UISCE
ÉIREANN : IRISH
WATER

Greater Dublin
Drainage Project

Natura Impact Statement

JACOBS

TOBIN
Consulting Engineers

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1. Introduction

RPS was commissioned by Irish Water Limited (Irish Water) to provide information in support of Screening for Appropriate Assessment (AA) and, if necessary, prepare a Natura Impact Statement (NIS) containing an assessment of implications for European sites to inform the AA for the proposed Greater Dublin Drainage (GDD) project. Irish Water is seeking consent for the GDD project from:

- An Bord Pleanála for planning permission as a Strategic Infrastructure Development application;
- The Environmental Protection Agency (EPA) for a Waste Water Discharge licence; and
- The Marine Planning and Foreshore Section of the Department of Housing, Planning and Local Government for a Foreshore Licence.

1.1 Purpose of the Document

A screening for AA exercise described in Section 4 of this report has concluded that, on the basis of objective information, the Proposed Project either individually or in combination with other plans or projects is likely to have significant effects on European sites in view of their conservation objectives. As such, the Proposed Project must be subject to AA in accordance with Article 6(3) of the EU Habitats Directive (Directive 92/43/EEC) on the Conservation of Natural Habitats and of Wild Fauna and Flora; the Planning and Development Act 2000 (as amended); and the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477/2011) (as amended).

This NIS document comprises a two-stage evaluation and analysis exercise (Stage 1 – shadow screening for appropriate assessment in Section 4; and Stage 2 – a shadow assessment of implications for European sites in Sections 6-7) to inform the AA of the proposed GDD project by the competent authority for planning which is An Bord Pleanála and subsequently the competent authority for a Foreshore Licence application which is the Marine Planning and Foreshore Section of the Department of Housing, Planning and Local Government and the competent authority for a Waste Water Discharge licence, which is the EPA Environmental Licensing Programme Office of Environmental Sustainability.

In their assessments, the competent and public authorities concerned must arrive at a definitive determination under Article 6(3) of the Habitats Directive and transposing domestic legislation applicable to the various consents as to whether or not the project, on its own or in combination with other plans and projects, will adversely affect the integrity of any European site.

1.2 Overview of Proposed Development

The land based elements of the GDD project are located along the southern fringe of Fingal in North County Dublin, between Blanchardstown and Baldoyle, and in the marine environment off North County Dublin between Baldoyle and Ireland's Eye (see Figure 1.1). The project comprises the following inter-linked elements:

- Regional Wastewater Treatment Plant (WwTP) to be located on a 29.8ha site in the townland of Clonshagh in Fingal (see Section 3.1.1);
- Sludge Hub Centre to be co-located on the same site as the WwTP (see Section 3.1.1);
- Abbotstown Pumping Station to be located in the grounds of the National Sports Campus (see Section 3.1.2);
- Orbital Sewers from Blanchardstown to the WwTP at Clonshagh (13,804m) (see Section 3.1.3);
- North Fringe Sewer (NFS) Diversion Sewer to the WwTP (570m) (see Section 3.1.3);
- Outfall Pipeline Route from the WwTP to the outfall point approximately one kilometre north-east of Ireland's Eye. The total length of the Outfall pipeline is 11,313m with the land based section comprising 5,379m and the marine section, including the multiport diffuser comprising 5,934m. As the Outfall pipeline crosses under (approximately 20m below ground level) the estuary habitats of Baldoyle Bay SAC & SPA, the tunnelled and the sub-sea pipeline sections will require connection approximately 700m offshore. This marine section will require the installation of works to protect an existing fibre optic cable approximately 4,200m offshore just northwest of Ireland's Eye (see Section 3.1.5.2);

- Marine Diffuser Section (see Section 3.1.6); and
- Regional Biosolids Storage Facility to be located on an 11.4ha site at Newtown/Kilshane in Fingal.

A detailed description of the Proposed Project, including construction and operational phases is included in Chapter 3 of this NIS.

The need for the GDD project is derived from the key findings of the Greater Dublin Strategic Drainage Study (GDSDS) Final Strategy Report and its associated Strategic Environmental Assessment (SEA) which were prepared in 2005 - 2008 respectively on behalf of the seven local authorities that form the Greater Dublin Area (GDA). The policy basis for the need for the proposed GDD project is set out in more detail in the Environmental Impact Assessment Report (EIAR).

1.3 Study Area and Zone of Influence

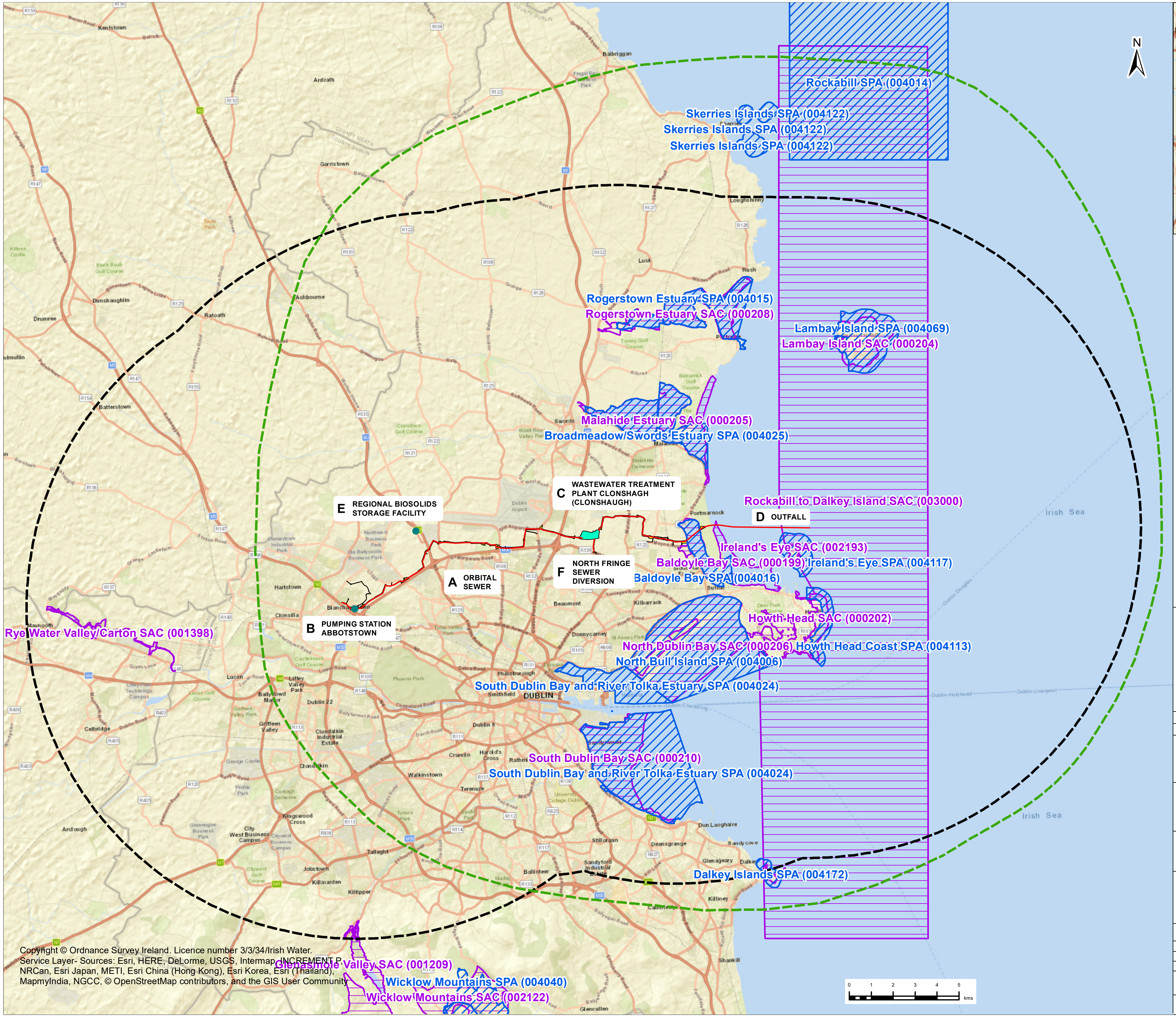
Determination of this Proposed Project's Zone of Influence (ZoI) was achieved by assessing all elements of the Proposed Project against the ecological receptors within the Proposed Project footprint, in addition to all ecological receptors that could be connected to and subsequently impacted by the Proposed Project through impact pathways. To this end, the ZoI extends outside of the Proposed Project infrastructure footprint to include ecological receptors connected to the Proposed Project through overlap / intersection, proximity and connectivity through features such as watercourses. The proposed GDD project is located within the following three European sites (see Figure 1-1 & Figure 1-2):

- Baldoyle Bay Special Areas of Conservation (SAC) (000199) – the proposed outfall pipeline will pass in a tunnel under Baldoyle Bay SAC. The two tunnelling compounds will be located either side of Baldoyle Bay but outside the SAC;
- Baldoyle Bay Special Protection Areas (SPA) (004016) – the outfall pipeline passes under Baldoyle Bay SPA. The two tunnelling compounds are located either side of Baldoyle Bay but outside the SPA; and
- Rockabill to Dalkey Island (SAC) (003000) - the marine diffuser and approximately 1,300m of the outfall pipeline are located within the Rockabill to Dalkey Island SAC.

Other designated sites, habitats, flora and fauna protected under Irish statute e.g. (p)NHA, are assessed in full in Chapters 9-11 of the accompanying EIAR contained in Volume 2.

1.4 Study Team

The NIS has been compiled by RPS with input from a team of specialist ecologists covering the fields of terrestrial and aquatic ecology and ornithology. In addition, the NIS includes input from a specialist marine ecology company - Benthic Solutions Ltd (BSL). The ecology team has worked closely with other inter-related disciplines and has had regard to outputs including noise modelling, sediment transport modelling and marine mammal surveys as part of their evaluation and analysis (see EIAR Volume 2 Part B Appendices).



Key

—	Pipe Alignment (11/10/2017)
▨	Special Protection Area (SPA)
▤	Special Area of Conservation (SAC)
🟩	Proposed WWTP
🟨	Proposed Compounds
🟫	Construction Wayleave
⬚	Buffer of Pipeline Corridor & Plant, 15km
⬚	Zone of Influence

NOTE:
The SAC and SPA data is downloaded from the National Parks and Wildlife Service website.
The SAC data is last updated in April 2018 and the SPA data in June 2017.

Greater Dublin Drainage

F01	06/06/2018	Final	SK	SK	CC	CC
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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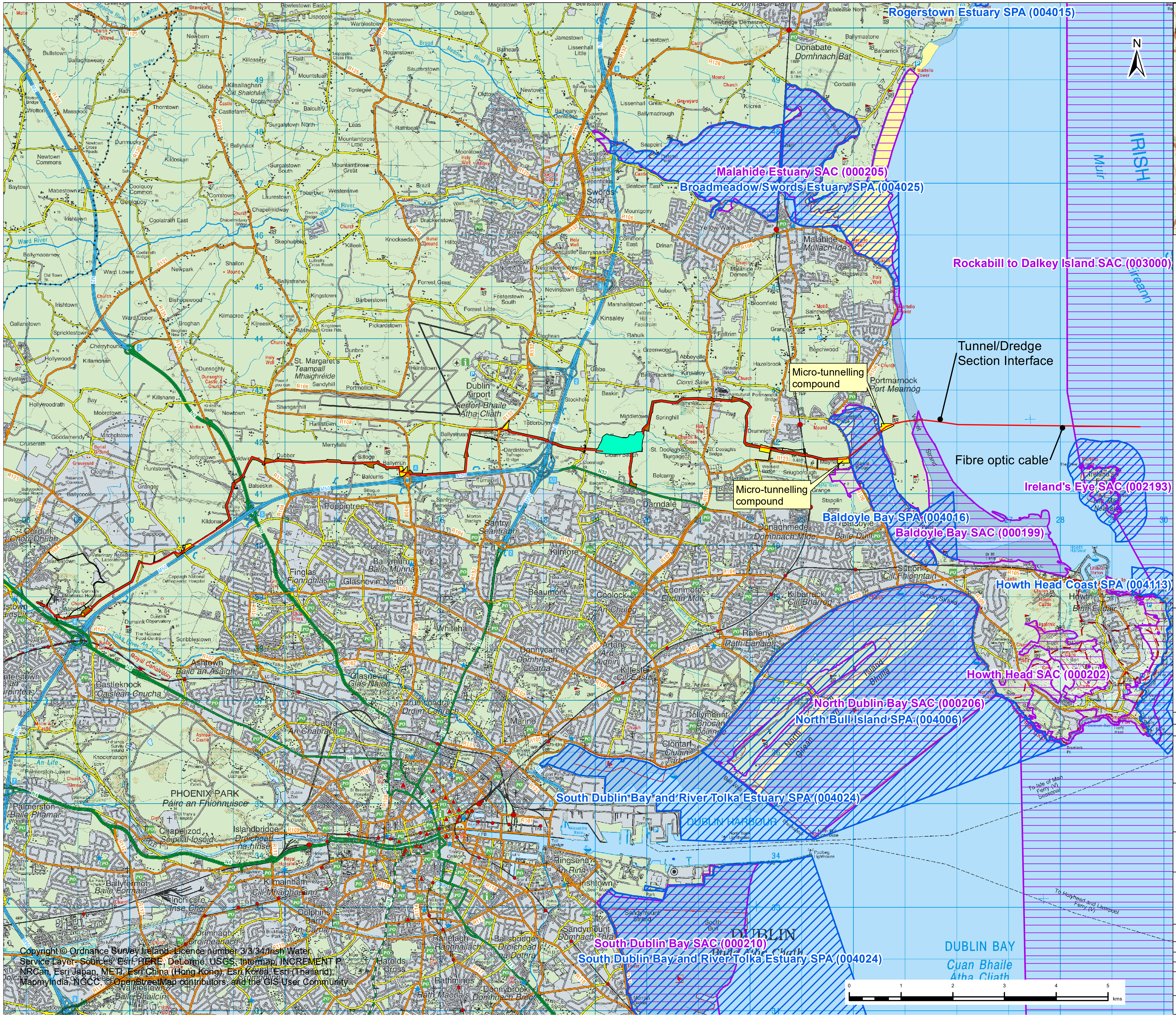
Project
Greater Dublin Drainage Project

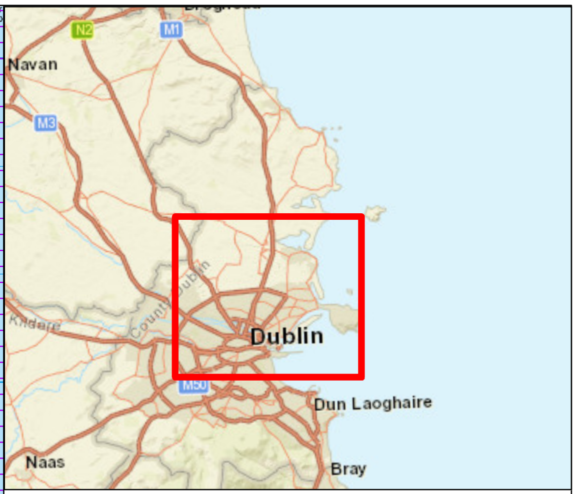
Drawing Title
Figure 1-1
Natura 2000 Sites and Zone of Influence

Drawing Status
For Issue

Scale @A3	1:165,000	DO NOT SCALE
RPS No.	MDE1046arc0016F01	
Filepath	R:\MDE1046_Specialist Ecology Services GDR\9.0 GIS\ARC\MDE1046Arc0016F01 15km Natura Buffer Zone of Influence.mxd	

Drawing No.
32102902-EIS





Key

- — Pipe Alignment (11/10/2017)
- ▨ Special Protection Area (SPA)
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- 🟨 Proposed Compounds
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Project
Greater Dublin Drainage Project

Drawing Title
Figure 1-2
Location of Greater Dublin Drainage Project and SACs & SPAs

Drawing Status
For Issue

Scale @A3: 1:70,000 — DO NOT SCALE
RPS No.: MDE1046arc0015F01
Filepath
Drawing No.: 32102902-EIS

This drawing is not to be used in whole in or part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.

2. Appropriate Assessment Approach

2.1 Legislative Background for Appropriate Assessment

The Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora, better known as "The Habitats Directive", provides legal protection for habitats and species of European importance. Articles 3 to 9 provide the legislative means to protect habitats and species of Community interest through the establishment and conservation of an EU-wide network of sites known as Natura 2000. Natura 2000 is a European ecological network of special areas of conservation, composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II, shall enable the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range.

In Ireland, these sites are designated as European Sites and include SPAs, established under the EU Birds Directive (79/409/EEC, as codified by 2009/147/EC) for birds and SACs, established under the Habitats Directive 92/43/EEC for habitats and species.

The Habitats Directive has been transposed into Irish law by Part XAB of the Planning and Development Act, 2000 - 2015 and the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. 477/2011) as amended.

Articles 6(3) and 6(4) of the Habitats Directive sets out the decision-making tests for plans and projects likely to have a significant effect on or to adversely affect the integrity of European sites. Article 6(3) establishes the requirement for Appropriate Assessment (AA):

Any plan or project not directly connected with or necessary to the management of the [Natura 2000] site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subjected to appropriate assessment of its implications for the site in view of the site's conservation objectives. In light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.

Both EU and national guidance exists in relation to Member States fulfilling their requirements under the EU Habitats Directive, with particular reference to Article 6(3) and 6(4) of that Directive. The methodology followed in this report to inform the assessment has had regard to the following legislation and guidance listed in Section 4.1.1:

- Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (also known as the 'Habitats Directive');
- Council Directive 2009/147/EC on the conservation of wild birds, codified version, (also known as the 'Birds Directive');
- The European Communities (Birds and Natural Habitats) Regulations 2011 to 2015; and
- The Planning and Development Act 2000-2017.

