoids waters with dense floating or emergent vegetation and steep rocks above the water. Outside of the breeding

Foraging Guild (Weller 1999)	Special Conservation Interest Species	Habitat Preference and Diet (IUCN and Bird Watch Ireland)
		season, the species frequents inshore waters along sheltered coasts, occasionally occurring inland on lakes, pools, reservoirs and rivers. Its diet consists predominantly of fish as well as crustaceans, molluscs, frogs, fish spawn, aquatic insects, annelid worms and plant matter.
Intertidal walker (in and out of water)	A160 Curlew (<i>Numenius arquata</i>)	The species frequents muddy coasts, bays and estuaries with tidal mudflats and sandflats, rocky and sandy beaches with many pools, saltmarshes coastal meadows and pasture and muddy shores of coastal lagoons. It also utilises wet grassland and arable fields during migration. Its diet consists chiefly of annelid worms and terrestrial insects especially during the summer although it will also take crustaceans, molluscs, polychaete worms.
	A130 Oystercatcher (<i>Haematopus ostralegus</i>)	Forages on intertidal soft substrates on bivalves and gastropods. Polychaetes and crustaceans are more important in estuaries however, and molluscs are most important on rocky shores. When inland, prey such as earthworms and insect larvae (e.g. caterpillars and crane fly larvae) are also taken.
	A140 Golden Plover (<i>Pluvialis apricaria</i>)	Diet consists of small crustaceans, molluscs, polychaete worms, isopods, amphipods, insects (e.g. ants, beetles, flies and fly larvae) and millipede. Found on muddy, sandy or pebbly coasts.
	A137 Ringed Plover (<i>Charadrius hiaticula</i>)	Its diet consists of small crustaceans, molluscs, polychaete worms, isopods, amphipods, insects (e.g. ants, beetles, flies and fly larvae) and millipede and favours muddy, sandy or pebbly coasts in the tropics and subtropics including estuaries, tidal mudflats, sandflats and exposed coral reefs.
	A142 Lapwing (<i>Vanellus vanellus</i>)	Its diet consists of adult and larval insects (e.g. beetles, ants, Diptera, crickets, grasshoppers, dragonflies, mayflies, cicadas and Lepidoptera), spiders, snails, earthworms, frogs, small fish and seeds or other plant material. The species shows a preference for breeding on wet natural grasslands meadows and hay meadows with short swards and patches of bare soil at low altitudes.
	A028 Grey Heron (<i>Ardea cinerea</i>)	Generalist in its habitat use, although shallow water, relatively large prey, and four or five months of ice-free breeding season are among the essential characteristics of its habitat. Mainly feeds on fish and eels 10-25 cm long, as well as amphibians,

Foraging Guild (Weller 1999)	Special Conservation Interest Species	Habitat Preference and Diet (IUCN and Bird Watch Ireland)
		crabs, molluscs, crustaceans, aquatic insects, snakes, small rodents, small birds and plant matter.
	A169 Turnstone (<i>Arenaria interpres</i>)	Its diet consists of insects, crustaceans, molluscs, annelids, echinoderms, small fish, carrion and birds' eggs. The species favours intertidal rocky shores and quay and pier surfaces.
Surface swimmer/ Water column diver (shallow)/ Terrestrial walker	A125 Coot (<i>Fulica atra</i>)	This species is omnivorous, although its diet consists primarily of vegetable matter such as algae (e.g. <i>Chara</i> , <i>Cladophora</i> , <i>Spirogyra</i>), the vegetative parts of aquatic and terrestrial plants. The species inhabits large, still or slow-flowing waters and shows a preference for shallow water with adjacent deeper water (e.g. > 2 m) for diving, and muddy substrates, marginal, emergent, floating or submergent vegetation.
Surface swimmer/ Water column diver (shallow)	A004 Little Grebe (<i>Tachybaptus ruficollis</i>)	Species inhabits a wide range of small and shallow wetlands usually less than 1 m deep with rich vegetation and high densities of aquatic invertebrates, generally avoiding waters with large predatory fish. Suitable habitats include small lakes, ponds, the sheltered bays and vegetated shores of larger freshwater, alkaline or saline lakes and reservoirs, slow-flowing rivers, canals flood-plain oxbows, coastal brackish lagoons, seasonally inundated areas, swamps. Outside of breeding season it is common on more open waters and is occasionally observed along the coast in estuaries or sheltered bays protected from strong wave action. Diet consists predominantly of adult and larval insects, especially mayflies, stoneflies, water bugs, beetles, flies, caddisflies and dragonflies, as well as molluscs, crustaceans, adult and juvenile amphibians and occasionally small fish during the winter.
Surface swimmer/ Water column diver (shallow)/ Intertidal walker (out of and in water) / Terrestrial walker	A183 Lesser Black-backed Gull (<i>Larus fuscus</i>)	Species breeds in colonies, showing a preference for level-ground that is well covered with fairly close, short vegetation, often nesting under heather, bracken or other vegetation (sometimes under pine trees). Suitable sites include flat, unbroken grassy slopes, sand-dunes, the tops and ledges of coastal cliffs, rocky offshore islands, saltmarshes, the margins of inland lakes, islands in lakes and rivers, and high moorland, although the species will also nest on buildings and rooftops. Outside of the breeding season the species chiefly inhabits inshore and offshore seas, as well as lagoons, estuaries, harbours and seashores. It may also frequent inland habitats during this season, such as large lakes and rivers. The species is an omnivorous, opportunistic feeder that forages extensively at

Foraging Guild (Weller 1999)	Special Conservation Interest Species	Habitat Preference and Diet (IUCN and Bird Watch Ireland)
		sea. Its diet consists of small fish, aquatic and terrestrial invertebrates (e.g. beetles, flies and larvae, ants, moths, grasshoppers, crustaceans, molluscs, segmented worms and starfish), bird eggs and nestlings, carrion, offal, rodents, berries and grain. It often follows fishing fleets, feeding on discarded bycatch.
	A184 Herring Gull (<i>Larus argentatus</i>)	Species inhabits coastal and near-coastal areas but may also forage inland on large lakes and reservoirs, fields and refuse dumps. It has no specific breeding habitat but may show a preference for rocky shores with cliffs, outlying stacks or islets, otherwise nesting on rocky and grassy islands, sandy beaches, gravel bars, saltmarshes, rocky outcrops, buildings. When inland on migration the species also shows a preference for large river valleys. The species has a highly opportunistic diet and will exploit almost any superabundant source of food. It takes fish, earthworms, crabs and other marine invertebrates (e.g. molluscs, starfish or marine worms), adult birds, bird eggs and young, rodents, insects (e.g. ants), berries and tubers. It also scavenges at refuse dumps, fishing wharves and sewage outfall zones and frequently follows fishing boats.
	A179 Black-headed Gull (<i>Chroicocephalus ridibundus</i>)	Terrestrial and coastal marine (mainly feeding on: aquatic and terrestrial insects, earth worms and marine invertebrates and some dead/sick fish).
	A182 Common (or Mew) Gull (<i>Larus canus</i>)	Its diet consists of earthworms, insects, aquatic and terrestrial invertebrates, crayfish and molluscs and small fish. On the coast it nests on grassy and rocky cliff-ledges, grassy slopes, inshore rocky islets, islands and stacks, and on sand and shingle beaches, banks and dunes amongst tide-wrack or flood debris. Inland the species nests on small islands in freshwater and saline lakes, shingle bars or small islets in streams or rivers islets, artificial structures and shores of artificial waterbodies with short, sparse vegetation.
Surface swimmer/ Intertidal walker (out of water),	A050 Wigeon (<i>Anas penelope</i>)	It is vegetarian and consumes the leaves, seeds, stems and root bulbs of pond weeds, fine grasses. Mainly uses Grassland, Wetlands (inland), Marine Neritic, Marine Intertidal, Marine Coastal/Supratidal.
Surface swimmer/ Terrestrial walker	A043 Greylag Goose (<i>Anser anser</i>)	In the winter, the species inhabits lowland farmland in open country, swamps, lakes, reservoirs, coastal lagoons and estuaries. The species is herbivorous, its diet consisting of grass, the roots, shoots, leaves,

Foraging Guild (Weller 1999)	Special Conservation Interest Species	Habitat Preference and Diet (IUCN and Bird Watch Ireland)
		stems, seedheads and fruits of other herbaceous marsh vegetation, aquatic plants, and agricultural grain and potatoes (especially in the winter).
Terrestrial walker	A395 Greenland White-fronted Goose (<i>Anser albifrons flavirostris</i>)	Species winters in open country on agricultural land, improved grassland, stubble fields, and wet meadows or in brackish and freshwater marshy habitats such as upland bogs, peatlands and floodlands. It may also roost on tidal marshes, in sheltered bays or in estuaries and frequents inland lakes. The species is herbivorous, its diet consisting of the roots, leaves, stems, seeds and fruits of terrestrial plants such as herbs, grasses and sedges, as well as agricultural grain, wheat, rice and barley, potatoes and sprouting cereals (especially in the winter).