2.2 Overview of Appropriate Assessment (AA) Stages

The Department of the Environment Heritage and Local Government Guidelines (DoEHLG, 2010a) outline the European Commission's methodological guidance (EC, 2002) promoting a four-stage process to complete the Article 6 assessments, and outlines the issues and tests at each stage. An important aspect of the process is that the outcome at each successive stage determines whether a further stage in the process is required.

The four stages are summarised diagrammatically in Figure 2-1. Stages 1 and 2 deal with the main requirements for assessment under Article 6(3). Stage 3 is a necessary precursor to Stage 4. Stage 4 is the main derogation step of Article 6(4).

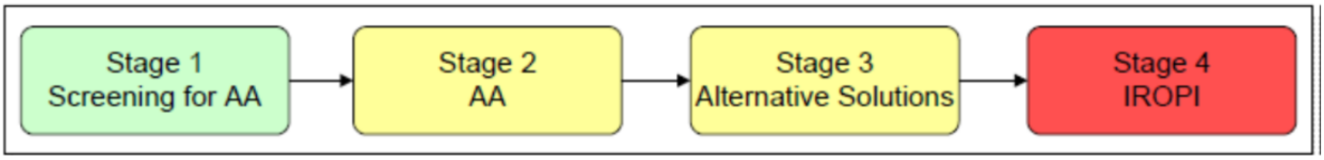

Figure 2-1: Stages in Appropriate Assessment[1]

In complying with the obligations under Article 6(3) and 6(4) and following the EC2000 and MN2000 Guidelines, this assessment has been structured as a stage by stage approach as outlined below.

Stage 1: Screening for Appropriate Assessment

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

(i) whether a plan or project is directly connected to or necessary for the management of the site; and

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

A screening exercise has been undertaken for the Proposed Project and is presented in Section 4.

In relation to mitigation measures, EC (2001) states that "*project and plan proponents are often encouraged to design mitigation measures into their proposals at the outset. However, it is important to recognise that the screening assessment should be carried out in the absence of any consideration of mitigation measures that form part of a project or plan and are designed to avoid or reduce the impact of a project or plan on a Natura 2000 site*". This direction in the European Commission's guidance document is unambiguous in that it does not promote the inclusion of mitigation at screening stage.

In April 2018, the Court of Justice of the European Union issued a ruling in case C-323/17 that Article 6(3) of Directive 92/43/EEC must be interpreted as meaning that, in order to determine whether it is necessary to carry out, subsequently, an appropriate assessment of the implications, for a site concerned, of a plan or project, it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site.

For this project, mitigation measures intended to avoid or reduce the harmful effects of the Proposed Project on European sites have not been taken into consideration at screening stage.

Stage 2: Appropriate Assessment

This stage considers whether the plan or project, alone or in combination with other projects or plans, is likely to have adverse effects on the integrity of European sites. If so, the applicant will be required to submit a NIS. The interpretation of what constitutes an NIS is described under Part 1 of the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended), as follows: "*Natura Impact Statement" means a report comprising the scientific examination of a plan or project and the relevant European Site or European Sites, to identify and characterise any possible implications of the plan or project individually or in combination with other plans or projects in view of the conservation objectives of the site or sites, and any further information including, but not limited to, any plans, maps or drawings, scientific information or data required to enable the carrying out of an Appropriate Assessment"*.

Where adverse effects are identified, and if clear, effective and enforceable mitigation measures can be conditioned to a consent that would avoid, reduce or remedy any such negative impacts, the project can be consented at that stage, thereby avoiding the need to progress to Step 3.

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[1] Stage 4 IROPI refers to Imperative Reasons of Overriding Public Interest

If the assessment is negative, i.e. adverse effects on the integrity of a site cannot be avoided, then the process must proceed to Stage 3.

Stage 3: Alternative Solutions

If it is not possible during the Stage 2 to reduce impacts to acceptable, non-significant levels by avoidance and/or mitigation, Stage 3 of the process must be undertaken which is to objectively assess whether alternative solutions exist by which the objectives of the plan or project can be achieved. Explicitly, this means alternative solutions that have less or no negative impacts on the integrity of a European site. It should also be noted that EU guidance on this step of the process states that, '*other assessment criteria, such as economic criteria, cannot be seen as overruling ecological criteria'* (EC, 2002). In other words, if alternative solutions exist that have less or no negative impacts on European sites; they should be adopted regardless of economic considerations.

The process must return to Stage 2, where an alternative solution is to be progressed, as any alternative solution must be subject to a Stage 2 Appropriate Assessment before it can be subject to the Article 6(4) test. If it can be demonstrated that all reasonable alternatives have been considered and assessed, the AA progresses to Stage 4.

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

This stage of the process is undertaken when it has been determined that negative impacts on the integrity of a European site will result from a plan or project, but that no alternatives exist. At this stage of the AA process, it is the characteristics of the plan or project itself that will determine whether or not the public authority can allow it to progress. This is the determination of IROPI.

It is important to note that in the case of European sites that include in their qualifying features 'priority' habitats or species, as defined in Annex I and II of the Directive, the demonstration of 'over-riding public interest' is not sufficient and it must be demonstrated that the plan or project is necessary for 'human health or safety considerations'. Where plans or projects meet these criteria, they can be allowed, provided adequate compensatory measures are proposed.

Stage 4 of the process defines and describes these compensation measures. The Commission must be informed of the compensatory measures. Compensatory measures must be practical, implementable, likely to succeed, proportionate and enforceable, and they must be approved by the Minister.

3. Description of the Proposed Project

3.1 Receiving Environment

The location of the Proposed Project is illustrated on Figure 1-1 and shown in detail on Planning Drawings Nrs. 32102902 – 2000 to 32102902 – 2014. The land based elements of the Proposed Project are located along the southern fringe of Fingal in North County Dublin, between Blanchardstown and Baldoyle, and in the marine environment off North County Dublin between Baldoyle Bay and Ireland's Eye.

The proposed site for the proposed **WwTP** is located in the townland of Clonshagh, in Fingal. It is situated in open agricultural land approximately 2.4km south east of Dublin Airport and approximately 500m north of the R139 Road. The Cuckoo Stream (a tributary of the Mayne River) lies immediately north, with the Mayne River itself approximately 400m south of the proposed WwTP site.

The proposed **Sludge Hub Centre** is to be co-located with the WwTP on the site at Clonshagh.

The proposed site for the WwTP and Sludge Hub Centre has a total area of 29.8ha. There are no designated European sites within or adjacent to the proposed WwTP site.

The proposed **Regional Biosolids Facility (RBSF)** will be located in the townland of Newtown, Dublin 11. The proposed site is 11.0ha in area, situated adjacent to the R135 Finglas Road and north-east of Huntstown power station. Fingal County Council (FCC), who own the site has partially developed the proposed site (i.e. road infrastructure, drainage, power, boundary treatments, access/egress gates to the R135 Finglas Road and some administration buildings) for a waste recycling centre, in accordance with planning permission PLO6F.EL.2045.

The proposed **Orbital Sewer** will transfer flows from the existing Blanchardstown drainage catchment, which includes Blanchardstown and its environs and the Meath towns and villages of Ashbourne, Ratoath, Kilbride, Dunboyne & Clonee, to the proposed WwTP at Clonshagh (Clonshaugh). This orbital sewer will commence in the grounds of Waterville Park, Blanchardstown where it intercepts the existing Blanchardstown main sewer line, which is known as the 9C sewer. From this point it will be routed through the grounds of Connolly Hospital and the grounds of the National Sports Campus to the proposed **Abbotstown Pumping Station**, which will be located adjacent to the M50. From this pumping station the Orbital Sewer will be routed north of and generally parallel to the M50 to Clonshagh passing, en-route, south of the Dublin Airport complex. The lands along the length of the orbital sewer are generally open fields with agriculture being the main land use pattern. The total length of this Orbital Sewer will be approximately 13,700m. There are no designated European sites within the Orbital Sewer Route.

The proposed **NFS Diversion** Sewer will transfer flows in the NFS upstream of the point of interception to the proposed WwTP. It is proposed to intercept the NFS in the vicinity of the junction of the proposed access road to the WwTP with the R139. From this point the sewer will be routed to the proposed WwTP along the proposed access road. The total length of this diversion sewer is approximately 600m. There are no designated European sites within the corridor for the NFS diversion sewer corridor.

The proposed **Outfall Pipeline** route consists of a land based section (Clonshagh – Baldoyle), a marine section (Baldoyle – Ireland's Eye) and a multiport marine diffuser. The land based section commences at the proposed WwTP and is routed in an easterly direction towards the coast between Baldoyle and Portmarnock. The lands along the length of the proposed Outfall pipeline (land-based) are generally open fields with agriculture the main land use pattern. The land based section of the outfall pipeline terminates to the west of the Coast Road (R106). There are no environmentally designated sites within corridor of the proposed Outfall pipeline, however both tunnelling compounds are located directly adjacent to Baldoyle Bay SAC and SPA. .

The proposed Outfall Pipeline Route commences at the tunnel launch shaft in the tunnelling compound located just off the R106 Coast Road, north of Baldoyle and is routed in a north easterly direction across the Baldoyle Estuary to the public car park immediately north of Portmarnock Golf Club where it turns in an easterly direction terminating approximately 1km north east of Ireland's Eye (approximately 1,400m into the Rockabill to Dalkey Island SAC).

The proposed Outfall Pipeline Route will cross under the estuary habitats of Baldoyle Bay SAC) and Baldoyle Bay SPA from the Coast Road to approximately 600m offshore, where it exits the tunnel. It will then continue in an easterly direction where it terminates just north of Ireland's Eye within the Rockabill to Dalkey Island SAC (site code: 003000). Ireland's Eye SAC (002193) & Ireland's Eye SPA (004117) lies approximately 700m & 200m respectively to the south of the outfall pipeline.

The total length of the proposed outfall pipeline route will be approximately 11,400m, with the land based section comprising 5,400m and the marine section, including the multiport diffuser comprising 5,900m.

The proposed multiport **marine diffuse**r is located on the final section of the proposed Outfall pipeline and will consist of a number of vertical risers from the outfall pipeline to above sea-bed level onto which diffuser valves will be attached to allow the treated wastewater to achieve the required initial dilution on discharge to the marine environment. The proposed marine diffuser lies within the Rockabill to Dalkey Island SAC and lies approximately 700m & 200m respectively to the north east of Ireland's Eye SAC (002193) & Ireland's Eye SPA (004117).

The coast in the vicinity of the proposed Outfall Pipeline Route is characterised by sandy beaches. Water depths in this area range from 0m – 25m LAT (Lowest Astronomical Tide). The seabed is gradually sloping eastward and the bottom is sandy in nature with varying depth to bedrock.

The proposed Outfall Pipeline Route terminates within the Irish Sea Dublin (HA 09) Coastal Water Body as defined under the Water Framework Directive (WFD)

The proposed GDD Project will traverse the following Natura 2000 sites as illustrated on Figure 1-2:

- Baldoyle Bay SAC (000199) – the proposed Outfall Pipeline Route will pass under Baldoyle Bay SAC. The two tunnelling compounds will be located directly adjacent to Baldoyle Bay but outside the SAC;
- Baldoyle Bay Special Protection Areas (SPA) (004016) – the proposed Outfall Pipeline Route will pass under Baldoyle Bay SPA. The two tunnelling compounds will be located directly adjacent to Baldoyle Bay but outside the SPA; and
- Rockabill to Dalkey Island Special Areas of Conservation (SAC) (003000) - the proposed marine diffuser and approximately 1,300m of the proposed Outfall Pipeline Route are located within the Rockabill to Dalkey Island SAC.

Ireland's Eye SAC (002193) & Ireland's Eye SPA (004117) lie approximately 700m & 200m respectively to the south of the proposed Outfall Pipeline Route and marine diffuser.

3.2 Description of Construction Stage including Techniques and Approaches

The following sections describe the construction methodology for each of the elements of the Proposed Project. However an outline Construction & Environmental Management Plan (CEMP) including a Surface Water Management Plan has been prepared for the Proposed Project and is included in Volume 2 Part B Appendices.

3.2.1 Proposed WWTP and Sludge Hub Centre

Construction of the proposed WwTP will involve:

- Excavation for building foundations and tanks;
- Reinforced concrete works;
- Erection of structural steel/concrete building frames;
- Erection of building walls (concrete/blockwork)
- Erection of prefabricated cladding panels to walls and roofs of buildings;
- Erection of prefabricated steel tanks;
- Mechanical and electrical fit out of buildings and tanks;

- Installation of below and above ground pipework;
- Construction of screening berms;
- Construction of access/egress roads to/from site; and
- Internal circulation roads, car parks and footpaths, landscaping and final planting.

Over the three-year construction period, these activities will be sequentially scheduled by the appointed contractor to optimise resources and programme, moving various work crews from building to building in a sequential manner. A typical sequence of work is outlined below (refer to the Outline CEMP for further detail):

- Erect fencing to site and access roads;
- Strip topsoil from site and access roads, set aside for reuse;
- Grade site/access roads to finished profile. Excavated material deposited in screening berms;
- Establish appointed contractor's compound on-site;
- Construct access roads and site circulation roads to subbase level;
- Excavate foundations for first building/tank, move to next building/tank;
- Pour concrete foundations/base to first building tank, move to next structure;
- Erect structural steel/concrete building frame, or reinforced concrete walls of tanks, move to next structure;
- Erect inner/outer walls and roof of building (prefabricated panels), move to next building;
- Install doors/windows and make building weather proof, move to next building;
- Commence first fix mechanical/electrical fit out of structure (building/tank), move to next building;
- Commence second fix mechanical/electrical fit out of structures;
- Erect prefabricated steel tanks (e.g. mesophilic anaerobic digesters);
- Erect biogas holding tanks;
- Install below ground pipework;
- Install above ground pipework;
- Test tanks and pipework for watertightness;
- Commence commissioning work on wastewater and sludge treatment systems;
- Finish construction of access/egress roads and internal circulation roads, car parks and footpaths;
- Erect permanent site security fencing;
- Landscape and plant site;
- Remove temporary construction fencing;
- Remove/demobilise appointed contractor's compound; and
- Hand-over of site to Client/operator.

Excavated material will be reused on-site in construction of the screening berms and landscaping, where possible, such that quantities of excavated material will balance the fill material required in the screening berms and site landscaping.

3.2.2 Proposed Pumping Station at Abbotstown

The preliminary design of the proposed Abbotstown pumping station indicates that the invert level of the inlet sewer is approximately 17m deep, and as a result, the base slab for the wet well and dry well will be constructed significantly below the existing ground level.

Construction of the Abbotstown pumping station will be undertaken using conventional construction methodologies and will involve deep excavation for basement wet well/dry well, reinforced concrete works, erection of reinforced concrete building frame, erection/building walls (concrete/blockwork); erection of prefabricated cladding panels to walls and roofs of building, mechanical and electrical fit out of building, construction of access road car park and footpaths, landscaping and final planting.

Preliminary site investigation indicates rock at approximately 2.5m below ground level. The rock shall be excavated to the required invert level in such a manner as to minimise noise generation. Overburden above the rock will most likely be retained using a temporary concrete retaining wall. All excavated material will be removed off site to an appropriately licenced facility.

3.2.3 Orbital Sewer Pipeline, North Fringe Sewer and Outfall pipeline (land sections)

An outline construction methodology is provided in the Outline CEMP (see Volume 2 Part B Appendices) for these elements and summarised in the following paragraphs.

The construction methodology for the proposed land based pipeline routes will be a combination of open cut and trenchless methods. A conventional open cut methodology will be employed for the majority of the proposed land based pipeline routes. A typical work sequence for a conventional open cut methodology is as follows:

- Fence pipeline construction corridor;
- Fence proposed temporary construction compound area;
- Establish the proposed temporary construction compounds;
- Strip topsoil carefully and store to one side of the proposed construction corridor for later reinstatement;
- Import pipes and string along the proposed construction corridor;
- Excavate pipeline trench and store to side of the proposed construction corridor (opposite side to topsoil storage) for later reinstatement;
- Import granular pipeline bedding material and place in excavated trench;
- Place pipeline on bedding material in excavated trench;
- Import granular pipeline surround material and place around pipeline in excavated trench;
- Test pipeline for watertightness;
- Backfill pipeline trench with suitable excavated material;
- Remove excess excavated material off site;
- Reinstate land drains; and
- Reinstatement of the proposed construction corridor to pre-construction condition (e.g. replacement of topsoil, seeding and replanting as appropriate) in accordance with the Outline CEMP for the Proposed Project.

Open cut methodology will not be suitable for all of the proposed pipeline routes, as a number of areas will require the use of trenchless techniques. In particular, the crossing of physical, natural and manmade obstructions, such as significant watercourses, significant topographical features, major roads, railways and major infrastructure, will necessitate the use of trenchless techniques.

Suitable trenchless techniques include pipe jacking and microtunnelling methods. Trenchless techniques require drive shafts to be constructed at the start of each trenchless section and reception shafts at the end of each section. These shafts will be constructed within the proposed temporary construction compounds located within the proposed construction corridor. At watercourse crossings, the drive and reception shafts will be located a minimum of 20m from the watercourse.

Locations where trenchless techniques will be employed are indicated on Planning Drawing nr. 32102902 – 2220.

The construction of the proposed orbital sewer and outfall pipeline (land based section) is estimated to take 18 months. Depending on the depth and size of the particular section of pipeline, it is envisaged that progress will be in the order of 15 to 30m per day. In advance of pipeline construction, a period will be required for the fencing of the construction corridor, topsoil stripping and archaeological monitoring of the excavations. Post pipeline construction, a period will be required for reinstatement and establishment, particularly where grass is to be planted.

3.2.3.1 Testing & Commissioning

Upon installation of the pipelines and prior to backfilling operations a hydrostatic/water test will be carried out on complete sections of pipeline to ensure there are no leaks. The pipe will be tested in discrete lengths, the lengths of which will be decided based on operational constraints and the quantity of water available. Water for testing will be taken from the closest public water supply network in agreement with Irish Water. Water will be re-used in multiple test sections by over pumping as required and finally discharged through the proposed outfall pipeline.

3.2.4 Proposed Outfall Pipeline Route (marine section micro tunnelled)

The proposed outfall pipeline route (marine section) will be constructed using microtunnelling and subsea pipe laying (dredging) techniques.

Microtunnelling techniques will be used between section chainage 0,000m and chainage 2,000m, from the open fields immediately west of the R106 Coast Road to approximately 600m offshore terminating below the low tide water mark.

The microtunnelled section will have an internal diameter of 2m and will be constructed at depths between 15m and 20m below ground level using a microtunnelling machine, with pipe sections installed as the microtunnelling machine progresses.

The microtunnelled section will require two proposed temporary construction compounds onshore, in the open field immediately west of the R106 Coast Road (chainage 0,000m) (proposed temporary construction compound no. 9) and in the grassed space (chainage 1,000m) adjacent to the public car park off the Golf Links Road, immediately north of Portmarnock Golf Club (proposed temporary construction compound no. 10). At proposed temporary construction compounds no. 9 and no. 10, the drive/reception shafts will be constructed, tunnelling equipment will be located and the tunnel materials will be stored temporarily. Waste material from the tunnel will be removed and disposed of in accordance with waste management legislation. Preliminary analysis estimates that microtunnelling will progress at a rate of approximately 60m per week and that the tunnelling will take in the region of 12 months, which includes for site mobilisation.

On completion of the construction works, proposed temporary construction compounds no. 9 and no. 10 will be dismantled and the ground will be reinstated to its original condition.

The proposed area for temporary construction compounds no. 9 and no. 10 will require a plan area of approximate dimensions of 150m x 100m and will contain the following plant and facilities:

- Office area including car parking;
- Launch (Jacking) shaft with Jacking station;
- Tunnelling equipment including:

  - Tunnel Boring Machine (TBM);
  - Control unit;
  - Hydraulic pump units;
  - Generators;
  - Bentonite mixing plant; and
  - Water separation plant;
- Storage area for jacking pipes, fuel, bentonite;
- Crane; and
- Excavator.

Microtunnelling will operate on a continuous 24-hour/7-day basis for the duration of the tunnelling works.

3.2.5 Proposed Outfall Pipeline (marine section sub-sea pipe laying)

Subsea pipe laying (dredging) techniques will be used between chainage 2,000m and the final outfall location (chainage 5,940m).

A 5m deep trench of trapezoidal section in the Seabed, will be excavated using a combination of backhoe dredger in the shallower areas and trailer suction hopper dredger (TSHD) where the water depths are beyond the limits of the backhoe dredger.

Excavated material from the backhoe dredger will be placed in a barge and subsequently deposited and stockpiled parallel to the proposed outfall pipeline route (marine section) trench, within the 250m wide proposed construction corridor. Where the TSHD is used it will deposit and stockpile the excavated material parallel to the proposed outfall pipeline route (marine section) trench, within the 250m wide proposed construction corridor. The stockpiled material will be subsequently reused to refill the trench over and around the pipe once it is installed in the trench.

Long length large diameter (LLLD) polyethylene pipe will be utilised on this dredged section of the proposed outfall pipeline route (marine section). These pipes will be constructed at the factory in the required diameter in continuously extruded strings up to 650m long. The pipe strings will then be towed to a pipe assembly/ballasting area in close proximity to the proposed outfall location.

Potential pipe assembly/ballasting areas identified include Dublin Port and adjacent to the pipeline trench. Pipe assembly will take place at Dublin Port (at quay wall or in sheltered waters) or in sheltered waters along the route of the outfall pipeline. At Dublin Port, mobile cranes would lift the concrete collars into place along a quay wall. Collars would be delivered by road to the port. In sheltered waters, a floating jack up platform supported by tugs and multicat vessels would be used to assemble the pipe strings and place the concrete collars. Collars would be delivered on a daily basis by ship to platform.

At the pipe assembly/ballasting areas, the pipe lengths will be joined together into longer pipeline strings and a concrete ballast will be placed over the pipe.

The typical method for connecting pipe strings is flanged connections. However, alternatives such as mechanical couplings or welding of sections may also be used.

It is noted that there are a number of alternatives for concrete ballast, and the concrete ballast design will be project specific depending on the installation scenario, pipeline parameters and contractor preferences. Options include rectangular, circular or starred ballast blocks or, alternatively, continuous concrete collars.

The assembled pipeline strings will then be towed to the proposed outfall pipeline route and surface positioned over the dredged trench. The pipeline will then be installed in the dredged trench in a continuous operation involving:

- Surface to seabed transfer utilising the polyethylene pipe's flexible properties (the 'S-bend' installation method); and
- Submersion by water filling/air evacuation.
- Connecting the pipeline strings together, using mechanical joints, as the installation progresses.

Once the pipe is confirmed to be in place at the bottom of the trench, the previously excavated material will be replaced around and over the pipe.

Preliminary analysis indicates that the construction period for the subsea pipe-laying element would take six months. However, it should be noted that all marine operations are weather dependent.

3.2.5.1 Dredge / Tunnel Interface

The tunnelled section will terminate approximately 600m offshore and this will be the interface point between the two sections of the marine outfall, i.e. the tunnelled section and the section constructed by subsea pipe construction techniques.

To facilitate retrieval of the Tunnel Boring Machine (TBM) the tunnel section will terminate into a temporary structure, such as a cofferdam for a 'dry' retrieval of the TBM, or into a pre-excavated section of trench filled with loose sand/granular material sourced from elsewhere along the trench alignment.

Where a cofferdam will be used the TBM is removed from the cofferdam using a crane mounted on a jack-up platform and a bulkhead is installed in the tunnel. The cofferdam will then be removed and the dredged trench completed. This will take approximately 1 month.

Where a 'wet' retrieval is used, the TBM will be driven into the pre-excavated section of trench. A bulkhead will be installed in the tunnel. The loose material will be carefully excavated by dredger from around the TBM and the TBM lifted from the trench using a crane mounted on a jack-up platform. The pipe trench will then be completed. This will take approximately 2 weeks.

When the pipe strings are installed in the trench as close as possible to the tunnel end the connection between the tunnel section and the sub-sea pipeline is made. This connection can be made by a number of methods;

- Inserting the HDPE spool piece sufficiently into the tunnel and sealing the annulus between the tunnel and the HDPE marine outfall pipeline route (marine section) to form a water tight seal.
- Making a mechanical connection between the tunnel and the outfall pipeline, using a flanged spool piece or similar.

3.2.5.2 Fibre optic cable protection

The proposed engineering solution is to install interlocking sheet piles to support the outfall pipeline trench in the vicinity of the fibre optic cable. This will reduce the width of the trench and allow the cable to be supported during the installation of the outfall pipeline route (marine section).

Once supported, the cable will be shielded with a suitable conduit to provide additional protection. This will allow the contractor to excavate below the supported cable. Following excavation of a suitable trench, the contractor will install a short length of PE pipeline, beneath the cable. This short length of PE pipeline will then be connected to the overall outfall, by means of subsea connections, in a similar manner to that described above.

The envisaged methodology for the outfall pipeline crossing of the fibre optic cable is provided hereunder;

- Sheet piles are driven to support the trench;
- The fibre optic cable is fitted with a Uraduct cable protection system, or similar;
- The cable is supported on either side of the trench using precast concrete structures. The trench is then excavated and the ballasted pipeline is laid; and
- After the pipe has been laid the previously excavated material shall be used as backfill around the new pipe and the cable protection system shall be removed.

3.2.5.3 Testing & Commissioning

The outfall pipeline (marine section) will be tested prior to transportation to the proposed outfall pipeline route. Therefore no onsite hydrostatic/water testing is required.

3.2.6 Proposed Diffuser

The proposed multiport marine diffuser will be located on the final section of the proposed outfall pipeline route (marine section) and will consist of a number of vertical risers from the proposed outfall pipeline to above sea-bed level onto which diffuser valves will be attached to allow the treated wastewater to achieve the required initial dilution on discharge to the marine environment.

The pipeline will be supplied with pre-installed flanged openings (capped) for the diffusers. Once the pipeline is lowered into the trench divers will remove the flanged caps and attach the riser pipes via bolted connections. The trench will then be backfilled. Divers will then attach the diffuser valves, again using bolted connections, to the end of the riser pipes which are protruding above the reinstated sea bed. Protective covers – precast concrete or steel will then be placed over the diffuser valves.

3.2.7 Proposed Access and Construction Compounds.

Access to the outfall pipeline route will be be via the public road network and also along the construction corridor, where practicable. However, in certain circumstances it will not be possible to access along the corridor andin these circumstances access will be along permanent wayleaves acquired through 3rd party lands. The proposed locations of such temporary access roads are identified on Figure 1-2.

To facilitate the construction of the Proposed Project, proposed temporary construction compounds will be required at various locations (e.g. at the proposed Abbotstown pumping station site, various locations along the proposed pipeline routes, trenchless crossing locations, etc.). The proposed temporary construction compounds will be in place for periods of one to 12 months, depending on their location and the construction activity taking place at that particular location. The proposed temporary construction compounds will have a site office, welfare facilities, parking and a materials storage area. The proposed locations of temporary compounds are identified on Figure 1-2.

3.2.8 Proposed Regional Biosolids Facility (RBSF)

The RBSF, which forms part of the Proposed Project, is an 11Ha site at Newtown, Dublin 11 and will include the following elements:

- Demolition of existing single storey structures on site comprising of a security kiosk (approx. 22 sq.m gfa), the weighbridge kiosk (approx. 19 sq.m gfa), an ESB Sub-Station (approx. 16 sq.m gfa) and an administration building (approx. 85 sq.m gfa), together with the partial removal of existing internal roads and partial removal / diversion of existing drainage infrastructure as appropriate to accommodate the development;
- Provision of 2no. biosolids storage buildings, each approximately 50m wide, 105m long and 15m in height, including solar panels on the roof of one building. These buildings have a combined capacity to store up to 48,000 cubic metres of biosolids waste at any one time;
- Provision of 4no. odour control units, each with 18.2m high discharge flues;
- Mechanical and electrical control building (approx. 35 sq.m gfa, 4 m high);
- Provision of a single storey site administration building for office, welfare facilities and meeting rooms (approx. 130 sq.m gfa) and associated staff car parking;
- Use of the existing vehicular access off the R135, including provision of new 2.7m high entrance gates to serve the Regional Biosolids Storage Facility;
- All ancillary landscape and site development works, including:
  - Provision of 2no. new weighbridge facilities (1no. weighbridge on entry and exit of the Regional Biosolids Storage Facility).
  - Provision of new ESB Sub-Station (approx. 40 sq.m gfa).

- Landscaping and boundary treatments, including new 2.7m high boundary to North Road/R135.
- Provision of fire protection holding tank (approx. 6.7m high).
- Provision of a HGV cleaning and set down area.
- Formation of new footpath and landscaped verge to R135 along site frontage.
- Provision of drainage, water, external lighting, and other utilities.
- Diversion of 450mm surface water pipe.
- 1no. signage structure, 5.2m in height erected on posts accommodating 2no. signage zones: 2.4m x 1.7 and 2.4m x 1.2m, located at the site entrance.

The Regional Biosolids Storage Facility will require a Certificate of Registration for the activity of storing biosolids (treated wastewater sludge).

These proposals are described in further detail in Volume 2 Part A, Section 4.

3.2.9 Programme

The proposed programme for Construction is presented overleaf.

Description	Estimated Construction Programme	2021	Q2022				2023				2024				2025			
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Mobilisation	3 months	🟦																
WwTP	3 years		🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧				
Abbotstown Pumping Station	12 months			🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜	⬜	⬜					
Construction Corridor Fencing, Topsoil Stripping and Archaeological Monitoring	3 months		🟦															
Orbital Sewer Route (Blanchardstown to Clonshagh) incl. NFS Diversion Sewer	18 months			🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜					
Outfall Pipeline Route (Land Based Section)	18 months			🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜					
Outfall Pipeline Route (Marine Section)																		
Establishing Temporary Construction Compounds for Tunnelling	3 months			🟦														
Tunnelling Works	9 months				🟦	🟦	🟦	🟦	⬜									
Demobilisation of Temporary Construction Compounds	2 months								🟦									
Subsea Pipeline Manufacture	6 months				🟦	🟦												
Subsea Pipeline Delivery	3 months						🟦											
Subsea Pipeline Assembly	3 months							🟦										
Subsea Pipeline Installation	2 months								🟦	⬜								
Dredging	3 months							🟦										
Backfilling	2 months									🟦								
Tunnel Subsea Pipeline Connection	1 month								🟦	⬜								
Install Diffusers	1 month								🟦									
Commissioning	12 months														🟧	🟧	🟧	🟧

Key:

Critical Path	🟧
Activity - Estimated Duration	🟦
Activity - Programme Float	⬜

3.3 Description of Operational Stage

3.3.1 Proposed Treatment Standards

A system for the licensing or certification of waste water discharges from areas served by local authority sewer networks was brought into effect on 27th September 2007 with the introduction of the Waste Water Discharge (Authorisation) Regulations, 2007 (S.I No. 684 of 2007). This licensing and certification process gives effect to a number of EU Directives by the imposition of restrictions or prohibitions on the discharge of dangerous substances and the implementation of measures required under the Water Framework Directive (WFD) and thus preventing or reducing the pollution of waters by waste water discharges. All discharges to the aquatic environment from sewerage systems owned, managed and operated by water service authorities require a waste water discharge licence or certificate of authorisation from the EPA.

The authorisation process provides for the EPA to place conditions on the operation of such discharges to ensure that potential effects on the receiving water bodies are limited and controlled with the aim of achieving good surface water status and good groundwater status no later than December 2015. The proposed Regional WwTP will require a waste water discharge licence to be granted by the EPA under the Waste Water Discharge (Authorisation) Regulations, 2007 (S.I No. 684 of 2007) prior to commissioning of the treatment plant.

Treatment standards for a treated wastewater from the proposed Regional WwTP to be discharged into the marine environment of the Irish Sea off the coast of North County Dublin were examined and reported on in the "*Key Wastewater Treatment Standards Report:*; December 2017". This report proposed, subject to the granting of a Wastewater Discharge Licence by the EPA, that the final treated wastewater produced at the proposed Regional WwTP should conform to the standards outlined in Table 3-1.

Table 3-1: Treated Wastewater Effluent Emission Limits for proposed Regional WwTP

Parameter		Emission Limit
pH		6 - 9
Toxicity		5 TU
Temperature		25°C (max)
BOD_5	95th Percentile	25 mg/l O_2
	Not to be exceeded	50 mg/l O_2
COD	95th Percentile	125 mg/l O_2
	Not to be exceeded	250 mg/l O_2
TSS	95th Percentile	35 mg/l
	Not to be exceeded	87.5 mg/l

3-dimensional hydrodynamic modelling studies undertaken on the proposed discharge have confirmed that, for the identified outfall location and the emission limit values set out in Table 3-1, the receiving water (apart from the small mixing zone) will meet good status criteria and meet the environmental quality objectives for coastal water nutrients levels. The modelling studies have also confirmed that:

- The Proposed Project will have negligible impact on the water quality of the coastal waters off County Dublin;
- The Proposed Project will not impact achieving the goals of the WFD of reaching good status in all water bodies; and
- The proposed discharge location will not negatively influence any designated bathing waters.

3.3.2 Chambers

Access chambers, manholes, air valves, scour valves and vent stacks are required to be constructed for the proper functioning, maintenance and operation of the proposed orbital sewer route and the proposed outfall pipeline route (land based section and marine section).

3.3.2.1 Air Valves

Air valves in pumped rising main systems serve two primary functions; the regular release of accumulated air that comes out of solution within a pressurised system, and to discharge large volumes of air from the pumped rising system when the pipeline is initially filled. Air valves are generally located at high points along the pumped rising main length.

3.3.2.2 Scour Valves

Scour valves are required at the low points on pumped rising main systems to facilitate the drain down of the pumped rising main system during maintenance.

3.3.2.3 Manholes

Access to the gravity sections of the proposed orbital sewer route (Section 1; chainage 5,220m – 12,745m) for maintenance purposes will be facilitated by the construction of access manholes. Manholes will be located at bends, changes in gradient and at approximately 200m centres along the proposed orbital sewer route.

3.3.2.4 Access Chambers

Access to the proposed outfall pipeline route (land based section) for maintenance purposes will be facilitated by the construction of access chambers.

3.3.3 Maintenance during Operation

The normal operation of the project and its constituent elements will be fully automated, which will be monitored, controlled and managed from a control centre located at the proposed Regional WwTP.

The automated control systems will report through supervisory control and data acquisition (SCADA) and telemetry systems to the control centre. The Regional WwTP and SHC will be manned 24 hours a day, 7 days a week. It is envisaged that between 30 – 40 operations staff will be employed, working in normal shift patterns, to ensure the continued and efficient operation of all elements of the project.

- Maintenance activities would typically include the following;
- General maintenance (daily);
- Preventative maintenance (as scheduled by operator);
- Pumping Station Inspections (weekly visit);
- Inspection Chambers on pipelines (annual visit); and
- Inspection of multiport diffusers (annual dive survey).