Table 10.14: Area of habitats lost at Arklow Town pNHA

Habitat (Fossitt classification)	Hectares Lost		Total Hectares Lost
	Habitat within pNHA and planning boundary	Habitat outside pNHA but within planning boundary	
GA1 Improved agricultural grassland / GS4 Wet grassland	1.37	0.83	2.20
FS1 Reed and tall sedge swamp	1.05	0.28	1.33
WL2 Treelines	0.31	-	0.31
WS1 Scrub	0.19	-	0.19
FS2 Tall-herb swamp	0.01	-	0.01
GS4 Wet grassland	0.12	-	0.12
CW2 Tidal / FW2 Depositing Lowland Rivers	0.20	-	0.20

Potential in-situ effects to resident bird species

As described above, the vegetated islands and gravel banks which are located immediately upstream of the Arklow Bridge will be removed as part of the development are used by a range of birds for roosting, resting, bathing and preening.

The habitats, in particular the gravel banks, are not well represented in the Arklow area; consequently, the loss of the habitats would be result in significant changes to bird behaviour in the area.

In order to mitigate effect on bird's behaviour due to the loss of in-river gravel beds due to the river dredging works, it is proposed to install three roosting platforms in the river channel upstream of Arklow Bridge. Along River Walk and South Bank riparian habitat/refuge areas will be also created to mitigate direct and indirect effects of the river dredging works on birds.

As described above the work involve the removal of trees to accommodate the construction of the FRS. The impact of the removal of trees during construction on bird foraging, roosting and nesting will be mitigated through the tree/landscape planting. Detail of the planting proposed is presented in **Appendix 4.2**.

Section 10.6.4 also describes the installation of nesting boxes at Arklow Bridge for the Red-listed species Grey wagtail and for Pied wagtail. These species have been consistently recorded along the Avoca River banks and feeding on exposed gravels.

Otter

As noted in **Section 10.4.10.4**, whilst otter runs, slides and holts were not identified during the walkover surveys within the planning boundary, otter have been observed using the river in the Arklow area and it is likely that the vegetation at the banks of the Arklow Town pNHA may provide suitable habitat for the species. Potential mitigation required for resident otter is presented in **Section 10.6.6**.

10.5.4.3 Impact Mechanism 3 Noise Disturbance

Construction activity including the construction and installation of earth embankments, demolition works, pilling operations, dredging, construction traffic movements, removal and disposal of dredge spoil and removal of debris from the brash trap will result in noise emissions resulting in disturbance to both aquatic and terrestrial taxa.

The taxa considered here with regard to Impact Mechanism 3 Noise Disturbance are:

- Marine Mammals
- Fish
- Otter
- Bats

Marine Mammals

As outlined in **Section 10.4.10.3** the Arklow River Avoca River and Arklow FRS development area does not represent an important foraging area for the marine mammals. As the area is highly unlikely to support significant number of marine mammal species it is possible to rule out the potential for significant effects.

With regard to impact of noise on marine mammals, the record of one Common Seal in the estuary is not considered of sufficient significance to merit the necessity of marine mammal observer to be on site during the construction period.

Fish

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

Hearing in salmon is considered to be relatively poor, with the species responding only to low frequency tones (below 0.38 kHz). While there are no data available for hearing in lamprey, it is highly unlikely that they detect sound close to 10 kHz (Popper, 2005). The lamprey ear is relatively simple and there is nothing within the structure of the ear or associated structures to suggest any specialisations that would make them into anything but a hearing generalist, with maximum hearing to no more than several hundred Hz. Noise disturbance can result in auditory injury and behaviour changes.

Exposure to high energy noise emissions (piling, drilling, seismic noise) can result in recoverable auditory injury (termed Temporary Threshold Shift [TTS]) and non-recoverable auditory injury (termed Permanent Threshold Shift [PTS]). Behavioural reactions to acoustic exposure are generally more variable, context-dependent, and less predictable than the effects of noise exposure on hearing or physiology. This is because behavioural responses to anthropogenic sound are dependent upon operational and environmental variables, and on the physiological, sensory, and psychological characteristics of exposed animals.

It should be noted that the potential impact of noise on fish in open water are considered to be minimal as they can readily move away from the noise source (Popper, 2005). Experiments on fry demonstrated balance problems resulting from exposure to an energy source, however, the effects were temporary with full recovery observed after a few minutes upon cessation of the noise (Kostyuchenko, 1971). Some studies of high energy seismic noise sources have also demonstrated fish's ability to acclimatise to noise associated with an energy source over time (e.g. Chapman and Hawkins, 1969).

Prolonged exposure of individual fish to injurious noise from construction noise and vibration is unlikely occur as fish are unlikely to stay in the vicinity noise sources.

Based on the above it can be concluded that there will be no significant adverse effects to the diadromous fish species from noise.

Otter

Otters are quite tolerant of human disturbance and are often recorded in urban areas. Otter are mainly active in the early morning and/ or late evening. Given this behaviour, it is unlikely that the species will be active in the project area during operations and encounter rates will be low; consequently, significant disturbance effects will not occur. It is possible that while ongoing, construction activity will deter otter from foraging in the immediate project area. It should be noted however that given the general daylight timing of construction activities, any disturbance resulting in displacement of the species will be temporary and short lived and will not result in significant effects. In addition, there are extensive alternative areas of otter habitat available to the species away from the project area.

Bats

Bat Roosts

The Arklow Bridge bat roost will be subjected to considerable disturbance and disruption and may be temporarily lost during the work carried out here or permanently lost through any work carried out on the bridge structure. The following works will potentially impact on the bat roost:

- Repairs to Arklow Bridge will remove crevice roost sites for bats such as the Daubenton's bat.
- Vegetation on the bridge is required to be removed for engineering integrity reasons.
- There is the potential for leakages of grout getting into the river
- There will be permanent loss of riverbed habitat where the scour protection is constructed.
- Underpinning of the bridge piers and abutments;
- Lowering of the floor of the Arklow Bridge by approximately metre;
- Provision of scour protection to the bridge piers; and
- Repairs to the masonry work of the older section of the bridge.

In all, this creates a long-term moderately negative impact upon bats.

The approach for carrying out the works on the bridge will be as follows. All bridge works (phases 1-4) will be fully completed for approx. a third of the bridge each year. Note that the working area will extend beyond a third to allow for bunds, working space, *etc.* In-stream works are restricted to the summer season due to fisheries constraints, therefore it is not possible to carry out the in-stream underpinning works between 1st September and-31st March.

- Year 1 (2022) - Works to southern half of the bridge (phases 1-4). There will be considerable disturbance in the southern half during that summer but there will be little/no disturbance to northern half of the bridge for first year.

- Year 2 – Works to central part of the bridge (phases 1-4). There will be little/no disturbance to southern quarter of bridge and little disturbance to northern quarter of bridge (passing construction traffic) for second year;
- Year 3 - Works to northern half of the bridge (phases 1-4). There will be considerable disturbance in the northern half during that summer but there will be little/no disturbance to southern half of the bridge for third year.

Overall, the potential impact would be loss of Actual and Potential Roosts and Risk of Injury to Bats.

Lighting

There will be an increased level of lighting through illumination during the 4 year construction period required for night-time work at the river. There may be an increased level of lighting brought about through tree removal and exposure of the area to the town lighting. Lighting upon the bridge at present is most probably intrusive for roosting bats but is primarily focussed to the east of the bridge while roost sites are to the western side of the bridge. This may create disturbance of light intolerant or shy species at present while the more urban-adapted species will be affected only over a short-term period. Of the species noted on and around the site, no bats would be considered light intolerant as they will generally avoid direct illumination but are not usually fully excluded by the presence of light.

Lighting for the night work may be more disruptive as it will need to create suitable illumination for work as well as access.

Pipistrelles, the main species within the area, are negatively affected by lighting but to a lesser extent than most Irish species. Leisler's bats are the most tolerant of light of the three species noted. This species will feed around lighting in car parks as the night progresses. There are no roosts directly illuminated by changes to the site as there were no roosts noted within the site in June 2016 or in August 2017.