4. Screening for Appropriate Assessment

4.1 Methodology

4.1.1 Published Guidance on Appropriate Assessment

Appropriate Assessment Guidelines for Planning Authorities have been published by the Department of the Environment Heritage and Local Government (DEHLG, 2010a). In addition to the advice available from the Department, the European Commission has published a number of documents which provide a significant body of guidance on the requirements of Appropriate Assessment, most notably including, '*Assessment of Plans and Projects Significantly Affecting Natura 2000 sites - Methodological Guidance on the Provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC'* (EC, 2001), which sets out the principles of how to approach decision making during the process. These principal national and European guidelines have been followed in the preparation this report. The following list identifies these and other pertinent guidance documents:

- Communication from the Commission on the Precautionary Principle., Office for Official Publications of the European Communities, Luxembourg (EC, 2000a);
- Managing Natura 2000 Sites: the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC, Office for Official Publications of the European Communities, Luxembourg (EC, 2000b);
- Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Articles 6(3) and (4) of the Habitats Directive 92/43/EEC. Office for Official Publications of the European Communities, Brussels (EC, 2001);
- Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC – Clarification of the concepts of: alternative solutions, imperative reasons of overriding public interest, compensatory measures, overall coherence, opinion of the commission; (EC, 2007);
- Estuaries and Coastal Zones within the Context of the Birds and Habitats Directives - Technical Supporting Document on their Dual Roles as Natura 2000 Sites and as Waterways and Locations for Ports. European Commission (EC, 2009);
- Appropriate Assessment of Plans and Projects in Ireland. Guidance for Planning Authorities. Department of the Environment, Heritage and Local Government, Dublin (DEHLG, 2010a);
- Department of Environment Heritage and Local Government Circular NPW 1/10 and PSSP 2/10 on Appropriate Assessment under Article 6 of the Habitats Directive – Guidance for Planning Authorities (DEHLG, 2010b);
- Guidance document on the implementation of the birds and habitats directive in estuaries and coastal zones with particular attention to port development and dredging. European Commission (EC, 2011a);
- European Commission Staff Working Document 'Integrating biodiversity and nature protection into port development' (EC, 2011b);
- Marine Natura Impact Statements in Irish Special Areas of Conservation: A working document, National Parks and Wildlife Service, Dublin (NPWS, 2012); and
- Interpretation Manual of European Union Habitats. Version EUR 28. European Commission (EC, 2013).

4.1.2 Likely Significant Effect

The threshold for a Likely Significant Effect (LSE) is treated in the screening exercise as being above a *de minimis* level. A *de minimis* effect is a level of risk that is too small to be concerned with when considering ecological requirements of an Annex I habitat or a population of Annex II species present on a European site necessary to ensure their favourable conservation condition. If low level effects on habitats or individuals of species are judged to be in this order of magnitude and that judgment has been made in the absence of reasonable scientific doubt, then those effects are not considered to be likely significant effects.

> *"the requirement that the effect in question be 'significant' exists in order to lay down a de minimis threshold. Plans or projects that have no appreciable effect on a European site are thereby excluded. If all*

> *plans or projects capable of having any effect whatsoever on the site were to be caught by Article 6(3), activities on or near the site would risk being impossible by reason of legislative overkill".*
>
> *[Paragraphs 46-50 of the Opinion of the Advocate General in CJEU case C-258/11]*

4.1.3 Mitigation Measures at Screening Stage

In relation to mitigation measures, EC (2001) states that "*project and plan proponents are often encouraged to design mitigation measures into their proposals at the outset. However, it is important to recognise that the screening assessment should be carried out in the absence of any consideration of mitigation measures that form part of a project or plan and are designed to avoid or reduce the impact of a project or plan on a Natura 2000 site*". This direction in the European Commission's guidance document is unambiguous in that it does not permit the inclusion of mitigation at screening stage.

In April 2018, the Court of Justice of the European Union issued a ruling in case C-323/17 that Article 6(3) of Directive 92/43/EEC must be interpreted as meaning that, in order to determine whether it is necessary to carry out, subsequently, an appropriate assessment of the implications, for a site concerned, of a plan or project, it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site.

For this project, mitigation measures intended to avoid or reduce the harmful effects of the GDD project on European sites have not been taken into consideration at screening stage.

4.2 Elements of the Project with Potential for Likely Significant Effects

There is a significant number of designated sites at and close to the marine aspects of the Proposed Project (see Figure 1-1). This screening stage of the assessment considers European sites designated under European Council Directives 92/43/EEC and 2009/147/EC. The Proposed Project will be screened against those European sites for which a pathway of effect can be reasonably established between a receptor and the source of effect.

The possibility of significant effects is considered in this report using the source-pathway-receptor model. 'Source' is defined as the individual elements of the proposed works that have the potential to affect the identified ecological receptors. 'Pathway' is defined as the means or route by which a source can affect the ecological receptor. 'Ecological receptor' is defined as the Special Conservation Interests (SCIs) for SPAs or Qualifying Interests (QIs) for SACs, and for which Conservation Objectives (COs) have been set for the European sites being considered. Each element can exist independently however an effect is created when there is a linkage between the source, pathway and receptor.

Elements of the Proposed Project with the potential for LSEs are discussed in Table 4-1 with the possibility of impact pathways noted under one of four effect themes:

- Water quality and habitat deterioration;
- Airborne noise and visual disturbance;
- Underwater noise and disturbance; and
- Habitat Loss.

Table 4-1: Project Elements that can give rise to Likely Significant Effects (LSEs)

Project Element	Stages of Development	Type of Effects	Impact Pathways
Clonshaugh Regional WWTP and Sludge Hub Centre including Access Road to WWTP	Enabling Works – Excavations, earthworks, construction traffic.	Water quality and habitat deterioration. Other effect themes are not applicable as this element of the Proposed Project is located >3.5km from any European site. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this element of the project to those marine receptor species. Habitat loss cannot occur at this distance.	There is a possibility of release of suspended sediment or contaminated run off during construction stage and a possibility of release of polluting emissions as a result of leaks or spillages from the WWTP at operational stage, as the Cuckoo Stream lies directly north of this element of the Proposed Project and is located within the River Mayne Catchment, which flows into Baldoyle Bay.
	Construction Works – Excavations, earthworks, concrete works, construction traffic, surface water management. Instream works for culvert along access access road.		
	Commissioning	Release of test water (potable water) into outfall pipeline. No effects predicted.	
	Operational Stage	Water quality and habitat deterioration.	
Pumping Station at Abbotstown including Access Road	Enabling Works – Excavations, earthworks	Water quality and habitat deterioration. Other effect themes are not applicable as this element of the Proposed Project is located >9km from any European site. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this element of the project to those marine receptor species. Habitat loss cannot occur at this distance.	There is a possibility of release of suspended sediment or contaminated run off during construction stage and a possibility of release of polluting emissions as a result of leaks from the pumping station at operational stage, as this element of the Proposed Project is located within the Tolka River Catchment, which flows into the Tolka Estuary.
	Construction Works – Excavations, earthworks, concrete works, construction traffic, surface water management.		
	Commissioning	Release of test water (potable water) into outfall pipeline. No effects predicted.	
	Operational Stage -	Water quality and habitat deterioration.	
Orbital Sewer Pipeline	Enabling/Advance Works - surveys,	Water quality and habitat deterioration.	There is a possibility of release of suspended sediment or

Project Element	Stages of Development	Type of Effects	Impact Pathways
	hedgerow removal, trenchless crossing advance works	Other effect themes are not applicable as this element of the Proposed Project is located >4.5km from any European site. Disturbance or displacement of feature species of European sites as a result of underwater or airborne noise, vibration or other visual stimuli cannot occur at this distance. Habitat loss cannot occur at this distance.	contaminated run off within the wayleave at construction stage and a possibility of release of polluting emissions as a result of leaks from the pipeline at operational stage, as this element of the Proposed Project is located within the Santry, Mayne and Tolka River catchments which flow to Dublin Bay and Baldoyle Bay.
	Construction – Earthworks, surface water management, trenching, pipeline deliveries and installation, backfilling, resinstatement		
	Commissioning/Testing -	Release of test water (potable water) into outfall pipeline. No effects predicted.	
	Operation	Water quality and habitat deterioration	
Orbital Sewer Pipeline - Trenchless Crossings (local roads, rail, water courses, etc.)	Earthworks, excavations, pumping, drilling, management of drilling fluid, reinstatement	Water quality and habitat deterioration. Other effect themes are not applicable as this element of the Proposed Project is located >4.5km from any European site. Disturbance or displacement of feature species of European sites as a result of underwater or airborne noise, vibration or other visual stimuli cannot occur at this distance. Habitat loss cannot occur at this distance.	There is a possibility of release of suspended sediment or contaminated run off within the wayleave at construction stage, as this element of the Proposed Project is located within the Santry, Mayne and Tolka River catchments which flow to Dublin Bay and Baldoyle Bay.
North Fringe Sewer (see also WWTP access road)	Enabling/Advance Works surveys, hedgerow removal, trenchless crossing advance works	Water quality and habitat deterioration. Other effect themes are not applicable as this element of the Proposed Project is located >4.5km from any European site. Disturbance or displacement of feature species of European sites as a result of underwater or airborne noise, vibration or other visual stimuli cannot occur at this distance. Habitat loss cannot occur at this distance.	There is a possibility of release of suspended sediment or contaminated run off within the wayleave at construction stage and a possibility of release of polluting emissions as a result of leaks from the pipeline at operational stage, as this element of the Proposed Project is located within the River Mayne Catchment, which flows into Baldoyle Bay. The route crosses the River Mayne.
	Construction – Earthworks, trenching, pipeline deliveries and installation, backfilling, resinstatement		
	Commissioning/Testing -	Release of test water (potable water) into outfall pipeline. No effects predicted.	
	Operation	Water quality and habitat deterioration	
Outfall pipeline (land section)	Enabling/Advance Works - surveys, hedgerow removal, trenchless crossing advance works	Water quality and habitat deterioration Airborne noise and visual disturbance.	There is a possibility of release of suspended sediment or contaminated run off within the wayleave at construction stage and a possibility of release of polluting emissions as

Project Element	Stages of Development	Type of Effects	Impact Pathways
	Construction – Earthworks, surface water management, trenching, pipeline deliveries and installation, backfilling, resinstatement	Disturbance or displacement of feature species of European sites as a result of underwater noise cannot occur as this element of the Proposed Project is terrestrial. Habitat loss cannot occur as this element of the Proposed Project is not located within or adjacent to a European site.	a result of leaks from the pipeline at operational stage, as the Proposed Project corridor crosses the Cuckoo Stream and is located within the River Mayne Catchment, which flows into Baldoyle Bay. There is a possibility of disturbance and/or displacement by habitat loss, visual stimuli, general construction noise, piling noise, vibration or the presence of construction plant, machinery and operatives at the eastward terminal of the Outfall pipeline (land-based section) directly on qualifying species (outside the SPA boundary) and in proximity to lands used by SCI species of European sites.
	Commissioning/Testing	Release of test water (potable water) into outfall pipeline. No effects predicted.	
	Operation	Water quality and habitat deterioration	
Outfall pipeline marine sections – micro tunnelling & tunnelling compounds (compounds 9&10)	Enabling/Advance Works – Earthworks	Water quality and habitat deterioration Airborne noise and visual disturbance Habitat loss. Disturbance or displacement of feature species of European sites as a result of underwater noise will not occur as this element of the Proposed Project comprises terrestrial excavations each side of a shallow estuary and marine feature species do not occur in the estuary. Construction traffic associated with the microtunnelling compounds will utilise existing roads (R106) and will therefore not result in displacement or disturbance to feature species of European sites.	There is a possibility of release of suspended sediment or contaminated run off at construction stage, as this element of the Proposed Project is located directly adjacent to Baldoyle Bay and surface water will flow into Baldoyle Bay. There is a possibility of habitat loss by direct land take (outside the SPA boundary) disturbance to SPA-qualifying features through visual disturbance, vibration or construction noise due to the presence of construction plant, machinery and operatives at the micro tunnelling compounds adjacent to lands used by overwintering birds at Baldoyle Bay. There is a possibility of habitat loss at construction phase as this element of the Proposed Project is located immediately adjacent to a European site, on habitats potentially utilised by SCIs of European sites outwith their boundaries.
	Construction – Earthworks, excavations, pumping, piling, management of drilling fluid, reinstatement, night time working (including lighting), construction traffic		
	Commissioning/Testing	Release of test water (potable water) into outfall pipeline. No effects predicted.	
	Operation	None (no operational stage activity).	
Outfall pipeline (Marine section – sub sea pipe laying)	Construction – Dredging along a 250m wide working corridor, stringing in pipelines, return of excavated material to sea bed, marine vessel traffic .	Water quality and habitat deterioration. Underwater noise and disturbance. Airborne noise, vibration and visual disturbance. Habitat loss	There is a possibility of suspended sediment plumes or contaminated run off from marine vessels at construction stage affecting European sites, or the SCIs of European sites utilising habitats outwith their boundaries. There is a possibility of release of polluting emissions as a result of leaks from the pipeline at operational stage.

Project Element	Stages of Development	Type of Effects	Impact Pathways
	Construction - Ballasting and pipe assembly operation at Dublin Port or along outfall pipeline route	Airborne noise, vibration and visual disturbance (see Section 4.4.1)	There is a possibility of general construction noise or the presence of construction vessels, construction plant, machinery and operatives along the working corridor of the marine outfall pipeline corridor affecting habitats outwith European sites being used by their SCI species. This could result in disturbance and/or displacement. There is a possibility of construction noise emissions in the water column of the working corridor of the marine outfall pipeline corridor which could disturb or injure mobile marine mammal feature species of Rockabill to Dalkey Island SAC or Lambay Island SAC. There is a possibility of habitat loss occurring where this element of the Proposed Project passes through a European site.
	Testing and Commissioning of marine pipeline	No testing required after installation.	
	Operation	Water quality and habitat deterioration	
Interface option 1 (dredged pit)	Enabling Works – mobilisation of vessels	Water quality and habitat deterioration Underwater noise and disturbance Airborne noise and visual disturbance Habitat loss	There is a possibility of suspended sediment plumes or contaminated run off from marine vessels at construction stage, as this element of the Proposed Project is located in the nearshore waters of Velvet Strand within Baldoyle Bay SAC. The piling noise, vibration and the presence of vessels, construction plant, machinery and operatives at the interface between the land-based and marine-based outfall pipeline could impact areas of habitat used by SCI species beyond the boundaries of European sites. This could result in disturbance and displacement. There is a possibility of construction noise emissions in the water column at the interface between the land-based and marine-based outfall pipeline which could disturb or injure mobile marine mammal feature species of Rockabill to Dalkey Island SAC or Lambay Island SAC. There is a possibility of habitat loss occurring as this element of the Proposed Project is located in proximity to nearshore waters of Velvet Strand within Baldoyle Bay SAC.
	Construction – Dredging		
Interface option 2 (cofferdam)	Enabling Works - set up jack-up platform		
	Cofferdam construction, Removal of TBM, connection of pipelines, removal of cofferdam		

Project Element	Stages of Development	Type of Effects	Impact Pathways
FO cable	Construction - install sheet piles, excavate, place precast concrete structure, remove sheet piles and precast concrete structures	Water quality and habitat deterioration Underwater noise and disturbance Airborne noise and visual disturbance	There is a possibility of suspended sediment or contaminated run off from marine vessels at construction stage, as this element of the Proposed Project is located in the marine waters between Baldoyle Bay SAC and Rockabill to Dalkey Island SAC. There is a possibility of construction noise or the presence of marine vessels, construction plant, machinery and operatives at the FO cable in areas used by breeding seabirds of nearby SPAs. There is a possibility of construction noise emissions in the water column at the FO cable which could disturb or injure mobile marine mammal feature species of Rockabill to Dalkey Island SAC or Lambay Island SAC. There is a possibility of habitat loss occurring as this element of the Proposed Project is located in proximity to nearshore waters of Velvet Strand within Baldoyle Bay SAC.

Diffuser	Construction – installation, backfilled, divers attach diffuser valves, precast concrete or steel are then placed over the diffuser valves.	Water quality and habitat deterioration Underwater noise and disturbance Airborne noise and visual disturbance Habitat loss	There is a possibility of suspended sediment plumes or contaminated run off from marine vessels at construction stage, or release of elevated levels of pollutants as a result of operational emissions, as this element of the Proposed Project is located in Rockabill to Dalkey Island SAC and in proximity to Ireland's Eye SPA. The construction noise, vibration and the presence of marine vessels, construction plant, machinery and operatives at the marine diffuser could impact areas of habitat used by SCI species within and beyond the boundaries of European sites. This could result in disturbance and displacement. There is a possibility of construction noise emissions in the water column at the diffuser which could disturb or injure mobile marine mammal feature species of Rockabill to Dalkey Island SAC or Lambay Island SAC. There is a possibility of habitat loss occurring as this element of the Proposed Project is located in Rockabill to Dalkey Island SAC
Regional Biosolids Storage Facility (RBSF)	Construction Works – Excavations, earthworks, concrete works	Water quality and habitat deterioration	There is a potential pathway between the RBSF Component of the Proposed Project and the Malahide Estuary SAC via the surface water network. However no significant effects are predicted, due to the absence of discharge/emissions from the proposed site, other than the collection of rainfall and surface water runoff (see Ringend Wastewater Treatment Plant Upgrade - Stage 1 Screening & Stage 2 NIS Report, May 2018). Other effect themes are not applicable as this element of the Proposed Project is located >8km from any European site. Disturbance or displacement of feature species of European sites as a result of underwater or aerial noise, or other visual stimuli cannot occur at this distance. Habitat loss cannot occur at this distance. Therefore, the RBSF element of the project can be screened out of further assessment of implications on
	Commissioning -	n/a	
	Operational Stage –collection of rainfall and surface water management.	Water quality and habitat deterioration	

			European Sites.
Access Roads (see Planning Drawings Nrs. 32102902-1110 to 1112.)	Construction - Earthworks, reinstatement	Water quality and habitat deterioration Airborne noise and visual disturbance. Disturbance or displacement of feature species of European sites as a result of underwater noise will not occur as this element of the Proposed Project is terrestrial with no impact pathway to marine feature species. There is no possibility of disturbance to SCIs of European sites as construction plant moves along the R106 regional road, as this is an existing major traffic route. There is no possibility of habitat loss in a European site as this element of the Proposed Project is terrestrial and not located within a European site.	There is a possibility of release of contaminated run off from spillages during construction stage as construction plant moves along access roads; as this element of the Proposed Project is located generally within the Santry, Mayne and Tolka River catchments which flow to Dublin Bay and Baldoyle Bay, and in particular includes use of the R106 regional road which runs along the boundary of Baldoyle Bay SAC and SPA. There is a possibility of construction noise from the presence of construction plant, machinery and operatives during construction of 125m of access track to the south of the western microtunnelling compound. This could result in disturbance to SCIs of European sites using habitats outwith their boundaries.
Satellite Compounds (1-8) (see Planning Drawings Nrs. 32102902-1110 to 1112.)	Construction - Earthworks, reinstatement	Water quality and habitat deterioration	There is a possibility of release of contaminated run off from spillages at construction compounds (excluding microtunnelling compounds at Baldoyle Bay); as this element of the Proposed Project is located within the Santry, Mayne and Tolka River catchments which flow to Dublin Bay and Baldoyle Bay,
Utility Connections (gas & electricity) at Clonshaugh and Abbottstown Pumping Station	Construction – earthworks along access & egress roads to WWTP to install underground cables to connect gas and esb. All works to be undertaken within the proposed wayleave.	Water quality and habitat deterioration. Other effect themes are not applicable as these elements of the Proposed Project are located >3.5km from any European site. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this element of the project to those marine receptor species. Habitat loss cannot occur at this distance.	There is a possibility of release of suspended sediment or contaminated run off during construction into the River Mayne Catchment, which flows into Baldoyle Bay and the Tolka River Catchment, which flows into the Tolka Estuary.

4.2.1 Water Catchments traversed by the Proposed Project

The Tolka River rises near Dunshaughlin in Co. Meath and flows in a south-easterly direction where it crosses through the north of Dublin city before entering the sea at Clontarf through South Dublin Bay and the River Tolka Estuary SPA (004024) and North Dublin Bay pNHA (000206). The Tolka River has a length of approximately 20km from source to the sea, nearly half of which is located within the urban sprawl of Dublin City. The Tolka River will not be crossed by the orbital pipeline, however the Abbotstown Pumping station and associated compound, will be located approximately 130m from this river. The course of the river has been altered in this location and flows in a straight line under the M50 within an artificial channel with concrete banks.

The Santry River rises near Harristown, in Co. Dublin, and flows east via Santry, Kilmore, Edenmore and Raheny, through several designated nature conservation areas, before entering the sea at Dublin Bay. The Santry River flows through the Santry Demesne pNHA (00178) and discharges through North Bull Island SPA (004006) and North Dublin Bay SAC and pNHA (000206). The Santry River will be crossed once by the orbital sewer at Silloge. A satellite compound will be located at the M50 Interchange No. 4, and will be located approximately 100m from this river.

The Mayne River rises near Harristown, in Co. Dublin, and flows east entering the sea via Portmarnock Estuary at Mayne Bridge. The Cuckoo Stream, a tributary of the Mayne River, rises near Huntstown, in Co. Dublin, and flows east merging with the Mayne River at Balgriffin. The Mayne River discharges through Baldoyle Bay SAC and pNHA (000199) and Baldoyle Bay SPA (004016). The Mayne River will be crossed once by the orbital sewer just north of the M50 and south of Ballystruan. A satellite compound will be located at the Old Airport Road / R132 Swords Road junction (the Collinstown Crossroads) and will be located approximately 650m from the Mayne River, and approximately 235m from the Cuckoo Stream. The Mayne River will also be crossed by a new culvert system which will be constructed to provide access to Craobh Chiaráin Gaelic Athletic Association (GAA) Pitches and the new WwTP at Clonshaugh. The Cuckoo Stream will be crossed once by the orbital sewer directly downstream of the new WwTP which will be constructed at Clonshagh. The Cuckoo Stream also lies immediately north of the WwTP site, while the Mayne River lies approximately 400m to the south. The site of the WwTP will also constitute a compound for the duration of the works.

4.2.1.1 Surface Water Management Plan

An outline Surface Water Management Plan (see EIAR Volume 2 Part B Appendices) has been prepared for the Proposed Project. It includes details of the proposed discharge locations where treated surface water will be discharged to the aforementioned water cactchments during the construction of the project. It includes a number of measures to ensure there is no direct discharge of surface water from any element of the works without proper attenuation and treatment.

4.3 European Sites within the Study Area of the Proposed Project

Table 4-2 lists the European Sites potentially affected by the Proposed Project as shown in Figures 1-1 & 1-2 and summarises the potential pathways for Likely Significant Effects as identified in Table 4-1.

Table 4-2: European Sites potentially affected by the Proposed Project

Ref No.	Site Name	Designation Type	Site Code	Approximate Location Relative to Proposed Works	Potential Pathways for LSEs
1	Baldoyle Bay	SAC	000119	Marine outfall passes through this SAC	• Hydrological (water quality and habitat deterioration) • Underwater noise and disturbance • Habitat loss
2	Baldoyle Bay	SPA	004016	Marine outfall passes through this SPA	• Hydrological (water quality and habitat deterioration) • Airborne noise and visual disturbance • Habitat Loss
3	Rockabill to Dalkey Island	SAC	003000	A 1,300m section of the marine outfall and diffuser are located in this SAC	• Hydrological (water quality and habitat deterioration) • Underwater noise and disturbance • Habitat loss

Ref No.	Site Name	Designation Type	Site Code	Approximate Location Relative to Proposed Works	Potential Pathways for LSEs
4	Ireland's Eye	SAC	002193	1.0km south of the marine outfall	Designated for coastal and not marine habitats. There is no hydrological link and no open pathway of effect, thus there is no real possibility of LSEs.
5	Ireland's Eye	SPA	004117	0.4km southwest of the marine outfall	• Hydrological (water quality and habitat deterioration) • Airborne noise and visual disturbance • Habitat Loss
6	North Dublin Bay	SAC	000206	2.3km to the south of the marine outfall	• Hydrological (water quality and habitat deterioration)
7	North Bull Island	SPA	004006	2.3km to the south of the Marine Outfall	• Hydrological (water quality and habitat deterioration) • Airborne noise and visual disturbance • Habitat Loss
8	Malahide Estuary[2]	SPA	004025	2.5km to the north of the Marine Outfall	• Hydrological (water quality and habitat deterioration) • Airborne noise and visual disturbance • Habitat Loss
9	Malahide Estuary	SAC	000205	2.5km north of the marine outfall	• Hydrological (water quality and habitat deterioration)
10	Howth Head Coast	SPA	004113	2.6km to the south of the Marine Outfall	• Hydrological (water quality and habitat deterioration) • Airborne noise and visual disturbance • Habitat Loss
11	Howth Head	SAC	000202	2.6km to the south of the marine outfall	Designated for coastal terrestrial habitats. There is no hydrological link and no open pathway of effect, thus there is no likelihood of significant effects.
12	South Dublin Bay and River Tolka Estuary	SPA	004024	7.6km south of the Marine Outfall Ballasting and pipe assembly operations may occur in the Liffey channel in Dublin Port where Tern breeding sites are located on structures on the south side of the River	• Hydrological (water quality and habitat deterioration) • Airborne noise and visual disturbance • Habitat Loss
13	Rogerstown Estuary	SAC	000208	8.5km north of the marine outfall	• Hydrological (water quality and habitat deterioration)
14	Rogerstown Estuary	SPA	004015	8.5km north of the Marine Outfall	• Hydrological (water quality and habitat deterioration) • Airborne noise and visual disturbance • Habitat Loss
15	South Dublin Bay	SAC	000210	9.1km to the south of the Marine Outfall	• Hydrological (water quality and habitat deterioration)
16	Lambay Island	SAC	000204	9.3km north-east of the marine outfall	• Hydrological (water quality and habitat deterioration) • Underwater noise and disturbance

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[2] NPWS also refer to this as Broadmeadows / Swords Estuary SPA.

Ref No.	Site Name	Designation Type	Site Code	Approximate Location Relative to Proposed Works	Potential Pathways for LSEs
17	Lambay Island	SPA	004069	9.3km north-east of the Marine Outfall	• Hydrological (water quality and habitat deterioration) • Airborne noise and visual disturbance • Habitat Loss
18	Dalkey Island	SPA	004172	14.9km south of the Marine Outfall	• Hydrological (water quality and habitat deterioration) • Airborne noise and visual disturbance • Habitat Loss
19	Skerries Islands	SPA	004122	16.7km to the north of the Marine Outfall	• Hydrological (water quality and habitat deterioration) • Airborne noise and visual disturbance • Habitat Loss
20	Rockabill	SPA	004014	16.9km to the north of the Marine Outfall	• Hydrological (water quality and habitat deterioration) • Airborne noise and visual disturbance • Habitat Loss
21	Glenasmole Valley	SAC	001209	14.8km south of the project	This SAC is situated 14.8km south of the Orbital Sewer. It is considered that there is no potential for effects on this site as no connecting pathways, e.g. streams or rivers) potentially lie within the zone of influence.
22	Rye Water Valley/Carton	SAC	001398	8.7km to the west of the project	This SAC is situated 8.7km to the west of the Orbital Sewer. It is considered that there is no potential for effects on this site as no connecting pathways, e.g. streams or rivers) potentially lie within the zone of influence.

The sites shaded in grey in Table 4-2 above have no potential pathway for impact and as such are not considered further in the screening assessment.

4.4 Analysis of Potential for Likely Significant Effects

Table 4-3 identifies the potential for likely significant effects on the Qualifying Interests (QIs) or Special Conservation Interests (SCIs) of the European sites as a result of construction, commissioning or operation of the Proposed Project.

Table 4-3: Potential for Likely Significant Effects on European Sites

Ref.	Site name & Code	Approximate Location Relative to Proposed Works	Qualifying interests (or) Special Conservation Interests	Potential for Likely Significant Effects (LSEs)	LSEs
1	Baldoyle Bay SAC 000199	Marine outfall pipeline will be installed in a tunnel that passes below the SAC.	Mudflats and sandflats not covered by seawater at low tide; *Salicornia* and other annuals colonizing mud and sand; Atlantic salt meadows (Glauco-*Puccinellietalia maritimae*); and Mediterranean salt meadows (*Juncetalia maritimi*).	• Possible deterioration of water quality of estuarine habitats due to pollution events or elevated suspended solids during construction of all project elements upstream of this site that could lead to runoff into the Mayne River which flows into the SAC. • Possible deterioration of water quality of estuarine habitats due to pollution events or suspended sediment plumes during construction of marine project elements including bentonite blowout or surface venting. • Possible deterioration of water quality of estuarine habitats due to plume arising from operation of project. • No direct habitat loss will occur within the SAC as the marine pipeline will be installed in a tunnel that passes below the SAC; tunnelling compounds on the surface are to be located outside the boundary of the SAC, and the interface of the tunnelled section and seabed section of the marine pipeline will be located outside of the SAC. However, there is the potential for bentonite release or surface venting during the tunnelling operations that could lead to habitat loss.	LSEs upon estuarine habitats as a result of polluting events upstream of the SAC cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon estuarine habitats as a result of construction (including dredging plumes or bentonite release/surface venting during tunnelling) and operational phases cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.
2	Baldoyle Bay SPA 004016	Marine outfall pipeline will be installed in a tunnel that passes below the SPA.	Light-bellied Brent Goose (*Branta bernicla hrota*); Shelduck (*Tadorna tadorna*); Ringed Plover (*Charadrius hiaticula*); Golden Plover (*Pluvialis apricaria*); Grey Plover (*Pluvialis squatarola*); Bar-tailed Godwit (*Limosa	• Possible deterioration of water quality of intertidal wetland habitats in the SPA due to pollution events or elevated suspended solids during construction of all project elements upstream that could lead to runoff into the Mayne River which flows into the SPA. • Possible deterioration of water quality of intertidal wetland habitats in the SPA due to pollution events or suspended sediment plumes during construction of marine project elements, including dredging, bentonite blowout or surface venting.	LSEs upon intertidal wetland habitats in the SPA as a result of polluting events upstream of the SPA cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon intertidal wetland habitats in the SPA as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments

Ref.	Site name & Code	Approximate Location Relative to Proposed Works	Qualifying interests (or) Special Conservation Interests	Potential for Likely Significant Effects (LSEs)	LSEs
			lapponica); and Wetlands and Waterbirds.	• Possible deterioration of water quality of intertidal wetland habitats in the SPA due to plume arising from operation of project. • Possible disturbance or displacement of SCI species inside and outside the SPA as a result of noise or visual stimuli of construction stage activities causing birds to change their behaviour. No direct habitat loss will occur within the SPA as the marine pipeline will be installed in a tunnel that passes below the SPA, and tunnelling compounds on the surface are to be located outside the boundary of the SPA. However, habitat loss outwith the SPA boundary during construction is possible and as a result of surface venting/bentonite release.	or polluting substances, and the application of mitigation as necessary. LSEs upon SCI species as a result of airborne noise, vibration and visual disturbance within and in proximity to the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon SCI species as a result of habitat loss outwith the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary.
3	Rockabill to Dalkey Island SAC 003000	A 1,300m section of the Marine outfall and diffuser are located in this SAC	*Phocoena phocoena* (Harbour porpoise); Reefs.	• Possible deterioration of water quality of reef habitats due to pollution events or elevated suspended solids during dredging of marine outfall pipeline, diffuser, FO cable protection works, interface works. • Possible deterioration of water quality for reef habitats due to treated wastewater discharge during operation. • Possible noise disturbance of mobile cetacean species during construction of marine outfall and diffuser, FO cable protection works, interface works. • Possible deterioration of water quality leading to reduction in prey of mobile cetacean species during operation. • Habitat Loss associated with 1,300m of marine outfall and diffuser.	LSEs upon reef habitats as a result of polluting events from marine plant cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon reef habitats as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary. LSEs upon Harbour porpoise as a result of underwater noise and disturbance cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon Harbour porpoise as a result of habitat loss cannot be excluded without further analysis and the application of mitigation as necessary.

Ref.	Site name & Code	Approximate Location Relative to Proposed Works	Qualifying interests (or) Special Conservation Interests	Potential for Likely Significant Effects (LSEs)	LSEs
4	Ireland's Eye SPA 004117	0.4km southwest of the Marine outfall	Cormorant (*Phalacrocorax carbo*); Herring Gull (*Larus argentatus*); Kittiwake (*Rissa tridactyla*); Guillemot (*Uria aalge*); and Razorbill (*Alca torda*).	• Possible deterioration of water quality from construction and operational sediment/pollution plumes resulting in change in foraging potential as a result of changes in water quality impacting on food resource abundance. • Possible disturbance or displacement of SCI species inside and outside the SPA as a result of noise or visual stimuli of construction stage activities for the marine outfall pipeline, marine diffuser, FO protection cable works and the microtunnelling/subsea interface, causing birds to change their behaviour. It is considered that underwater noise will not result in LSE as birds will likely be disturbed or displaced by the presence of vessels (i.e. visual disturbance) first.	LSEs upon SCI species as a result of airborne noise and visual disturbance (both inside and outside the SPA boundary) cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon water quality in the SPA as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary. LSEs upon SCI species as a result of habitat loss outwith the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary.
5	North Dublin Bay SAC 000206	2.3km to the south of the Marine outfall	*Petalophyllum ralfsii* (Petalwort); Mudflats and sandflats not covered by seawater at low tide; *Salicornia* and other annuals colonizing mud and sand; Atlantic salt meadows (Glauco-*Puccinellietalia maritimae*); Mediterranean salt meadows (*Juncetalia maritimi*); Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes); Fixed coastal dunes with	• Possible deterioration of water quality of estuarine habitats due to pollution events or elevated suspended solids during construction of all project elements upstream of this site that could lead to runoff into the Santry River, which flows into the SAC. • Possible deterioration of water quality of estuarine habitats due to pollution events or suspended sediment plumes during construction of marine project elements.. • Possible deterioration of water quality of estuarine habitats due to plume arising from operation of project.	LSEs upon estuarine habitats as a result of polluting events upstream of the SAC or from marine plant cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon estuarine habitats as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.

Ref.	Site name & Code	Approximate Location Relative to Proposed Works	Qualifying interests (or) Special Conservation Interests	Potential for Likely Significant Effects (LSEs)	LSEs
			herbaceous vegetation (grey dunes); Annual vegetation of drift lines; Embryonic shifting dunes; and Humid dune slacks.		
6	North Bull Island SPA 004006	2.3km to the south of the Marine Outfall	Light-bellied Brent Goose (*Branta bernicla* hrota); Shelduck (*Tadorna tadorna*); Teal (*Anas crecca*); Pintail (*Anas acuta*); Shoveler (*Anas clypeata*); Oystercatcher (*Haematopus ostralegus*); Golden Plover (*Pluvialis apricaria*); Grey Plover (*Pluvialis squatarola*); Knot (*Calidris canutus*); Sanderling (*Calidris alba*); Dunlin (*Calidris alpina*); Black-tailed Godwit (*Limosa limosa*); Bar-tailed Godwit (*Limosa lapponica*); Curlew (*Numenius arquata*); Redshank (*Tringa totanus*); Turnstone (*Arenaria interpres*); Black-headed gull (*Chriocoephalus ridibundus*); and Wetland and Waterbirds	• Possible deterioration of water quality of intertidal wetland habitats in the SPA due to pollution events or suspended sediment plumes during construction of marine project element. • Possible deterioration of water quality of intertidal wetland habitats in the SPA due to plume arising from operation of project. • Possible disturbance or displacement of SCI species inside and outside the SPA as a result of noise or visual stimuli of construction stage activities causing birds to change their behaviour.	LSEs upon SCI species as a result of airborne noise, vibration and visual disturbance within and in proximity to the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon SCI species as a result of habitat loss outwith the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon water quality in the SPA as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.