Lighting will be increased by the presence of lighting for night-time work and as regards long-term changes by vegetation clearance and no additional lighting is foreseen for the Flood Relief Scheme. Species such as common pipistrelle and Leisler's bat are less affected than all other Irish bat species (but are less common in lit sites than in dark sites of similar habitat) and this would not be a significant impact overall in the current situation. Lighting along the river is higher in 2020 than in it was in 2016 or 2017.

At worst, it would be a permanent slightly negative impact as well as a short-term moderately negative impact.

Removal of vegetation and reduced feeding

There will be tree felling and some scrub removal within the river. The mature conifers along the river have already been removed but there may be some further tree removal here, of which there is low to no roost potential considered for the remaining trees. The provision of any screening with vegetation provides feeding and commuting potential for bats.

There will be alterations (removal) to the vegetation including mature trees within the river.

Dredging will affect insect availability and would affect feeding success within this area for bat species such as Daubenton's bat and soprano pipistrelle in particular. There will be reduced feeding at Arklow Bridge from the removal of trees and small islets within the river. Dredging will affect insect availability. Feeding loss around the existing trees may constitute a long-term slightly negative impact. Dredging may create a short-term moderate negative impact.

Cumulative Loss of Feeding and Commuting

The changes within Arklow, if following current trends would see a loss in green space, increase in lighting and increase in modern buildings with an associated removal of old buildings for some developments. These would all create a permanent moderate negative impact if not appropriately mitigated in each project.

10.5.5 Cumulative Effects

10.5.5.1 Initial Screening

This assessment of potential cumulative effects considers the potential impact associated with the proposed Arklow FRS development that in combination with other plans and project may result in significant effects to biological receptors of the environment outlined in **Section 10.3**.

Where necessary mitigation envisaged to avoid, prevent, reduce and where or, if possible, offset any identified significant effects on the environment during construction and operation phases of the development.

To inform the assessment of potential in combination effects a review of consent applications of current and proposed projects in the vicinity of the proposed project included on the following web-sites was completed in April 2021:

- Department of Housing, Local Government and Heritage (DHLGH) – Foreshore Applications
 - <https://www.housing.gov.ie/planning/foreshore/applications/>
- DHPLG - EIA Portal
 - <https://www.housing.gov.ie/planning/environmental-assessment/environmental-impact-assessment-eia/eia-portal>
- Wicklow Council - Planning System
 - <https://www.wicklow.ie/Living/Services/Planning/Planning-Applications>

Assessments of current and proposed projects listed on above websites identified potential cumulative effects from the following projects (in combination effects assessed in **Section 10.4.4.2**):

- Circle K Safeway Service Station (20426) - This project relates to the demolition of the existing, and construction of a new, fuel forecourt at the existing Circle K service station, which is located adjacent to Arklow Town Marsh and SC1 of the proposed scheme.

Both the Circle K project and Arklow FRS development carry the risk for the uncontrolled release of discharges including sediment laden water or other waste material pollution, to the nearby marsh habitats and river. There is potential that these discharges may act in combination to directly impacting habitat and water quality, and indirectly effect the availability of food items used by SCI birds foraging in the area. Further detailed consideration of the potential for in combination effects is required (see **Section 10.5.5.2**).

- FS006862 Irish Water - Arklow Waste Water Treatment Plan - The proposed Arklow Wastewater Treatment Plant Project comprising a new Wastewater Treatment Plant, associated infrastructure including sewer network and marine outfalls as well as an upgrade to existing coastal revetment. The proposed WwTP project planning boundary is concentrated around the waterfront area of Arklow, with the proposed interceptor sewers located along the northern and southern banks of the Avoca River channel and the WwTP located at the Old Wallboard site at Ferrybank. Given the relative location of the WwTP project and FRS development planning boundary areas there is potential for in-combination effects. Further detailed consideration of the potential for in combination effects is required (see **Section 10.5.5.2**).
- FS007049 Sure Partners Site Investigations at Arklow Bank – Site investigations proposed at sites and harbour marina on the south shore immediately adjacent to works proposed at the marina for the Arklow FRS development area. Further detailed consideration of the potential for in combination effects is required (see **Section 10.5.5.2**).

Potential cumulative effects from the following projects were excluded based on the distance from the Arklow FRS development:

- Action Health Enterprises GP Limited the Former Boland's Builders Providers, Castle Park (181170) - This project relates to the development of a primary care facility at Castle Park.
- Frank & Sandra Duffy No 7 and 8 Bridge Street &, No 34 Main Street (19750) - The project relates to the demolition of 2 existing buildings and the construction of a new retail and commercial building on Main Street.
- Gaines Europe Ltd Unit 1A Lower Tinahisk, South Quay (16248) - This project relates to the development of a new warehouse and distribution facility at Arklow Harbour.
- Gaines Europe Ltd Tinahisk Lower, South Quay (16414) - This project relates to the demolition of an existing industrial building at Arklow Harbour.
- Joby Developments North Quay, Arklow (15857) – This project relates to the demolition of existing structures and the construction of 2 no. 5 storey blocks.
- Mill Sea Ltd North Quay, Arklow (18316) – This project relates to the demolition of existing disused industrial buildings.
- Crag Digital Avoca Limited (18940/201285) – This project relates to the construction of a data storage facility comprising 3 data storage buildings in the Avoca River Business Park.

- Parade Ground (186) – This project relates to the transformation of the streetscape and public realm.
- Arklow Bank Wind Park Phase 2 Onshore Grid Infrastructure (Pre-application 306662) – This project relates to the onshore grid infrastructure to the Arklow Bank Phase 2 wind park.
- 20469 (Wicklow County Council Inner Harbour / Dock, Off South Quay) - Construction of 14 Storage units and associated site works

10.5.5.2 Assessment of Potential Cumulative Effect

Circle K Safeway Service Station

The project involves the demolition of the existing, and construction of a new, fuel forecourt at the service station, which is located adjacent to Arklow Town Marsh and SC1 of the proposed scheme. The Circle K project carries a risk of generation of discharges.

Consent to undertake the Circle K project will be subject to conditions that will require that activities are undertaken to ensure significant impact associated with discharges do not occur. As outlined in **Section 10.5.4.1** the biological receptors of concern with regard discharges are:

- Fish
- Otter
- Benthic Habitats
- Birds

Activities proposed for Arklow FRS development will be require implementation mitigation measures (see **Section 10.6** and the Construction Environmental Management Plan (CEMP) in **Appendix 5.1**) that will ensure no significant release of sediment in laden water and runoff chemicals or other waste material pollution into the Arklow River or marsh area. With the implementation of measures, it is concluded that significant cumulative effects will not occur.

Irish Water - Arklow Waste Water Treatment Plan

The main aim of the proposed Arklow Town WwTP development is to collect and appropriately treat the wastewater generated in Arklow town (which currently discharges untreated wastewater to the Avoca River) such that the treated effluent complies with national and EU standards.

Interceptor sewers proposed along the North and South Quays in Arklow will intercept the existing wastewater flows and convey them to the proposed wastewater treatment plant (WwTP). The proposed location of the WwTP is at the Old Wallboard Site at Ferrybank, immediately adjacent to the North Quay (on the northern bank of the Avoca River) and the Irish Sea. The final treated effluent from the WwTP will discharge into the Irish Sea via a *ca.* 900m long outfall pipe with a diffuser section at its end.

The Arklow FRS development and the Arklow WwTP project overlap within the Avoca River and Estuary. There is potential that activities proposed for the schemes to result in cumulative effect to biological receptors.

With regard to potential cumulative effects, the activities proposed for the Arklow FRS development and the Arklow WwTP project of concern are those that have potential to result in:

- release of sediment and pollutants
- loss of terrestrial habitat and disturbance
- generation of noise

Release of sediment and pollutants

As outlined in **Section 10.5.4.1** above the activities of concern proposed for the construction and operational phases of the Arklow FRS development with regard to the release of sediment and chemical pollutants from machinery include construction, dredging (both capital and occasional channel dredging) and excavation operations associated with the installation/ removal of temporary river access points, haul roads and causeways and the annual removal of debris from the debris and silt traps will result in the release of sediment to the river adjacent to, and downstream of, the development site. There is also potential risk of run off of sediment and chemical pollutants from stock piles of excavated material and dredge material.