Ref.	Site name & Code	Approximate Location Relative to Proposed Works	Qualifying interests (or) Special Conservation Interests	Potential for Likely Significant Effects (LSEs)	LSEs
7	Malahide Estuary SPA 004025	2.5km to the north of the Marine Outfall	Great Crested Grebe (*Podiceps cristatus*); Light-bellied Brent Goose (*Branta bernicla hrota*); Shelduck (*Tadorna tadorna*); Pintail (*Anas acuta*); Goldeneye (*Bucephala clangula*); Red-breasted Merganser (*Mergus serrator*); Oystercatcher (*Haematopus ostralegus*); Golden Plover (*Pluvialis apricaria*); Grey Plover (*Pluvialis squatarola*); Knot (*Calidris canutus*); Dunlin (*Calidris alpina alpine*); Black-tailed Godwit (*Limosa limosa*); Bar-tailed Godwit (*Limosa lapponica*); Redshank (*Tringa totanus*); and Wetlands and Waterbirds.	• Possible deterioration of water quality of intertidal wetland habitats in the SPA due to pollution events or suspended sediment plumes during construction of marine project elements. • Possible deterioration of water quality of intertidal wetland habitats in the SPA due to plume arising from operation of project. • Possible disturbance or displacement of SCI species inside and outside the SPA as a result of noise or visual stimuli of construction stage activities causing birds to change their behaviour.	LSEs upon SCI species as a result of airborne noise, vibration and visual disturbance within and in proximity to the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon SCI species as a result of habitat loss outwith the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon water quality in the SPA as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.
8	Malahide Estuary SAC 000205	2.5km north of the Marine outfall	Mudflats and sandflats not covered by seawater at low tide; *Salicornia* and other annuals colonizing mud and sand; Atlantic salt meadows (Glauco-*Puccinellietalia maritimae*);	• Possible deterioration of water quality of estuarine habitats due to pollution events or suspended sediment plumes during construction of marine project elements.. • Possible deterioration of water quality of estuarine habitats due to plume arising from operation of project.	LSEs upon estuarine habitats as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.

Ref.	Site name & Code	Approximate Location Relative to Proposed Works	Qualifying interests (or) Special Conservation Interests	Potential for Likely Significant Effects (LSEs)	LSEs
			Mediterranean salt meadows (*Juncetalia maritimi*); Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes); and *Fixed coastal dunes with herbaceous vegetation (grey dunes).		
9	Howth Head Coast SPA 004113	2.6km to the south of the Marine Outfall	Kittiwake (*Rissa tridactyla*).	• Possible deterioration of water quality from construction and operational sediment/pollution plumes resulting in change in foraging potential as a result of changes in water quality impacting on food resource abundance. • Possible disturbance or displacement of SCI species inside and outside the SPA as a result of noise or visual stimuli of construction stage activities for the marine outfall pipeline, marine diffuser, FO protection cable works and the microtunnelling/subsea interface, causing birds to change their behaviour. It is considered that underwater noise will not result in LSE as birds will likely be disturbed or displaced by the presence of vessels (i.e. visual disturbance) first.	LSEs upon SCI species as a result of airborne noise, vibration and visual disturbance within and in proximity to the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon SCI species as a result of habitat loss outwith the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon water quality in the SPA as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.
10	South Dublin Bay and River Tolka Estuary SPA 004024	7.6km south of the Marine Outfall	Light-bellied Brent Goose (*Branta bernicla hrota*); Oystercatcher (*Haematopus ostralegus*); Ringed Plover (*Charadrius hiaticula*); Grey Plover (*Pluvialis squatarola*);	• Possible deterioration of water quality of intertidal wetland habitats in the SPA due to pollution events or suspended sediment plumes during construction. • Possible deterioration of water quality of intertidal wetland habitats in the SPA due to plume arising from operation of project. • Possible disturbance or displacement of SCI species inside and outside the SPA as a result of	LSEs upon SCI species as a result of airborne noise, vibration and visual disturbance within and in proximity to the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon SCI species as a result of habitat loss outwith the SPA boundary cannot be

Ref.	Site name & Code	Approximate Location Relative to Proposed Works	Qualifying interests (or) Special Conservation Interests	Potential for Likely Significant Effects (LSEs)	LSEs
			Knot (*Calidris canutus*); Sanderling (*Calidris alba*); Dunlin (*Calidris alpina alpine*); Bar-tailed Godwit (*Limosa lapponica*); Redshank (*Tringa totanus*); Black-headed Gull (*Chroicocephalus ridibundus*); Roseate Tern (*Sterna dougallii*); Common Tern (*Sterna hirundo*); Arctic Tern (*Sterna paradisaea*); and Wetlands and Waterbirds.	noise or visual stimuli of construction stage activities including ballasting and pipe assembly operations causing birds to change their behaviour.	excluded without further analysis and the application of mitigation as necessary. LSEs upon water quality in the SPA as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.
11	Rogerstown Estuary SAC 000208	8.5km north of the Marine outfall	Estuaries; Mudflats and sandflats not covered by seawater at low tide; *Salicornia* and other annuals colonizing mud and sand; Atlantic salt meadows (Glauco-*Puccinellietalia maritimae*); Mediterranean salt meadows (*Juncetalia maritimi*); Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes); and Fixed coastal dunes with herbaceous vegetation (grey dunes).	• Possible deterioration of water quality of estuarine habitats due to pollution events or suspended sediment plumes during construction of marine project elements. • Possible deterioration of water quality of estuarine habitats due to plume arising from operation of project.	LSEs upon estuarine habitats as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.

Ref.	Site name & Code	Approximate Location Relative to Proposed Works	Qualifying interests (or) Special Conservation Interests	Potential for Likely Significant Effects (LSEs)	LSEs
12	Rogerstown Estuary SPA 004015	8.5km north of the Marine outfall	Greylag Goose (*Anser anser*); Light-bellied Brent Goose (*Branta bernicla hrota*); Shelduck (*Tadorna tadorna*); Shoveler (*Anas clypeata*); Oystercatcher (*Haematopus ostralegus*); Ringed Plover (*Charadrius hiaticula*); Grey Plover (*Pluvialis squatarola*); Knot (*Calidris canutus*); Dunlin (*Calidris alpina alpine*); Black-tailed Godwit (*Limosa limosa*); Redshank (*Tringa totanus*); and Wetlands and Waterbirds	• Possible deterioration of water quality of intertidal wetland habitats in the SPA due to pollution events or suspended sediment plumes during construction of marine project elements. • Possible deterioration of water quality of intertidal wetland habitats in the SPA due to plume arising from operation of project. • Possible disturbance or displacement of SCI species inside and outside the SPA as a result of noise or visual stimuli of construction stage activities causing birds to change their behaviour.	LSEs upon SCI species as a result of airborne noise, vibration and visual disturbance within and in proximity to the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon SCI species as a result of habitat loss outwith the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon water quality in the SPA as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.
13	South Dublin Bay SAC 000210	9.1km to the south of the Marine Outfall	Mudflats and sandflats not covered by seawater at low tide.	• Possible deterioration of water quality of estuarine habitats due to pollution events or suspended sediment plumes during construction of marine project elements.. • Possible deterioration of water quality of estuarine habitats due to plume arising from operation of project.	LSEs upon estuarine habitats as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.
14	Lambay Island SAC & 000204	9.3km north-east of the Marine outfall	*Halichoerus grypus* (Grey Seal); *Phoca vitulina* (Harbour Seal); Reefs; and Vegetated sea cliffs of the Atlantic and Baltic coasts.	• Possible disturbance of mobile cetacean species during construction of marine outfall and diffuser, FO cable protection works, interface works.. • Possible deterioration of water quality leading to reduction in prey of mobile pinniped species during construction. • Possible deterioration of water quality leading to reduction in prey of mobile pinniped species	LSEs upon Harbour seal as a result of underwater noise and disturbance cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon water quality in the SAC as a result of plumes at construction or operational phase

Ref.	Site name & Code	Approximate Location Relative to Proposed Works	Qualifying interests (or) Special Conservation Interests	Potential for Likely Significant Effects (LSEs)	LSEs
				during operation.	cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.
15	Lambay Island SPA 004069	9.3km north-east of the Marine Outfall	Fulmar (*Fulmarus glacialis*); Cormorant (*Phalacrocorax carbo*); Shag (*Phalacrocorax aristotelis*); Greylag Goose; Lesser Black-backed Gull (*Larus fuscus*); Herring Gull (*Larus argentatus*); Kittiwake (*Rissa tridactyla*); Guillemot (*Uria aalge*); Razorbill (*Alca torda*); and Puffin (*Fratercula arctica*).	• Possible deterioration of water quality from construction and operational sediment/pollution plumes resulting in change in foraging potential as a result of changes in water quality impacting on food resource abundance. • Possible disturbance or displacement of SCI species inside and outside the SPA as a result of noise or visual stimuli of construction stage activities for the marine outfall pipeline, marine diffuser, FO protection cable works and the microtunnelling/subsea interface, causing birds to change their behaviour. It is considered that underwater noise will not result in LSE as birds will likely be disturbed or displaced by the presence of vessels (i.e. visual disturbance) first.	LSEs upon SCI species as a result of airborne noise, vibration and visual disturbance within and in proximity to the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon SCI species as a result of habitat loss outwith the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon water quality in the SPA as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.
16	Dalkey Island SPA 004172	14.9km south of the Marine Outfall	Roseate Tern (*Sterna dougallii*); Common Tern (*Sterna hirundo*); and Arctic Tern (*Sterna paradisaea*).	• Possible deterioration of water quality from construction and operational sediment/pollution plumes resulting in change in foraging potential as a result of changes in water quality impacting on food resource abundance. • Possible disturbance or displacement of SCI species inside and outside the SPA as a result of noise or visual stimuli of construction stage activities for the marine outfall pipeline, marine diffuser, FO protection cable works and the microtunnelling/subsea interface, causing birds to change their behaviour.	LSEs upon SCI species as a result of airborne noise, vibration and visual disturbance within and in proximity to the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon SCI species as a result of habitat loss outwith the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary.

Ref.	Site name & Code	Approximate Location Relative to Proposed Works	Qualifying interests (or) Special Conservation Interests	Potential for Likely Significant Effects (LSEs)	LSEs
				- It is considered that underwater noise will not result in LSE as birds will likely be disturbed or displaced by the presence of vessels (i.e. visual disturbance) first.on food resource abundance.	LSEs upon water quality in the SPA as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.
17	Skerries Islands SPA 004122	The SPA is situated 16.7km north of the Proposed Project.	Cormorant (*Phalacrocorax carbo*); Shag (*Phalacrocorax aristotelis*) ; Light-bellied Brent Goose (*Branta bernicla hrota*) ; Purple Sandpiper (*Calidris maritima*); Turnstone (*Arenaria interpres*); and Herring Gull(*Larus argentatus*) .	- Possible deterioration of water quality from construction and operational sediment/pollution plumes resulting in change in foraging potential as a result of changes in water quality impacting on food resource abundance. - Possible disturbance or displacement of SCI species inside and outside the SPA as a result of noise or visual stimuli of construction stage activities for the marine outfall pipeline, marine diffuser, FO protection cable works and the microtunnelling/subsea interface, causing birds to change their behaviour. It is considered that underwater noise will not result in LSE as birds will likely be disturbed or displaced by the presence of vessels (i.e. visual disturbance) first.	LSEs upon SCI species as a result of airborne noise, vibration and visual disturbance within and in proximity to the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon SCI species as a result of habitat loss outwith the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon water quality in the SPA as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.
18	Rockabill SPA 004014	The SPA is situated 16.9km north of the Proposed Project.	Purple Sandpiper (*Calidris maritima*); Roseate Tern (*Sterna dougallii*); Common Tern(*Sterna hirundo*); and Arctic Tern (*Sterna*	- Possible deterioration of water quality from construction and operational sediment/pollution plumes resulting in change in foraging potential as a result of changes in water quality impacting on food resource abundance. - Possible disturbance or displacement of SCI species inside and outside the SPA as a result of noise or visual stimuli of construction stage	LSEs upon SCI species as a result of airborne noise, vibration and visual disturbance within and in proximity to the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon SCI species as a result of habitat

Ref.	Site name & Code	Approximate Location Relative to Proposed Works	Qualifying interests (or) Special Conservation Interests	Potential for Likely Significant Effects (LSEs)	LSEs
			paradisaea).	activities for the marine outfall pipeline, marine diffuser, FO protection cable works and the microtunnelling/subsea interface, causing birds to change their behaviour. It is considered that underwater noise will not result in LSE as birds will likely be disturbed or displaced by the presence of vessels (i.e. visual disturbance) first.	loss outwith the SPA boundary cannot be excluded without further analysis and the application of mitigation as necessary. LSEs upon water quality in the SPA as a result of plumes at construction or operational phase cannot be excluded without further analysis of the extent of predicted plumes and their concentration of suspended sediments or polluting substances, and the application of mitigation as necessary.

4.5 Screening Assessment Conclusions

A screening exercise was completed in compliance with the relevant European Commission and national guidelines to determine whether or not LSEs on any European site could be discounted as a result of the construction or operation of the proposed development.

From the findings of the Screening for Appropriate Assessment, it was concluded that the Proposed Project (as described in Section 3):

- Is not directly connected with or necessary to the management of any European site;
- Has the potential to give rise to significant effects on the qualifying interests of seven SACs and eleven SPAs as outlined in Table 4-3; and
- Does not have the potential to affect the remaining SAC and SPA sites identified in the wider study area. These sites have therefore been screened out as discussed in Section 4.3.

Having regard to the methodology employed and the findings of the screening stage exercise, it is concluded that an appropriate assessment of the implications of the Proposed Project on European sites is required, in view of their conservation objectives and in combination with any other relevant plans or projects.

5. Scientific Investigations to Support Appropriate Assessment

The following field surveys, assessments and modelling were undertaken to assess and examine the potential for the Proposed Project to impact on the conservation objectives.

5.1 Field Surveys

5.1.1 Estuarine Ornithological Survey

A wetland bird survey was undertaken during 2014/2015, 2015/2016, and 2017 to characterise the ornithological interests of Baldoyle Bay and surrounding areas, particularly with respect to spatial and temporal distribution of key SPA species. Surveys were carried out twice per month between December 2014 and May 2016, and an up to date survey campaign was restarted in 2017 with surveys again being conducted twice per month between March 2017 and May 2017.

The survey methodology was based on the British Trust for Ornithology (BTO) Wetland Bird Survey (WeBS) and Irish WeBS (I-WeBS) methodology as outlined in Gilbert *et al.* (1998) and BTO (2016a and 2016b). The survey method included both high tide and low tide waterbird counts. Surveys were conducted throughout a range of weather conditions and times of the day where good visibility prevailed.

Full details of the methodologies and survey effort employed during these surveys are provided in Appendix A

5.1.1.1 Results Summary

The species composition and temporal distribution of birds associated with the Baldoyle Bay SPA is fairly typical considering its geographical position and the nature of the habitat within it. Most SCIs (light-bellied brent goose, bar-tailed godwit, ringed plover, grey plover, and golden plover) were present in peak numbers in the winter and passage periods, and either completely absent or present in very low numbers during the breeding season. The exception was shelduck which was present in larger numbers during the breeding season but still peaked in the winter period. Accounts for each SCI of the Baldoyle Bay SPA are provided in the following paragraphs.

Light-bellied brent goose was present in peak numbers during the wintering and passage periods (Appendix A Table A10.2). The two year peak mean was 767 birds, exceeding the 1% national threshold of 360 birds and the 1% international threshold of 400 birds. Light-bellied brent geese were observed across the surveyed section of the Baldoyle Bay SPA and on both the seaward and landward sides of the estuary. Within the SPA, birds were frequently seen in association with wetted channels, where they were observed feeding, loafing and bathing. Birds were also observed roosting in the north, west and east of the section of the SPA that was surveyed.

Shelduck was present in the study area all year round (Appendix A, Table A10.2). The two year peak mean of 138 birds exceeds the 1% national threshold of 120 birds, but not the 1% international threshold of 3,000 birds. Shelducks were distributed evenly throughout the portion of the SPA covered by the surveys (Figure A10.6, Appendix A).

Ringed plover numbers peaked during the autumn passage and winter periods and were also regularly recorded during the breeding season (Appendix A, Table A10.2). The two year peak mean of 155 birds exceeded the 1% national threshold of 100 birds, but not the 1% international threshold of 730 birds. This species showed a preference for the habitats associated with the eastern side of the Baldoyle Bay SPA (Figure A10.5, Appendix A). As well as being recorded within the SPA, smaller numbers of records were made on the land to the western side of the Portmarnock Golf Course. A handful of records were also made in the Velvet Strand Beach intertidal area to the east of the SPA.

Golden plover was present in peak numbers during the wintering and passage periods. The two year peak mean of 2,336 birds exceeded the 1% national threshold of 1,200 birds, but not the 1% international threshold of 9,300 birds. There were comparatively few records of golden plover during the estuarine surveys, though when recorded, birds were present in large groups of up to 1,850 birds (Figure A10.3, Appendix A). All observations of this species were made within the Baldoyle Bay SPA boundary.

Grey plover was present in peak numbers during the passage periods (Appendix A, Table A10.2). These large passage peaks (two year peak mean of 487 birds) meant that the 1% national threshold of 30 birds was exceeded. The 1% international threshold of 2,500 birds was not exceeded. Grey plovers were observed within the study area exclusively within the Baldoyle Bay SPA (Figure A10.4, Appendix A). This species showed a preference for habitat to the eastern side of the Baldoyle Bay, though records were made across the estuary of birds feeding, roosting and loafing.

Bar-tailed godwit was present in peak numbers during the wintering and passage periods. The two year peak mean was 155 birds, exceeding the 1% national threshold of 150 birds, but not the 1% international threshold of 1,200 birds. Bar-tailed godwit records were predominantly located within the intertidal area of Balydoyle Bay SPA (Figure A10.1, Appendix A). Smaller numbers of birds were recorded in the intertidal area of Velvet Strand, and a single record was made in a field to the north of the R123 Moyne Road, west of the SPA.

Some SCI species of the Ireland’s Eye SPA were recorded during the estuarine surveys. 1% thresholds are given for waterbirds (i.e. cormorant) and are not available for seabird species.

Cormorant was recorded throughout the year during the estuarine surveys in relatively low numbers. Within the Baldoyle Bay SPA birds were observed in low numbers in wetted channels, but this species occurred predominantly within the subtidal area off Velvet Strand (Figure A10.43, Appendix A). The peak count was 42 birds (Appendix A, Table A10.4), which did not exceed the 1% national threshold of 120 birds.

Herring gull were commonly encountered across the entire Baldoyle Bay study area, including terrestrial, intertidal and subtidal habitats (Figure A10.37, Appendix A), with a peak count of 331 birds (Appendix A, Table A10.4). They are highly adaptable birds and utilise a range of coastal, inland and offshore habitats.

Kittiwake was recorded on a single occasion during the estuarine surveys (peak count of three birds; Appendix A, Table A10.4), with that record being made in the subtidal area off Velvet Strand (Figure A10.38, Appendix A). This species was absent from the Baldoyle Bay SPA.

Guillemot were recorded on several occasions during the estuarine surveys, with a peak count of 20 birds (Appendix A, Table A10.4). Only two records of this species were made within the Baldoyle Bay SPA, with the remaining records made in the subtidal area off Velvet Strand (Figure A10.24, Appendix A).

Razorbills were only recorded in the subtidal area off Velvet Strand during the estuarine surveys (Figure A10.25, Appendix A), and not in the Baldoyle Bay SPA on any occasion. The peak count was five birds (Appendix A, Table A10.4).

Full details of the estuarine baseline survey results are available in Appendix A.

5.1.2 Coastal and Marine Vantage Point (VP) Ornithological Surveys

VP surveys were carried out from December 2014, with six hours of surveys carried out monthly per VP to July 2017. Surveys were carried out twice per month between December 2014 to July 2016, and March 2017 to July 2017.

Two VPs were utilised; one on the mainland (“Velvet Strand, VP1” (IO250423, Lat. 53.41631, Long. -6.11966, mean viewing angle 70°)), and one on Ireland’s Eye (“Ireland’s Eye, VP2” (IO287415, Lat. 53.40792, Long. -6.06387, mean viewing angle 0°). The Velvet Strand VP covered the area of the outfall pipeline corridor out to sea using a 2km viewing arc, and the Ireland’s Eye VP covered the remaining outfall pipeline corridor using a 2km viewing arc. In this way, the proposed outfall pipeline and a large buffer was covered by the surveys.

Surveys were timed to give coverage over a range of tidal states, and to ensure that both spring and neap tides were covered. Key species / species groups for the VP surveys were primarily seabirds which utilise the marine environment for foraging and roosting/loafing and social interaction, particularly during the breeding season when nests are established on cliffs or offshore islands such as the Ireland’s Eye SPA.

Full details of the methodologies employed during these surveys, along with a priority species list and detailed records of survey timings are provided in Appendix A.

5.1.2.1 Results Summary

Summary accounts for each SCI of the Ireland's Eye SPA are provided in the following paragraphs.

Cormorant records were by far the most numerous in May, June and July (Graph A10.4, Appendix A), with a single monthly peak of 100 birds (Table A10.10, Appendix A). Between March and October, birds were recorded on the water most frequently in distances bands 1 and 2 from both VPs (i.e. 0-1000m from the VPs) (Table A10.17, Appendix A). From the Ireland's Eye VP (VP2), a clear preference for the area of sea between Ireland's Eye and Velvet Strand was observed, with the majority of records occurring to the south of the outfall pipeline corridor (Figure A10.51, Appendix A). From the Velvet Strand VP (VP1), cormorants displayed a preference for remaining close to the shore to the south of Velvet Strand.

Herring gulls were observed throughout the breeding season, with numbers peaking in July and high numbers reported in May and June. The peak single monthly count was 282 birds during the breeding season (Table A10.10, Appendix A). Both VPs recorded a similar number of birds on the water during the breeding season, which were distributed quite evenly across the viewing arcs. A higher number of birds were observed within 0-1,000m of Ireland's Eye in an area that lies to the south of the outfall pipeline corridor and marine diffuser (Figure A10.57, Appendix A). Whilst herring gulls were recorded on the sea in the outfall pipeline corridor, numbers were similar to those recorded in most of the rest of the study area.

Kittiwakes were observed throughout the breeding season, but in highest numbers in May and July (Table A10.10, Appendix A). 2,977 of 3,412 kittiwakes observed on the sea (87.3%) between March and October were recorded from VP2 on Ireland's Eye (Table A10.13, Appendix A). Records of kittiwakes on the water were distributed more to the east of the Ireland's Eye VP (VP2) viewing arc, with the sectors in which most bird records were made situated further away from Ireland's Eye (Figure A10.58, Appendix A). Kittiwakes on the water were recorded most frequently in sectors that did not include parts of the outfall pipeline corridor or marine diffuser.

The vast majority of guillemots (Table A10.14, Appendix A) and razorbills (Table A10.15, Appendix A) recorded on the sea between March and October were made from VP2 on Ireland's Eye (7,869 of 8,576 (91.8%) guillemots, and 6,801 of 7,456 (90.1%) razorbills). Feeding behaviour accounted for only 13.0% of guillemots and 12.7% of razorbills recorded on the sea from the Ireland's Eye VP, suggesting that feeding activity is conducted in areas beyond the outfall pipeline corridor. Both guillemots (Figure A10.55, Appendix A) and razorbills (Figure A10.60, Appendix A) were recorded in the main within 500m of the Ireland's Eye VP, but also in relatively large numbers between 500-1000m away from the VP. The distribution of feeding guillemot and razorbill records are illustrated in Figure 10.4 and Figure 10.6.

Some species that are SCIs of the Baldoyle Bay SPA were recorded during the VP surveys and are described below.

Light-bellied brent geese were recorded during breeding season VP surveys on three occasions (Table A10.11, Appendix A). The peak count was 24 birds. All of these records were of birds in flight.

Shelduck were recorded in low numbers during breeding season VP surveys (Table A10.11, Appendix A). The majority of birds were recorded in flight, with 13 birds observed on the water. The peak count of all birds was 17, whilst the peak count of birds on the sea was four. Whilst present at a low level, shelduck are only present in subtidal habitats in very small numbers.

Ringed plover was recorded during breeding season VP surveys in low numbers (Table A10.11, Appendix A), with over half of the birds recorded occurring in a single survey. The peak count was 70 birds, with 38 being the peak on-sea count.

A single bar-tailed godwit was recorded during the breeding season marine VP surveys (Table A10.11, Appendix A).

Golden plover and grey plover were not recorded during the breeding season marine VP surveys.

Full details of the results are available in Appendix B.

5.1.3 Boat-based Assessment of Auk Fledging

There is a substantial population of breeding auks at Ireland's Eye. When fledging, chicks and one or both parents tend to depart nests and disperse from breeding colonies to offshore areas to moult, and avoid predation of chicks by other seabirds. This can result in a situation where many birds are in the water at once, which could be susceptible to disturbance and displacement. The aim of the surveys was to assess the use of waters surrounding Ireland's Eye by auks during this leaving event.

Surveys were conducted in July 2016 and July 2017 and consisted of a single surveyor on a boat travelling round Ireland's Eye and noting numbers of auk chicks in nests on the cliffs, and any birds in the water. Visits occurred approximately twice weekly and were supplemented by additional observations from the boatman, who was present in the area almost daily.

5.1.3.1 Results Summary

Boat-based surveys in July of 2016 and 2017 revealed that fledged chicks were present on cliffs and not in the water until mid-July. At this point, numbers of guillemots and razorbills on nests on the cliffs rapidly declined; however, no rafts of fledged chicks (or adults) were observed on the water around Ireland's Eye at any time. By the final week of July, the majority of guillemots and razorbills had left the area without massing of large numbers of birds in the water being recorded. Survey observations suggest that rather than spending time on the water around the island, guillemots and razorbills leave the nest only when they intend to leave the area, and leave in small groups. Based on the lack of movements of large rafts of birds recorded it is possible that some movements may occur at night.

5.1.4 Baldoyle Estuary Walkover

This survey was undertaken to support the earlier coastal and intertidal habitat mapping carried out by Ecoserve in 2005, and a more detailed assessment undertaken for the NPWS on the saltmarsh community in Baldoyle estuary SAC (site code 00199) in 2006 (Mc Corry & Ryle 2009). The site was visited on 13th November 2013 by a Benthic Solutions Limited (BSL) botanist, and the habitat mapping prepared by Mc Corry and Ryle (2009) reviewed in the field in relation to the current conditions at the site and the proposed Outfall Pipeline. Geographic Information Systems (GIS) shapefiles, prepared by Mc Corry and Ryle (2009), were loaded onto electronic media and underlain by aerial photographs (Google Maps) to allow for an accurate assessment in the field of the extent of habitat types as previously described and mapped and to document any changes.

5.1.4.1 Results Summary

The habitat map showing the distribution and extent of Annex I habitats produced by Mc Corry and Ryle and deemed to be of favourable conservation status, was reviewed, visited and confirmed in 2013 and the habitat mapping and descriptions presented below on Figure 5-1.

The proposed outfall pipeline will be tunnelled underneath Baldoyle Bay SAC. The tunnelled section will cross under an area of the estuary near the public car park related to the Portmarnock beach and dune system/entrance to Portmarnock Golf Club. At this side of the estuary the tunnelled section will cross under a grassy embankment adjoining the public road, which is mown and maintained by FCC. It then reaches under a band of a mosaic of Atlantic salt-meadow (ASM) and Mediterranean salt-meadow (MSM) 20 to 30m wide in places. To the north of the proposed Outfall Pipeline is an area of Atlantic salt-meadow (ASM). These areas grade into extensive swards of *Spartina,* which extend towards the centre of the estuary where they become broken up forming a mosaic of clumps of *Spartina* and mudflats.

At the upper extent of the saltmarsh the vegetation is dominated by Creeping Bent Grass (*Agrostis stolonifera*), with occasional Sea Beet (*Beta maritima*), Sea Rush (*Juncus maritimus*), Red Fescue (*Festuca rubra*), Sea Purslane (*Halimione portulacoides*), Common Scurvy Grass (*Cochlearia officinalis*) and Sea Pink (*Armeria maritima*).

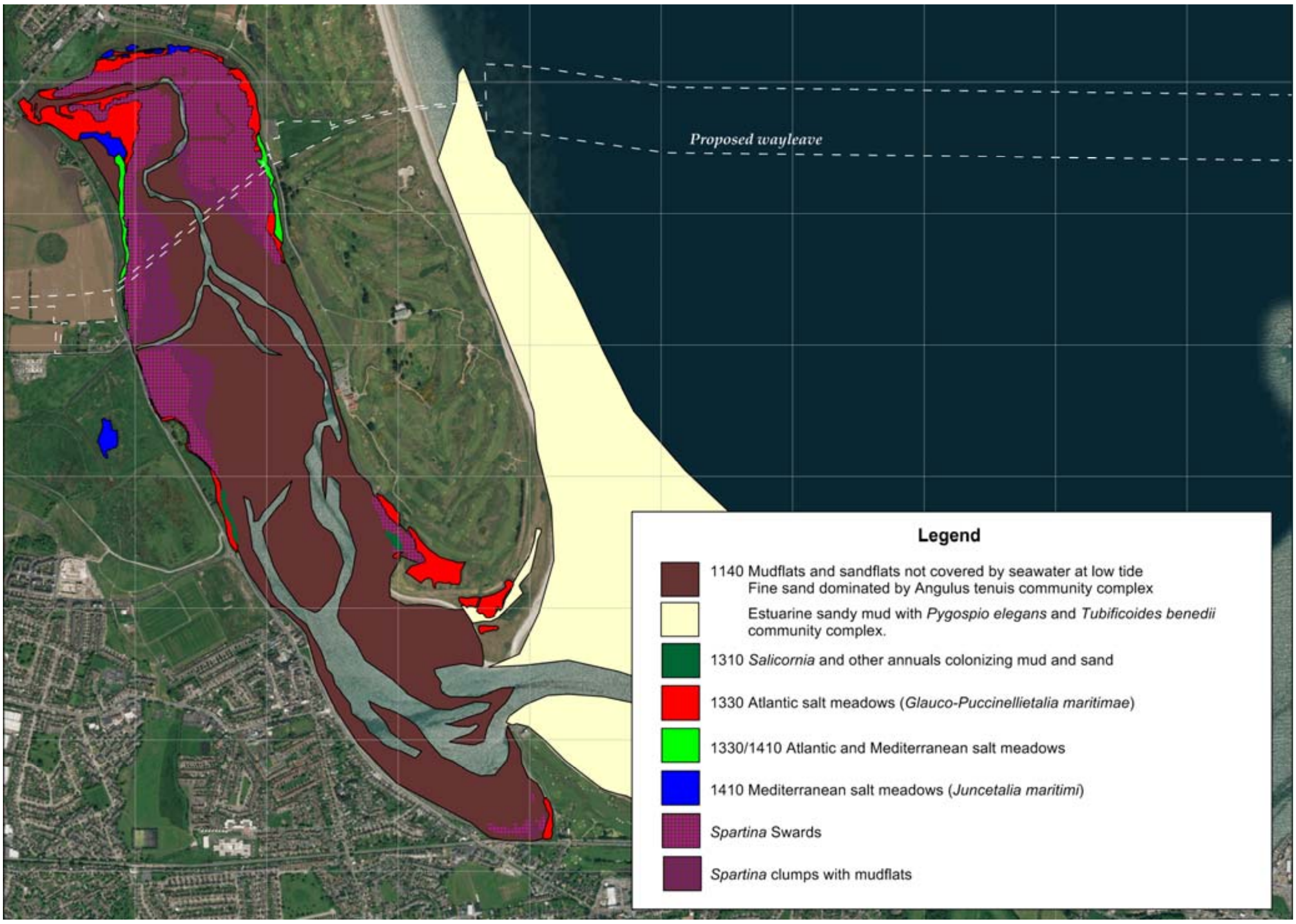


Figure 5-1: Habitat Map of the Annex I Habitats of Baldoyle Estuary.

These grade into an area of middle marsh with occasional pans and creeks which are dominated by Sea Pink, Sea Plantain (*Plantago maritima*), Lax-flowered Sea Lavender (*Limonium humile*) and Sea Aster (*Aster tripolium*) with occasional stands of Saltmeadow Rush (*Juncus gerardii*) and Sea Rush, whilst areas with higher inundation of the tide (lower marsh) contain Sea Arrow Grass (*Triglochin maritima*), Common Scurvy Grass and Sea Purslane. This then grades into areas of dense stands of Common Cord-grass (*Spartina anglica*) which dominate the mudflats and creeks with occasional Enteromorpha.

North of the main crossing point for the Outfall Pipeline is an area with better defined pans and creeks that indicates pure Atlantic Salt Meadows and a stand of Common Reed (*Phragmites australis*) is present near where the road turns back to the west.

The band of saltmarsh vegetation tapers off to the south towards the Mayne River and occasional sparse patches of Sea Aster, Common Scurvy Grass, Glasswort (*Salicornia sp.*) and Common Cord-grass are present on the open muds. Backing this is a stone wall with scattered Sea Aster, Lax-flowered Sea Lavender, Sea Arrowgrass and Sea Beet.

The central part of the estuary, including the entrance to the Bay the and the intertidal zone along Velvet Strand, are consistent with the Mudflats and sandflats not covered by seawater at low tide (1140), with a grading of sediments from a sandy silt within the main part of the bay to a slightly silty sand in the entrance and sand along the foreshore along the eastern shore of the Portmarnock peninsula and along Velvet Strand.

The habitats at Baldoyle Estuary do not appear to have undergone any significant changes in quality or extent at the proposed location of the outfall since the 2006 surveys conducted by NPWS. The boundaries of the Annex I habitats as mapped by Mc Corry and Ryle have not changed significantly since that time and the vegetation composition at the proposed marine route appears to have remained broadly similar. The proposed pipeline route crosses beneath the estuary and adjacent coastline eastern coastline (including the Velvet Strand) and therefore avoids direct impact with any parts of the SAC including the designated habitats of mudflats and sandflats not covered by seawater at low tide (1140), bordered by mixed Atlantic and Mediterranean salt meadows (1330/1140) on the eastern and western margins of the marine section.

5.1.5 Surveys for Reefs (1170) in Ireland's Eye SAC and Rockabill to Dalkey Island SAC

The Rockabill to Dalkey Island SAC (site code 3000) was established in April 2013 and designated for the marine Annex I qualifying interest Reefs and the Annex II species harbour porpoise (*Phocoena phocoena*). As the proposed Outfall Pipeline (including the proposed marine diffuser) is located within this SAC, additional surveys were carried out to cover both qualifying interests.

Within the Rockabill to Dalkey Island SAC, two community types are recorded within the Annex I habitat, namely intertidal reef community complex and subtidal reef community complex (Reefs 1170). Intertidal and subtidal surveys were undertaken in 2010 and 2011 (MERC 2010; 2012a; 2012b). These data were used to determine the physical and biological nature of the Annex I habitat. The area and quality of these qualifying features were based on broad interpolations from only limited drop-down video. Therefore, two additional survey campaigns were carried out to establish a greater understanding of these features within the vicinity of the proposed Outfall Pipeline. The surveys were undertaken in two phases. The initial phase of the investigation was based on a detailed video inspection of features identified in the bathymetry by BSL in May 2015 (BSL 2015a). During this survey additional bathymetry was carried out using a precision echo sounder to infill deficiencies in existing data close to the island's cliffs and rock outcrops. Detailed photography was also carried out using a high resolution camera on 9 drop-down video locations taken along the subtidal reefs around the island and at the proposed Outfall Pipeline. The results of this survey were used to identify key areas for the second phase of operations using an intertidal walk-over (three sites) and detailed subtidal transects using scientific divers (four sites) and presented in Table 5-1. This later phase was carried out by BSL and Aquatic Survey and Monitoring Limited in July 2015. Details of the survey are supplied in the Appendix B.

5.1.5.1 Results Summary

Intertidal Reef Community Complex Surveys

This reef community complex is recorded on the eastern and southern shores of Ireland's Eye immediately south of the proposed outfall pipeline route and Marine Diffuser location. The exposure regime of the complex ranges from exposed to moderately exposed reef for Ireland's Eye. The substrate here is that of flat and sloping bedrock, cobbles and boulders. Vertical cliff faces are found on the north and northeast shores of the island.

A detailed walkover survey was carried out in 2015 at three locations (see Figure 5-2) along the eastern edge of the Island, relating to the northern, central and southern extreme of the eastern shoreline (BSL 2015b). Survey operations were conducted in June/July. Sites were selected from aerial photography to present different exposures and the vertical profiles completed along all of the lower, middle and upper shorelines at these locations. Details of the survey are supplied in the Appendix B 'Reef Survey Reports'.