For the proposed Arklow WwTP project the main potential sources of releases of sediment and pollutants from machinery are construction activities occurring within the Avoca River channel including the construction of interceptor sewers along the North and South Quays and the construction and operation of temporary causeway and the storage/ transportation of excavated materials and construction materials. These activities all have the potential to give rise for silt, soil and chemical pollutants to enter into the Avoca River and estuary. In addition, there is potential that the unintentional release of bentonite used for drilling could contribute to levels of suspended material in the water column.

For the schemes, the biological receptors of concern with regard to the potential effect of the release of sediment and pollutants are fish (including diadromous species migrating through the area) and benthic habitats.

There is potential that increases in suspended sediments due to activities proposed for the schemes could effect the gills of fish including migratory fish species such as salmon and lamprey, resulting in injury or mortality. There is also potential that increases in suspended sediments could effect water turbidity reducing predation efficacy in visual feeders such as salmon.

There is potential that the schemes will result in run off of sediment, and hazardous and non-hazardous material from stockpiles of material, and the accidental release of hydrocarbons from plant machinery and fuel stocks.

Organic polymers or heavy metals associated with cementing/ concreting materials used for construction activities for the schemes are toxic to organisms in sufficient quantities and have the potential to contaminate the seabed sediments adjacent to the project, inhibiting recolonisation of the area after construction and or dredging.

For the Arklow FRS development a suite of mitigation measures have been identified to ensure likely significant effects to fish and benthic habitats from discharges do not occur. These mitigation measures are detailed in **Section 10.6** and the CEMP presented in **Appendix 5.1** below.

Consent to undertake the Arklow WwTP project is subject to the meeting of conditions that require that activities are undertaken to ensure significant impact associated with discharges do not occur.

Following the implementation of mitigation measures proposed for the Arklow FRS development and the consent conditions set for the Arklow WwTP project, significant cumulative environmental effects due to discharges will not occur whether the schemes are undertaken concurrently or consecutively. The mitigation measures and consent conditions include the implementation of seasonal restrictions of in-stream works and standard construction best practices.

It should be noted that increased water turbidity following dredging for the Arklow FRS development will not introduce significant amounts of sediment to the lower Avoca or nearby marine environment, as local water currents will result in the deposition of the majority of sediment near the dredging activity. Where sediment is deposited outside of the immediate dredge areas, any effects of deposition are not likely to be significant for the local sedimentary habitats and fauna, as the areas are naturally turbid (see above) and hydrodynamically active experiencing a high degree of natural suspended solids due to the current tidal regime and sedimentary nature of the area.

Loss of habitat and Disturbance

Birds

Tree felling, removal of scrub and other tall vegetation is required to accommodate the proposed Arklow FRS development and the Arklow WwTP project. In a number of instances, the areas to be impacted by the schemes are foraging, resting and roosting habitats for resident birds. For both schemes tree/landscape planting will be undertaken to address the loss of terrestrial habitat. For the proposed Arklow FRS the landscape design/public realm drawings (**Appendix 4.2**) provide details on the planting types and species proposed in addition to the identification of trees to be retained within the planning boundary. The detail of the tree/landscape planting proposed is detailed in **Section 10.6** while further details is provided in **Chapter 11 Landscape and Visual**. The removal of all vegetation will be carried out between 1 September and 28 February, to avoid any risk to breeding birds and their habitats.

In addition to the tree/landscape planting described above, the proposed Arklow FRS and the Arklow WwTP project include the installation of nesting boxes at the Arklow Bridge to provide nesting habitat for the Red-listed species Grey Wagtail, and for Pied Wagtail that feed extensively along the river channel.

In addition to above mitigation, the Arklow FRS development also includes mitigation to avoid direct and indirect effects on bird behaviour due to the loss of in-river gravel beds and habitats.

Specifically, it is proposed to install three roosting platforms in the river channel upstream of Arklow Bridge and creation of riparian habitat. The details of the proposed mitigation is presented in **Section 10.6**.

Following the implementation of the mitigation measures described above for the schemes, significant cumulative environmental effects to birds due to habitat loss will not occur whether the schemes are undertaken concurrently or consecutively.

Bats

There is potential for disturbance, displacement, or habitat loss arising from the proposed schemes to affect bat species recorded during baseline surveys. The sources of effects common to the schemes relevant to bats are vegetation clearance and construction activities at Arklow Bridge. Given the potential for impacts, Bat Derogation Licences have been issued for schemes. Mitigation measures have been developed for the schemes to address potential effects. Mitigation measures proposed for the Arklow FRS development are detailed in **Section 10.6.5** below.

Following the implementation of the mitigation measures for the schemes significant cumulative environmental effects to bat will not occur whether the schemes are undertaken concurrently or consecutively.

Generation of noise

The Arklow WwTP project includes for a range of mitigation measures required to ensure no significant effect of the project to marine mammals in coastal and marine environments east of Arklow Harbour at South Quay.

Section 10.4.10.3 above has concluded that as the FRS development area does not represent an important foraging area for the marine mammals, it is highly unlikely to support significant number of marine mammal species and it is possible to rule out the potential for significant effects with regard to impact of noise on marine mammals. Consequently, it can be concluded here that significant cumulative environmental effects to marine mammal will not occur whether the schemes are undertaken concurrently or consecutively.

Sure Partners Site Investigations at Arklow Bank

Arklow Wind Park Project - SSE/ Sure Partners have proposed site investigations to inform the engineering and design of an offshore wind farm. The objectives of the site investigation are to gather geotechnical and wind resource information. The site investigation surveys proposed are:

1. Array Area Preliminary Site Investigation:

- a. Boreholes x 25 locations
- b. Cone Penetration Testing (CPT)'s x 40 locations
- c. Vibrocores (VC)'s or Grab samples x 30 locations
2. Cable Route Site Investigations:
 - a. CPTs every 500m along each route
 - b. VCs or Grab samples every 500m along each route
3. Floating LiDAR Deployment x 2 locations
4. Sediment Dynamic Measurements
 - a. Benthic Flume x 9 locations
 - b. Benthic Lander x 4 locations
5. Nearshore Landfall Site Investigation:
 - a. Landfalls: Boreholes x 4 locations at each landfall
 - b. CPT's x 8 locations at each landfall
 - c. Trial Pits on the beach x 5 at each landfall
6. Arklow Harbour Site Investigation for O&M Base
 - a. 6 x boreholes locations

Given the nature of the investigations proposed for the Arklow Wind Park Project the only impact mechanism associated with the Arklow FRS development that could result in cumulative effects is noise emissions from geotechnical survey proposed for 1, 2, 4, 5 and 6, (*i.e.* coring, borehole, trial pits excavation *etc.*).

Site investigations proposed for 1, 2, 4, and 5 are all located outside of the Arklow FRS development area in nearshore areas; given the location, nature and scale of the works there is no potential for cumulative effects with the Arklow FRS project.

Site investigations proposed for 6 are located in the harbour marina on the south shore immediately adjacent to works proposed at the marina for the Arklow FRS development area.

As outlined in **Section 10.5.4.3** the biological receptors of concern with regard impact of noise emissions are:

- Marine Mammals
- Fish
- Otter
- Bats

It was demonstrated that as the Arklow FRS development area is highly unlikely to support significant number of marine mammal species it is possible to rule out the potential for significant noise disturbance effects. Consequently, it is concluded that significant cumulative effects will not occur.

Given the hearing biology of the fish species and the fact that individual fish are unlikely to stay in the vicinity noise sources, significant adverse effects from injurious noise from construction noise and vibration are unlikely occur. The same remains true for the potential for injury at Arklow Harbour Site Investigation as a result of boring operations. Consequently, it is concluded that significant cumulative effects will not occur.

Otter have been recorded a significant distance upstream from the site of the proposed operations at harbour marina. Given this distance it is concluded that significant cumulative effects will not occur.

Underwater noise from the operations do not pose a risk to bats. Consequently, it is concluded that significant cumulative effects will not occur.

10.6 Mitigation Measures and Monitoring

10.6.1 Overview

The biological receptors identified for the provision of mitigation measures to ensure likely significant effects do not occur during the construction and operational phases of the proposed FRS development are listed below in **Table 10.15** alongside the associated Impact Mechanisms and a brief description of potential effects.

It should be noted that measures not specifically designed to address potential effect in the specific species groups listed here but that will be implemented as a matter of course during the Arklow FRS and to address potential effects associated with the Arklow WwTP project are also listed in the sections.

Proposed monitoring to be undertaken prior to and during work are briefly discussed in **Section 10.6.10** while mitigation to be implemented during scheme maintenance works are summarised in **Section 10.6.11**.

Table 10.15: Biological receptors requiring mitigation

Impact Mechanism	Biological Receptor	Summary of Potential Effects	For mitigation refer to:
Impact Mechanism 1 Discharges	Habitats	Potential for project discharges to contaminate habitats at the marsh and nearby river impacting resident flora and fauna, and inhibiting future recolonisation of the areas.	Section 10.6.2
	SCI Bird Species	Indirect effect of discharges on bird foraging success by reducing food availability.	
	Resident Bird Species		
	Diadromous Fish Species	Diadromous species have evolved over geological time to migrate through estuaries on their way to spawning grounds and as many estuaries are naturally high in turbidity, these species evolved mechanisms to deal with high suspended sediment loads. Despite these mechanisms and the fact that the Avoca River is naturally turbid conditions there remains potential that dredging activity may result in effects to Lamprey, Salmon. Mitigation is required to reduce any potential effect of the dredging on migrating fish species	Section 10.6.2.6

Impact Mechanism	Biological Receptor	Summary of Potential Effects	For mitigation refer to:
Impact Mechanism 2 Loss of In-River Habitats Impact Mechanism 4 Loss of Habitat at Arklow Town Marsh pNHA	Resident Bird Species	In order to mitigate direct and indirect effects on bird's behaviour due to the loss of in-river gravel beds due to the river dredging works, it is proposed to install three roosting platforms in the river channel upstream of Arklow Bridge. Marsh habitats used by bird species for foraging, roosting and nesting will be lost due to works at SC1 and SC3, and the installation of the embankment.	Section 10.6.4
Impact Mechanism 3 Noise Disturbance	Bat Species	As all bat species recorded within the planning boundary of the proposed FRS development are protected under Annex IV of the Habitats Directive, the works to be carried out to the two southernmost arches of Arklow Bridge and their associated piers require the aforementioned derogation license from the NPWS to allow works that would create a risk to bats and would remove existing roosting options. The following measures were proposed as part of the application for the derogation license and will be implemented during construction to meet the requirements for protecting the bats availing of Arklow Bridge.	Section 10.6.5

10.6.2 Habitats and Flora

10.6.2.1 Habitats

The site preparation of the compounds will be as described in **Section 5.4.3 of Chapter 5 Construction Activities** of the EIAR.

For the duration of the construction period when SC1 is in use and during WP5, Arklow Marsh pNHA and the river area will be protected from runoff by the installation of a temporary low bund constructed of impermeable material. It will be situated along the western boundary and will redirect surface water run off towards siltation traps before discharge.

Dredge material will be managed in an area situated on the south eastern portion of SC1 behind Circle K filling station. A low bund will be installed around the area on top of geotextile membrane and hardcore material. A localised stormwater drainage system will be constructed within the area to convey runoff to a sedimentation collection system. The collection system will be periodically monitored during material testing. Run-off collected will be directed to a siltation trap before discharge.

These measures will ensure that the likelihood of impacts is low. SC1 will be planted as described below in the following section on completion of the permanent works and as shown in the landscape design and public realm drawings in **Appendix 4.2**.

The site preparation of SC2 will be as described in Section 5.4.3 of Chapter 5 Construction Activities of the EIAR. In summary, a suitable geotextile membrane will be placed over the existing ground and suitable hardcore material will be placed over the geotextile to form a trafficable surface. A low bund, comprising precast concrete traffic barriers or similar wrapped in an impermeable membrane, will be constructed around the perimeter of the site to retain the temporary surface and the dredged material. The temporary surface will be graded to allow any water from dredged material to flow to a shallow drain around the perimeter by which it will flow to a sump from where it will be pumped to a storage tank for collection by tanker for disposal. SC2 will be returned to its current condition by levelling and reseeding the grass area.

At SC3, suitable geotextile membrane will be placed over areas of soft ground and hardcore material will be placed over the site to form a trafficable surface. Surface water run-off at SC3, which is likely to contain sediment due to the movement of construction traffic through it to the river and to WP5 works, will be prevented from running into the adjacent Avoca River by the construction of a low bund along the river edge and the diversion of any runoff to a sump from where it can be discharged through a sedimentation tank. SC3 will be grassed as per the Drawing No 304 (Appendix 4.2).

At SC5 and SC6, a low bund, comprising precast concrete traffic barriers or similar, will be constructed around the perimeter of the site to retain the dredged material.

At SC6, a 5m buffer zone will be created between the working area and the *Equisetum Moorei* habitat through the construction of a low bund (approximately 0.5m high) and 1.5m high fence. The bund will prevent any runoff from the dredged material flowing into the habitat of the *Equisetum Moorei*.

SC5 and SC6 will be reinstated to their existing condition on completion of the permanent works.

The northern bank, upstream of Arklow Bridge, will be extended into the river channel for a length of c.75m and up to 12.0m in width. The realigned river bank will be formed using rip rap at the river bed level and inert dredge material and earth will be placed on top to match the levels of the existing river bank. The extended river bank will be landscaped with mixed native woodland trees. This area is referred to as Area No 1 on **Dwg 304 (Appendix 4.2)** and will consist of: *Alnus glutinosa* (Black Alder), *Salix aurita*, *Salix cinerea oleifolia*, *Salix caprea*, *Salix petrandra* (Willow) and *Betula pubescens* (Downy Birch).

The increase in levels of sections of the river bank along River Walk and South Bank will provide some opportunities for riparian habitat creation and refuge areas to mitigate direct and indirect effects of the river dredging works on aquatic mammals and birds (Refer to (refer to **Drawing Nos. 1003, 1013 and 1016 in Appendix 4.1**).

10.6.2.2 Planting

Tree/landscape planting will be undertaken to address the loss of terrestrial habitat to accommodate the FRS. The landscape design/public realm drawings (**Appendix 4.2**) provide details on the planting types and species proposed in addition to the identification of trees to be retained within the planning boundary. Further details are also provided in **Chapter 11 Landscape and Visual**. The following details on the drawings are of particular relevance for habitat mitigation:

- **Dwg 300:** River Walk (South Bank) Planting proposed: Semi-mature tree species proposed include: *Acer platanoides* 'Columnare' (Norway Maple), *Betula pendula* (Birch), *Crataegus laevigata* 'Paul's Scarlet' (Hawthorn), *Pinus sylvestris* (Scot's Pine), *Prunus avium* 'Plena' (Double flowered Wild Cherry). Ornamental shrubs and perennials, amenity grass.
- **Dwgs 301, 302 and 303:** South Quay to Arklow Harbour (South Bank) - Planting proposed: Semi-mature tree species proposed include: *Acer platanoides* 'Columnare' (Norway Maple), *Ulmus* "Lobei" (Elm), *Prunus avium* 'Plena' (Double flowered Wild Cherry). Ornamental shrubs and perennials, amenity grass.
- The landscaping at Arklow Marsh (adjacent to the proposed embankment) and the extension to the north river bank upstream of Arklow Bridge will provide some opportunities for habitat creation and mitigation of direct and indirect effects on biodiversity due to the loss of in-river vegetated islands and loss of habitat in the marsh pNHA. Further details are provided below.
- Native Woodland planting (Area No 1) is proposed along the new extended north bank of the river (Refer to **Dwg 304**) and will consist of: *Alnus glutinosa* (Black Alder), *Salix aurita*, *Salix cinerea oleifolia*, *Salix caprea*, *Salix petrandra* (Willow) and *Betula pubescens* (Downy Birch).
- Irish Native species rich grass and wildflower mixture is proposed along the river side of the new floodwall on north bank (SC3) and along the length of the embankment (Refer to **Dwg 304, 305 and 306**).
- Native Woodland planting (Area No 2) is proposed along the east side of the embankment and in SC1 (Refer to **Dwg 304, 305 and 306**) and will consist of: *Alnus glutinosa* (Black Alder), *Salix spp.* (Willow) and *Betula pubescens* (Downy Birch), *Prunus spinosa* (Blackthorn), *Crataegus monogyna* (Hawthorn) and *Viburnum opulus* (Guelder Rose).
- Upon completion of the works, in-stream (aquatic) vegetation will be allowed to re-colonise naturally, however, this will be monitored and if deemed necessary additional planting of suitable aquatic plant species will be undertaken.
- Upon completion of the works any other grassland areas disturbed during the construction works, will be re-sown with an appropriate species-rich grass and/or native wildflower seed mix option (refer to planting detail above and landscape drawings in **Appendix 4.1**).

10.6.2.3 Tree Removal

The plans for tree removal for construction of the proposed scheme are shown in the landscape drawings in **Appendix 4.2**. Tree removal is also described in **Chapter 12 Landscape and Visual**.

Mitigation measures for bats during tree felling are described in **Section 10.6.7** below.

10.6.2.4 Bryophytes

As noted previously in **Section 10.4.5.7**, it is considered that the bridge does not support a bryophyte flora of conservation interest. However, it does support moderate to high bryophyte cover in some areas (*e.g.* the top concrete).

Bryophyte cover on the bridge be retained where possible. Where bryophytes do need to be removed from a surface, the surface shall be replaced with similar material and the use of very smooth surfaces will be avoided where possible. Urban and aquatic bryophytes tend to quickly re-colonise surfaces as long as there is some texture to the surface.

10.6.2.5 Non-native Invasive Species

As outlined in **Section 10.4.5** invasive alien plant species have been identified and documented within the proposed works areas. Construction (and potentially operational maintenance works) could potentially disturb stands of invasive plants and/or soils contaminated with invasive plant material. In addition to lands within the proposed works areas, there is an identified risk of invasive plant species being spread onto neighbouring lands and onto public roads and other locations. The invasive plant species which have been identified in the proposed works areas include Butterfly-bush (*Buddleia davidii*), and Rhododendron (*Rhododendron ponticum*). Outside of the planning boundary along the Avoca River, Himalayan balsam (*Impatiens glandulifera*) and Japanese Knotweed (*Fallopia japonica*) have both been previously recorded.

A strategy to manage and prevent the spread of the invasive plants is outlined in the Invasive Alien Plant Species Management Plan of the CEMP in **Appendix 5.1** of **Chapter 5 Construction Strategy**. The management plan includes specific mitigation measures regarding the eradication and biosecurity procedures to protect the habitats and fauna. The management plan also details the careful application of herbicide to treat these species.

Prior to commencement, all works areas, site compounds and access routes will be re-surveyed for non-native plant species to ensure that new infestations have not been established. If found, appropriate mitigation strategies will need to be devised and implemented. Monitoring for re-emergence of non-native invasive species will be undertaken by the Contractor's Ecologist or a suitably qualified Ecologist.

10.6.2.6 Use of Herbicide at Arklow Bridge

Specific mitigation measures regarding the careful application of herbicide to remove woody vegetation in the bridge during WPI are presented in the CORA report in **Appendix 11.8** of **Chapter 11** *Archaeological, Architectural and Cultural Heritage*.

10.6.3 Diadromous Fish Species

It shall be a requirement of the Contract that the CEMP will provide the minimum requirements that the Contractor will be required to implement.

The Contractor shall submit a detailed programme of work to the client and to Inland Fisheries Ireland showing the order of procedure and the method by which it is proposed to carry out the authorised works, together with a timetable for completion of such work. These works shall comply with the IFI guidance.

The seasonal restrictions contained in the guidance has been modified in consultation with Inland Fisheries Ireland, in respect of the proposed scheme, to take account of the presence and seasonal passage on migration of Habitats Directive Annex II listed fish species Atlantic Salmon, River Lamprey, and potentially also Sea Lamprey in the Avoca River and Estuary. All instream works including the installation and removal of sheet piling or geotextile wrapped gabions required to provide barriers between works areas /temporary haul roads and aquatic habitats will be carried out during the five months of May to September inclusive.

The following mitigation measures will apply:

- Four weeks' notice shall be given in writing to the Employer's Representative and Inland Fisheries Ireland before the authorised works commence;
- To further reduce any potential effect of the dredging on migrating fish species *e.g.* Lamprey and Salmon, dredging shall not be carried out between October to April.
- A suitably qualified Environmental Clerk of Works shall be appointed to oversee and monitor all measures taken to protect the aquatic environment;
- The Contractor shall pay all statutory fees associated with the works;
- The Contractor shall be responsible for maintaining flows in the river at all times. The Contractor will be permitted to construct temporary haul roads in the river however the flow must be maintained throughout this period to enable free passage of fish. The details of the all temporary works in and immediately adjoining the Avoca River shall be subject to approval by the Employer's Representative and by Inland Fisheries Ireland;
- The Contractor shall take all practicable measures to prevent the deposition of silt or other material in, and the pollution or damage to the Avoca River;
- Any construction equipment and vehicle which in the opinion of the
- Employer's Representative presents a risk of affecting the Avoca River shall be removed from Site;

- Instream machine works shall be minimised, and any machines working in the watercourse must be protected against leakage or spillage of fuels, oils, greases and hydraulic fuels;
- Instream earthworks must be executed so as to minimise the suspension of solids. Construction works, especially ones involving the pouring of concrete, must be conducted in the dry;
- De-watering of any in-stream or marine sheet piled areas will be via a screened water intake pipe, to avoid injury or mortality to any fish that may be present;
- Search for and safe removal to safe waters of any fish trapped in enclosed works areas in the aquatic environment will be carried out by suitably qualified and licenced personnel, using methodologies to be agreed with Inland Fisheries Ireland (e.g. electrofishing);
- Discharge from the dewatering process will be passed to a suitably sized settlement tank or a proprietary silt removal system, before discharge to the Avoca River or the local sewer network. Back-up equipment will be required to be maintained ready for use at all works sites.;
- In order to minimise the volumes of water required to be removed from contained works areas in which in-situ cement works and/or excavation are required, works areas will be covered overnight and other periods when works are not in progress, in order to minimise infiltration of rainfall into works areas;
- To minimise the risk of spills and/or leaks, standard good practice will be followed with regard to pollution prevention as part of the appointed Contractor's detailed CEMP(s);
- All in-situ cement works will be monitored by the appointed contractor's Environmental Manager to ensure that spill prevention and remediation measures are in place, to minimise the risk and extent of spills and to rapidly deploy clean up equipment;
- Machinery maintenance work, re-fuelling of construction equipment and the addition of hydraulic oil or lubricants to vehicles / equipment will take place in designated bunded areas within the temporary construction compounds. All waste oil, empty oil containers and other hazardous wastes will be disposed of in compliance with the requirements of the Waste Management Acts 1996, as amended. All of the construction machinery operating near any watercourse will be systematically checked in order to avoid leaks of oils, hydraulic fluids and fuels; and
- Spill-kits and hydrocarbon absorbent packs will be stored in the cabin of each vehicle and operators will be fully trained in the use of this equipment.

Every effort will be made to prevent pollution incidents associated with spills during the construction of the proposed scheme. The risk of oil/fuel spillages and leaks will exist on the site and any such incidents will require an emergency response procedure. The following steps provide the procedure to be followed in the event of an oil/fuel spill occurring on site:

- Identify and stop the source of the spill/leak and alert people working in the vicinity;
- Notify the Environmental Manager immediately giving information on the location, type and extent of the spill/leak so that they can take appropriate action;
- If applicable, eliminate any sources of ignition in the immediate vicinity of the incident;
- Contain the spill/leak using the spill control materials, track mats or other material as required. Do not spread or flush away the spill/leak;
- If possible, cover or bund off any vulnerable areas where appropriate such as drains, watercourses and/or sensitive habitats;
- If possible, clean up as much as possible using the spill control materials;
- Contain any used spill control material and dispose of used materials appropriately using a fully licensed waste contractor with the appropriate permits so that further contamination is limited;
- The Environmental Manager shall inspect the site as soon as practicable and ensure the necessary measures are in place to contain and clean up the spill and prevent further spillage from occurring; and
- The Environmental Manager will notify the appropriate stakeholders such as WCC, National Parks and Wildlife Service, Department of Communications, Climate Action and Environment and Department of Housing, Planning and Local Government and/or the EPA.

10.6.4 Resident Bird Species

The proposed planting as described in **Section 10.6.2** above will mitigate the loss of terrestrial habitat for birds, in particular in the Arklow town marsh pNHA (Refer to **Dwg 304, 305 and 306** in **Appendix 4.2**).

The proposed river dredging will remove the in-river gravel banks. It is proposed to replace the habitat provided by these sandbanks through the use of three manmade roosting platforms (floating islands) (8m x 5m each). These will be low platforms with timber edges and finished in a layer of gravel and will provide roosting areas for birds at all tides. These will be anchored to the bed of the river, upstream of Arklow Bridge, with concrete anchor blocks and chains.

The proposed installation of these three roosting platforms in the river channel upstream of Arklow Bridge will provide for some mitigation of direct and indirect effects on birds due to the loss of in-river gravel beds due to the river dredging works (Refer to **Dwg 304 and 301** in **Appendix 4.2**, refer also to **Dwg 1003** in **Appendix 4.1**). Refer also to Figures 12.5.2 and 12.7.2 photomontages (which show the proposed roosting platforms) of **Appendix 12.1** of **Chapter 12 Landscape and Visual**.

The increase in levels of sections of the river bank along River Walk and South Bank will provide some opportunities for riparian habitat creation and refuge areas to mitigate direct and indirect effects of the river dredging works on aquatic mammals and birds (Refer to Dwg **1003**, **1013** and **1016** in **Appendix 4.1**).

In addition, new riparian habitat will be created along the northern bank (see **Section 10.6.9** above) to mitigate direct and indirect effects of the river dredging works on birds.

All vegetation clearance works and site preparatory works will be conducted outside of the bird nesting season (March to 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.

In addition, nesting boxes for the Red-listed species Grey wagtail and for Pied wagtail will be provided in alternate arches of Arklow Bridge, on ledges above high water level in the existing concrete structure on the upstream side of the bridge, in order to provide nesting habitat for these species that feed extensively along the river channel. The nest boxes designs will be suitable for use beneath bridges. The Contractor will be required to consult with a suitably qualified ecologist in the design and installation of the nest boxes.

10.6.5 Bat Species

A Derogation Licence for the Arklow FRS has been issued. Refer to the specific mitigation measures detailed in **Appendix 10.3** of this EIAR and as detailed below.

As all bat species recorded within the planning boundary of the proposed scheme are protected under Annex IV of the Habitats Directive, the works to be carried out to Arklow Bridge will require a derogation from the National Parks and Wildlife Service of the Department of Culture, Heritage and the Gaeltacht to allow works that will create a risk to bats and will remove existing roosting options. The measures proposed will meet the requirements for protecting the bats availing of Arklow Bridge.

The measures proposed specifically for the two southernmost arches of Arklow Bridge derogation include:

- Examination of the bridge prior to works by the licensed bat specialist for evidence of bats.
- Exclusion of bats if necessary with one-way valves devised by the bat specialist.
- Capture of any bats that are still present prior to works and retention until the risk of injury or re-entry to the bridge has been removed.

To ensure that there is no possibility of direct disruption to a summer roost during repairs, the following is proposed:

- The roost on the southern side of the bridge will be excluded during the autumn / early winter season (2021) before construction commences during summer 2022 under the bridge.
- 3 bat boxes will be temporarily installed on the northern side of the bridge as an interim measure to mitigate for the loss of roost (in the period summer/autumn 2021).
- Once the works on the southern side are complete, bat boxes shall be installed on the southern side.
- If bats are using the interim bat boxes on the northern side, these will need to be excluded before works are carried out on the northern side.
- Provision of 4 x 2FR Schwegler woodcrete bat tubes for each arch of three arches at the northern end and 3 arches at the southern end where works are undertaken (i.e. 24 x 2FR bat tubes). These bat boxes must be attached to the bridge in an unlit area above high-water mark. Refer to Drawing No 1005 of Appendix 4.1 of the EIAR which shows the location of the bat tubes on the bridge,
- Provision of additional bat boxes in the flood walls. It is proposed that 6 Schwegler 1FR bat tubes will be incorporated into the flood walls on the southern section of the project (Refer to Drawing Nos 1036, 1039, 1040 and 1041 of Appendix 4.1 of the EIAR which shows the location of the bat tubes in the walls,). 13 x 1FR bat tubes shall be incorporated in the concrete piers of the proposed debris trap which will be located across the river channel upstream of Arklow Bridge (Refer to Drawing Nos 1021 of Appendix 4.1 of the EIAR which shows the location of the bat tubes in the concrete piers).
- This shall be achieved in two phases: Works to southern half of the bridge in the first year requires that only the three bat tubes are installed in the first year of works. Works to the northern half of the bridge in the third year requires that the bat boxes for the southern section of the bridge are installed for the third year of repair work. Provision of 4 x 2FR Schwegler woodcrete bat tubes for each arch of three arches at the northern end and 3 arches at the southern end where works are undertaken (i.e. 24 x 2FR bat tubes). These bat tubes must be attached to the bridge in an unlit area above high-water mark. All remaining shall be installed once all works liable to disturb or damage them has been completed.

Monitoring of bat boxes is described in **Section 10.6.10** below.

Examination of all mature trees, and bat boxes along River Walk with roost potential prior to removal

All mature trees along River Walk along the South Quay and in the works area for work package 5 in Arklow Marsh shall be examined for bats prior to felling.

This may be achieved through a bat detector assessment if undertaken in the active season (prior to November and after March) or alternatively may require supervision at the time of felling. Any mature trees will require survey prior to felling.

Lighting at the site compounds

External lighting will be installed around the contractor's compounds for the safety and security of staff on the site. The lighting will be kept close to the buildings and only operate when there is movement. The lighting will be designed in consultation with the licenced bat expert, using emerging lighting technologies and having regard to best practice.

Mitigation for bats includes the following additional lighting considerations:

- Floodlights will be LED, as these have glass lenses which can be used to direct the light to the working area and reduce light spillage;
- Floodlights for working areas will make use of multiple lights to produce a more uniform light output and to lower the individual output from a single source – these will however still be quite high output;
- The site lighting incorporates the use of street lights to light the roadway around the building. The street lights will be selected to minimize upward lighting spill, hoods, louvres, shields or cowls will be fitted on the lights to reduce light spillage, and will incorporate the use of presence detection;
- Perimeter fence lighting will also incorporate presence detection, and will be off by default until motion is detected;
- Low level (~ 1m high) bollard lighting is being used in selected areas (refer to architect's landscape plans);
- Lights will be of low intensity. It is better to use several low intensity lights than one strong light spilling light across the entire area. The source of light will be Light Emitting Diodes (LEDs) as this is a narrow beam highly directional highly energy efficient light source. They shall allow for a light level of 3 lux at ground level. This low lighting is thus easier to control both the direction but also the actual light level because it is so close to the target area (if using bollard lighting);
- Narrow spectrum lighting shall be used with a low UV component. Glass also helps reduce the UV component emitted by lights.

In the event of security lighting being required, it is recommended that infra-red lighting and infra-red cameras are employed to record anti-social activity to assist in crime solving and prevention. This will not raise the visible light levels that will affect mammals and birds to a much greater extent.

10.6.6 Otter

As noted above in **Section 10.4.10.4**, whilst otter holts were not identified during the walkover surveys within the planning boundary, otter have been observed using the river in the Arklow area and it is likely that the vegetation at the banks of the Arklow Town pNHA may provide suitable habitat for the species. Although, habitat surveys undertaken at the pNHA also did not report evidence of otter runs or slides in the area. Therefore, prior to commencement of works, a survey to identify the presence of any new Otter resting places/holts within 200m of the works areas will be undertaken.

If found and likely to be damaged/disturbed by the works, a derogation licence shall be applied for from NPWS. This licence will include otter resting places and holts identified during the pre-construction survey. Any further mitigation measures required by the derogation licence shall be implemented.

The increase in levels of sections of the river bank along River Walk and South Bank will provide some opportunities for riparian habitat creation and refuge areas to mitigate direct and indirect effects of the river dredging works on aquatic mammals such as otter.

To minimise the potential for otters becoming trapped, all excavations will be left open for the minimum possible time, and not over-night. If excavations have to be left open over-night, they will be fitted with an escape ramp (no more than 45°) to allow accidentally trapped animals to escape.

Materials to cover excavations or create escape ramps will be on site at all times so that all excavation areas can be made safe before leaving site.

All materials stored on site will be stacked securely so as to prevent accidental collapse if investigated by an Otter, or any other large mammals.

10.6.7 Badger

In order to mitigate construction impacts on Badger potentially commuting and foraging in the works area the following mitigation measures will be implemented:

- To minimise the potential for Badgers becoming trapped, all excavations will be left open for the minimum possible time, and not over-night. If excavations have to be left open over-night, they will be fitted with an escape ramp (no more than 45°) to allow accidentally trapped animals to escape. Materials to cover excavations or create escape ramps will be on site at all times so that all excavation areas can be made safe before leaving site.
- All materials stored on site will be stacked securely so as to prevent accidental collapse if investigated by Badger, or any other large mammals.
- Prior to commencement, all works areas, site compounds and access routes will be re-surveyed to ensure that new Badger setts have not been established. If found, appropriate mitigation strategies will need to be devised and implemented. This can be coupled with the survey for otter activity.

10.6.8 Pollution Prevention Measures

In addition to the measures proposed in **Chapter 14 Water**, the following measures will be implemented to ensure that the water quality of the Avoca River is not adversely affected through pollution incidents and silt mobilisation. This mitigation will include:

- Appropriate sediment control measures will be employed.
- Any chemical, fuel and oil stores will be located on an impervious base within a secured bund with a storage capacity 110% of the stored volume.
- Biodegradable oils and fuels will be used where possible.
- Drip trays will be placed underneath any standing machinery to prevent pollution by oil/fuel leaks. Where practicable, refuelling of vehicles and machinery will be carried out on an impermeable surface in one designated area well away from any watercourse or drainage (at least 10m).
- Emergency spill kits will be available on site and staff trained in their use.
- Operators will check their vehicles on a daily basis before starting work to confirm the absence of leakages. Any leakages will be reported immediately.
- Daily checks will be carried out and records kept on a weekly basis and any items that have been repaired/replaced/rejected noted and recorded.
- Any items of plant machinery found to be defective will be removed from site immediately or positioned in a place of safety until such time that it can be removed. All items of plant will be checked prior to use before each shift for signs of wear/damage.
- All washing out of grout pumps will be carried out in designated areas away from the river, such as in the lined compound area. At no point will grout pumps be washed out at the worksite.

The procedure for excavating the hazardous and non-hazardous contaminated dredge material along the south bank upstream of Arklow Bridge will be as described in **Chapter 5 Construction Activities**. This will include

- the installation of a temporary bund made up of impermeable material, approximately 500mm above high tide level will be constructed around the location.
- Dewatering, following removal of any fish for visibility of the riverbed and to enable the contractor to carry out the excavation process, will be required.
- The excavated contaminated dredge material will be transferred onto watertight trucks for transfer to SC2 for archaeological testing and monitoring or transported directly offsite.
- This material will be disposed offsite to an approved hazardous licenced facility or a non-hazardous licenced landfill as appropriate.

10.6.9 Enhancement Work

As detailed in the relevant sections above, planting is proposed as part of the outlined mitigation measures to replace lost habitat. The landscape design/public realm drawings (Appendix 4.2) provide details on the planting types and species proposed in addition to the identification of trees to be retained within the planning boundary.

As part of this mitigation, it is intended that the tree and grassland planting will be embraced by the Council and OPW to fulfil not only the mitigation function for habitat loss for bat and other species, but to uphold our national Policy for 'No Net Loss' as outlined in the National Biodiversity Action Plan 2017 -2021.

Action 1.1.3 of the National Biodiversity Action Plan 2017 -2021 states that 'All Public Authorities and private sector bodies will move towards no net loss of biodiversity through strategies, planning, mitigation measures, appropriate offsetting and/or investment in Blue-Green infrastructure. This will help ensure not only the 'no net loss' principal is upheld but that some enhancement effort is made to reverse the direction of biodiversity loss and carbon deficit overall.

To this effect, the planting plan has been designed with this in mind. One area of obvious biodiversity opportunity is the north bank and marsh area. Specific grass and native tree planting has been proposed in this location (Refer to **Section 10.6.2.1** above). In addition some of the grassed areas will be planted with a pollinator-friendly rich seed mixes. These areas can be adapted to be populated by a suitably biodiverse plant assemblage using a pollinator-friendly rich seed mix, adapted to the soil type present. The Irish based company Design by Nature can supply and provide advice on various wildflower mixes suitable for a range of pollinators local to the area.

The creation of pollinator friendly grasslands will be considered wherever possible throughout the scheme and wherever areas require re-seeding, a bee-friendly grass /wildflower seed mix will be used.

The landscaping at Arklow Marsh (adjacent to the proposed embankment) and the extension to the north river bank upstream of Arklow Bridge will provide some opportunities for habitat creation and mitigation of direct and indirect effects on biodiversity due to the loss of in-river vegetated islands and loss of habitat in the marsh.

The increase in levels of sections of the river bank along River Walk and South Bank will provide some opportunities for riparian habitat creation and refuge areas to mitigate direct and indirect effects of the river dredging works on aquatic mammals such as otter.

The proposed installation of three roosting platforms in the river channel upstream of Arklow Bridge will provide for some mitigation of direct and indirect effects on birds due to the loss of in-river gravel beds due to the river dredging works.

Bat boxes and bat tubes will be permanently installed in the arches of Arklow Bridge (upstream side), in the flood walls and in the RC columns of the debris trap to mitigate direct and indirect effects on bats due to the construction works at Arklow Bridge.

10.6.10 Establishing Up-to-date Baseline and Future Monitoring

Prior to any work commencing both aquatic and terrestrial biological surveys shall be carried out throughout the area including at the six site compounds to establish a pre-construction baseline.

Aquatic surveys shall include sampling the river bed upstream and downstream of the bridge and at the site of the proposed gravel and branch trap to record numbers of species and numbers of individuals of invertebrates and also to document sediment chemistry conditions including granulometry, organic carbon and depth of the REDOX layer.

Terrestrial surveys shall be designed to re-map plant communities and habitats throughout the work area. A survey of SC6 shall be undertaken in the summer months of 2021 to determine if *E.x moorei* is present or not.

All areas of the banks of the Avoca River that will be affected by the proposed plan shall be walked over to ensure that no otter holts or badger setts are present.

A monthly survey of water quality at a number of locations in the Avoca River, the Avoca Estuary and the Arklow Marsh shall be established if possible a year in advance of construction to establish levels of suspended solids, dissolved oxygen and salinity. Additionally, direct recording current meters and tide gauges shall be deployed upstream and downstream of the Arklow Bridge to record flow directions and velocities and pressure.

Monitoring for re-emergence of non-native invasive species will be undertaken by the Contractor's Ecologist or a suitably qualified Ecologist. Any new sighting will be reported the Employer's Representative during the construction phase and Wicklow County Council post construction and recommendations for treatment and eradication proposed.

Acceptance of boxes/tubes by bats can be less predictable than those for birds. Therefore, it is essential to monitor their use over a period of time. Those boxes/tubes that remain unused within two years of date of erection will be re-located. Bat boxes will also be checked in wintertime for general wear and tear and to remove droppings from the previous summer use.

Bat boxes will be inspected, by bat licence holder (bat specialist), at least once within 12 months of erection at appropriate season in order to monitor bat use and the species using boxes. This will be followed up with another inspection within 24 months of setting up. At this point, any bat boxes not used will be relocated to a new site. Any bats found will be counted and identified to species level. All data collected will be submitted to Bat Conservation Ireland.

Additionally, the bat box scheme will be registered with Bat Conservation Ireland and monitoring to be undertaken annually for 2 years.

10.6.11 Maintenance of the Scheme

The scope and nature of maintenance works for the proposed scheme is detailed in Chapter 4, however at this time the exact locations and frequency of maintenance activities are unknown.

Maintenance works (such as the gravel and debris traps and occasional channel dredging) which require in-stream works will follow the same mitigation measures for the protection of biodiversity and water quality set out above for construction stage.

Tree removal shall be limited to the removal of fallen trees or overhanging branches, unless identified as dead or diseased trees that are a risk of blockage. Tree roots shall not be removed from the river bank.

If a derogation licence is required for maintenance works, e.g. otter and bats, this shall be acquired prior to the decision to progress with the maintenance activities. Any further mitigation measures required by the derogation licence shall also be implemented during the channel maintenance activities.

10.7 Residual Effects

10.7.1 Habitats and Flora

With the implementation of the mitigation measures specified in **Section 10.6.4**, and from the considerations given in **Section 10.5.4.1** residual effects on habitats and flora, are assessed as not significant during construction and operation.

10.7.2 Diadromous Fish Species

With the implementation of mitigation measures included in **Section 10.6**, and from the considerations given in **Section 10.5.4.1**, residual effects on diadromous fish from construction and operation are assessed as not significant. No likely significant direct residual effects will arise diadromous fish from discharges during construction and operation.

10.7.3 Resident Bird Species

With the implementation of the mitigation measures specified in **Section 10.6.4**, and from the considerations given in **Section 10.5.4.1**, residual *in situ* effects on the resident bird species, are assessed as not significant during construction and operation.

10.7.4 Otter and Badger

With the implementation of the mitigation measures specified in **Section 10.6.4**, residual effects on resident otter and badger, are assessed as not significant during construction and operation.

10.7.5 Bat Species

With the implementation of the mitigation measures specified in **Section 10.6.5**, residual effects on species including Habitats Directive Annex IV listed bat species (Common pipistrelle, Soprano pipistrelle, Leisler's bat and Daubenton's bat), are assessed as not significant during construction and operation.

10.8 References

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