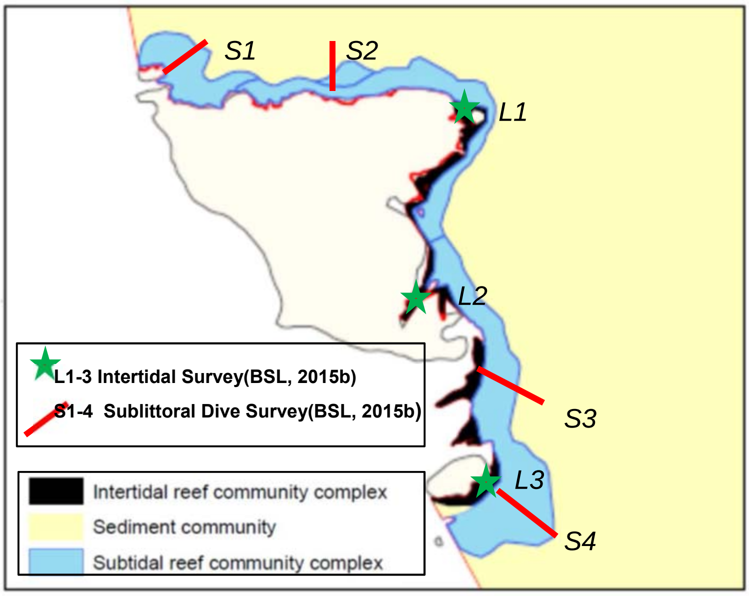


Figure 5-2: Ireland Eye Marine Community Types designated by Rockabill to Dalkey Island SAC

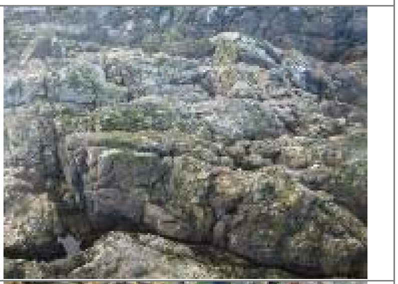
Table 5-1: Ireland Eye Marine Community Types designated by Rockabill to Dalkey Island SAC and locations of detailed Intertidal and Subtidal Surveys (BSL, 2015b).

	L1	L2	L3
General Description	Gully sheltered by northeast stack. Typical exposed shore to wave action amplified by the effect of surge through the gully. Shading with reduced algal component.	Sheltered inlet protected from wave action.	Southeast tip of the island partially separated from the main island by a connecting intertidal reef
Zone (i) supralittoral	Nitrate enriched LR.FLR.Lic.Pra	A typical lichen zone dominated by the nitrophilous yellow lichen *Xanthoria parietina* and the green algae *Pasiola stipitata* LR.FLR.Lic.Pra	nitrate enriched LR.FLR.Lic.Pra *Prasiola stipitata*
Zone (ii) Upper shore	LR.HLR.MusB	Limpets, barnacles and littorinids found amongst the algae Spiral wrack and channel wrack mixed to form an LR.MLR.BF.FspiB	Limpets, and *Semibalanus balanoides* barnacles. LR.HLR.MusB
Zone (iii) Middle upper shore (barnacle zone)	Barnacles LR.HLR.MusB.Cht	*Ascophyllum nodosum* and *Fucus vesiculosus* LR.LLR.F.Asc.FS	Patchy canopy of the bladderless 'Bladder wrack' *Fucus evesiculosus*. LR.HLR.MusB.Cht
Zone (iv) upper middle shore	faunally dominated LR.HLR.MusB.Sem	Typical *Fucus serratus* and red seaweeds LR.MLR.BF.Fser.R	Faunally dominated LR.HLR.MusB.Sem
Zone (v) lower middle shore	LR.HLR.FR.Mas		*Laminaria hyperborea* forest (with occasional *L. hyperborea*) with frequent patches of red algae dominated by coralline crusts. *Fucus serratus*, *Osmundea pinnatifida* and *Mastocarpus stellatus* LR.HLR.FR.Mas (v)
Zone (iv) Lower shore	Algae dominated LR.HLR.FR.Coff/IR.MIR.KR.Ldig	Algae dominated LR.HLR.FR.Coff/IR.MIR.KR.Ldig	Algae dominated LR.HLR.FR.Coff/IR.MIR.KR.Ldig

This survey has collected semi-quantitative data from two moderately exposed littoral stations (L1 and L3) and a sheltered station (L2). L1 was slightly modified by shading, wave surge and nitrogenous enrichment and the L3 upper shore biotope was similarly enriched by roosting seabirds. In the littoral zone, the biotopes '*Corallina officinalis* on exposed to moderately exposed lower eulittoral rock/*Laminaria digitata* on moderately exposed sublittoral fringe rock (LR.HLR.FR.Coff/ IR.MIR.KR.Ldig) usually emerged from the sublittoral, followed by a zone covered by seaweeds to a faunally dominated shore consisting of limpets, barnacles and littorinids. The littoral zone was separated into vertical zones up the shoreline, with six bands recorded at L1 and L3 (exposed shorelines) and five at L2 (within a sheltered gulley). Whilst slight community variations were recorded within the communities relating to site exposure of three different transects L1 to L3, all indicated a well-defined biological zonation. The supralittoral upper zone was dominated by the green algae *Pasiola stipitata* (LR.FLR.Lic.Pra complex) with all areas typically showing lichen and/or being nitrate rich from seabird activity. A further 5 zones were recorded with the upper and middle shores dominated by limpets, and barnacles *Semibalanus balanoides* (LR.HLR.MusB) along with brown algaes (littorinids and wracks), giving way to *Ascophyllum nodosum* and the fucoids *Fucus vesiculosus* *F.evesiculosus*a and *F.serratus* along with red seaweeds. The communities became faunally dominated in the upper middle shore with the LR.HLR.MusB.Sem complex. Lower middle shores showed occasional *Laminaria hyperborea* forest with frequent patches of red algae dominated by coralline crusts. *F.serratus*, *Osmundea pinnatifida* and *Mastocarpus stellatus* (LR.HLR.FR.Mas complex). The lower shore was algae dominated by LR.HLR.FR.Coff/IR.MIR.KR.Ldig

Overall, intertidal habitat indicated faunal populations that were well represented and moderately diverse habitats containing many of the common species found along the Irish Sea coastline.

Table 5-2: Summary of Intertidal Reef Community Complex (L3, BSL, 2015b)

Littoral Zonation	Example image
Southeast tip of the island partially separated from the main island by a connecting intertidal reef	
Zone (i) Supralittoral Upper shore **LR.FLR.Lic.Pra** *Prasiola stipitata* on nitrate-enriched supralittoral or littoral fringe rock.	
Zone (ii) Eulittoral Upper shore **LR.HLR.MusB** Mussel and/or barnacle communities.	
Zone (iii) Eulittoral Middle upper shore (barnacle zone) **LR.HLR.MusB.Cht** *Chthamalus* spp. on exposed upper eulittoral rock. Patchy canopy of the bladderless 'Bladder wrack' *Fucus evesiculosus*.	
Zone (iv) Eulittoral Upper middle shore **LR.HLR.MusB.Sem** *Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock Faunally dominated.	
Zone (v) Eulittoral lower shore **LR.HLR.FR.Mas** *Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock *Fucus serratus*, *Osmundea pinnatifida* and *Mastocarpus stellatus*	
Zone (iv) Sublittoral fringe **LR.HLR.FR.Coff/IR.MIR.KR.Ldig** *Corallina officinalis* on exposed to moderately exposed lower eulittoral rock/ *Laminaria digitata* on moderately exposed sublittoral fringe bedrock Algae dominated *Laminaria digitator* forest (with occasional *L. hyperborea*) with frequent patches of red algae dominated by coralline crusts	

<u>Subtidal Reef Community Complex Surveys</u>

This reef community complex is recorded off the northern, eastern and southern shores of Ireland's Eye immediately south of the proposed outfall route and Marine Diffuser location. The substrate ranges from that of flat and sloping bedrock, to bedrock with boulders and also a mosaic of cobbles and boulders. Vertical rock walls occur on the north and east of Ireland's Eye, whilst the northern reaches of the island show both sediment scouring and a thin veneer of silt covering the reef. In general, previous surveys (MERC 2010,MERC 2012a and MERC, 2012b) noted that where the reef was subjected to the effects of sediment, either through scouring or settlement of silt, low numbers of species and individuals occurred. The detailed assessment of the subtidal reefs carried out in 2015 using drop-down camera system (BSL 2015a) and latera more detailed assessment using a scientific dive team at four locations on the northern and eastern sides of the island in June/July (BSL 2015b). Details of the survey are supplied in the Appendix B.

Dive surveys collected semi-quantitative data from four locations, with two sites located beneath the steep cliff face of the northern coast (S1 and S2), and two located adjacent to the rocky shorelines in the southeast of the island (S3 and S4). The positions of these sites are shown in Figure 5-2. and a summary of results for tranect S2 are shown in Table 5-3. The sublittoral stations were characterised by Laminaria digitata forests in the shallower part (IR.MIR.KR.Ldig.Ldig) and were usually replaced by the biotope 'Foliose red seaweeds with dense Dictyota *dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock' (IR.HIR.KFaR.FoR.Dic). The deeper extend was dominated by a 'Mixed turf of bryozoans and erect sponges with *Sagartia elegans* on tide-swept circalittoral rock' (CR.HCR.XFa.ByErSp.Sag) or in the case of Sublittoral S2 '*Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock' (CR.HCR.XFa.FluCoAs). The deeper biotope at Sublittoral S4 was categorised as a possible '*Polyclinum aurantium* and *Flustra foliacea* on sand scoured tide-swept moderately wave-exposed circalittoral rock' (HCR.XFa.FluCoAs.Paur). Increased sedimentation was noted at these stations. The maximum depths surveyed for each site was between 10.5m and 14m below mean sea level.

Univariate analyses of the results of both reef assessments surface showed clear differences between the littoral and sublittoral stations in terms of species richness with twice as many species recorded from the sublittoral area (ca. 88.3as opposed to ca. 44.7). Both littoral and sublittoral environments indicated moderately high species diversity. Multivariate analyses revealed statistical separation of biotopes with the vertical zonation of the fauna (by water depth or height on the foreshore) constituting the dominant community patterns observed and being generally consistent at the different survey sites visited on Ireland Eye. No species of particular nature conservation interest were noted during any of the surveys and no rare or particularly fragile biotopes recorded. Naturally high levels of siltation were recorded in the sublittoral environment; a fact that has not appeared to have had a significant impact on the biological diversity in this area.

Table 5-3: Summary of Subtidal Reef Community Complex (S2, BSL, 2015b)

Sublittoral Zonation	Example image	
This stations were situated along the north coast of the island and showed significant evidence of a heavy silt burden. The deeper sediment plains gave way to a steeply inclined reef at a depth of circa 15.5m ODM. The reef was initially broken, with deposits of muddy gravel lying between boulders and outcrops of sloping bedrock.		
Zone (i) Infralittoral Upper shore **IR.MIR.KR.Ldig.Ldig** *Laminaria digitata* on moderately exposed sublittoral fringe bedrock Stunted *Laminaria digitata* kelp plants, with several other foliose red algae, such as *Palmaria palmata* and *Delesseria sanguinea*. Beneath these algae, crusts of mussels and barnacles predated by the common starfish *Asterias rubens*.		
Zone (ii) Infralittoral rock ca. 6-8.5m **IR.HIR.KFaR.FoR.Dic** Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock Add. algal species were *Rhodymenia holmesii, Sphondylothamnion multifidum* and *Apoglossum ruscifolium* amongst the sward. Fish observed were ling (*Molva molva*), the black goby (*Gobius niger*) and Greater pipefish (*Syngnathus acus*)..		
Zone (iii) Circalittoral ca 10-15.,5m **CR.HCR.XFa.FluCoAs** Flustra foliacea and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock**.** The biotope on these outcrops was dominated by the bryozoans *Flustra foliacea, Scupocellaria sp*. and *Bugulina flabellate and* **CR.HCR.XFa.ByErSp.Sag** Mixed turf of bryozoans and erect sponges with Sagartia elegans on tide-swept circalittoral rock Other sub-dominant taxa were feather-star *Antedon bifida*, plumose anemone *Metridium dianthus* and *Sagartia elegans* and *Urticina felina*, barnacle *Balanus crenatus*, soft coral *Alcyonium digitatum*, frequent erect sponges *Hymeniacidon perlevis, Amphilectus fucorum* and *Haliclona simulans*, the hydroids *Nemertesia antennina* and *Obelia dichotoma* as well as the tunicate *Clavelina lepadiformis*.	 	 

5.1.6 Surveys for the Harbour Porpoise in Rockabill to Dalkey Island SAC

A considerable number of surveys and sightings of the harbour porpoise have been gathered along the Irish east coast, including the area between Ireland's Eye and Skerries to the north (e.g. Pollock *et al*. 1997; Reid *et al*. 2003; Ó Cadhla *et al*. 2004; SCANS-II, 2008; Berrow *et al.* 2010; Berrow *et al*. 2011; Baines & Evans, 2012; Wall *et al*. 2012). The boundary of the SAC was supported by targeted surveys of the harbour porpoise community conducted in 2008 (Berrow *et al.* 2008). Recent, site specific information of cetacean activity in the vicinity of the proposed Outfall Pipeline and this section of the SAC were undertaken over a two year program based on three integrated methods in line with best practice; these were land-based vantage point surveys, boat-based transects and static acoustic monitoring. Visual surveys were only carried out in favourable weather conditions (Beaufort sea-state <2 and visibility >6km). Monthly land-based surveys were conducted from sites at Loughshinny for 6 months and Howth Head for 24 months. Single platform line-transect boat surveys were also conducted bi-monthly following a pre-determined route and standardised design. Finally, static acoustic monitoring using C-PODs was conducted for 6 months at a single site off Loughshinny and for 24 months at three locations off Portmarnock. Full details of these surveys are reported in Appendix C.

Passive acoustic monitoring recorders were deployed at three mooring sites along the proposed outfall pipeline between March 2015 and March 2017. An additional site was located east of Loughshinny in March 2015 for 6 months. Each mooring was fitted with a C-POD self-contained click detector which logs the echolocation clicks of porpoises and dolphins. The recovered data was interpreted by the IWDG. All C-POD data were analysed using only high probability clicks, which reduced the possibility of false positives (i.e. recorded as present when there were in fact no dolphins or porpoise present). Harbour porpoise detections were extracted as detection positive minutes per day and were analysed statistically for temporal and geographical trends. Porpoise detections were analysed with respect to season (spring, summer, autumn and winter), diel cycle (day and night-time), tidal state (ebb, flood, slack high, slack low) and tidal phase (spring, neap) at a resolution of one hour.

IWDG further supported the project by providing regular observations from both sea and land based surveys for cetaceans over the same survey period. Land-based observation sites were located on the cliffs at Howth Head, looking directly over the proposed Outfall Pipeline for a 24 month period, as well as the Loughshinny Martello Tower, for a six month period which recorded twenty hours of land-based monitoring conducted over six survey days. The weather was favourable throughout with no swell; sea state of Beaufort wind force of 2 or below and visibility of 6-20km. Marine mammals were sighted on 86% of survey days. The survey effort conducted from Howth Head amounted to around 144 hours (23 surveys) between 18 March 2015 and 11 March 2017. Environmental conditions were favourable with no swell, sea-state of Beaufort wind force of 2 or below for 99% and visibility >6km for 97% of survey effort. Marine mammals were sighted on 100% of survey days.

Eleven independent boat-based surveys were carried out from April 2015 to January 2017 over a total of 897km of track-lines. Environmental conditions were favourable with visibility of >6km for 91% of the time and swell of <1m for 100% of survey effort. Sea-state of Beaufort wind force of 2 or below was recorded for eight of the eleven surveys however sea-state of Beaufort wind force of 2 or below was recorded for 8% of the survey carried out in April 2015, 36% in June 2015 and 46% during December 2016. Marine mammals were sighted on all survey days.

The software programme DISTANCE was used for calculating detection functions, which is the probability of detecting an object a certain distance from the track-line and used to calculate the density of animals on the track-line of the vessel. A detection function was calculated from each boat survey, providing sufficient number of sightings were made to provide a robust estimate.

All of these datasets have been integrated and are reported in Appendix C.

5.1.6.1 Results Summary

Annex II Marine Mammal (harbour porpoise *Phocoena phocoena*) Surveys

This small toothed cetacean species occurs throughout Irish continental shelf waters including estuarine, coastal and offshore environments in which it carries out breeding, foraging, resting, social activity and other life history functions. Individual porpoises of all ages use sound as their primary sensory tool in order to navigate, communicate, avoid predators, or locate and facilitate the capture of prey under water. Group sizes tend to be small (i.e. in single figures, more commonly 2 to 3 individuals) although larger aggregations may occasionally be recorded, particularly in the summer months. The species breed annually in Ireland, predominantly during the months of May to September. The principal calving period in Irish waters is thought to occur in the months of May and June, although it may extend throughout the summer months and into early autumn. Newborn calves are weaned before they are one year old. Mating commonly occurs several weeks after the calving season.

The Rockabill to Dalkey Island SAC Code: 3000 was established off the Dublin coastline in April 2013. The occurrence of harbour porpoises within the SAC was estimated using visual observation and passive acoustic methods in order to deliver an assessment of community or population size (i.e. relative abundance or absolute abundance), density and distribution, although the size, community structure and distribution or habitat use of harbour porpoise inhabiting Rockabill to Dalkey Island SAC is not fully understood. In acknowledging limitations in the understanding of aquatic habitat use by the species within the site, it should be noted that all suitable aquatic habitat is considered relevant to the species range and ecological requirements at the site and is therefore of potential use by harbour porpoises. Initial survey estimates of individuals undertaken in 2008 indicated estimates of 0.54-6.93 animals per km^2 (and an overall estimate of 2.03 individuals per km^2 for the survey) within the northern half of the site and 0.48-2.05 animals per km^2 (and an overall estimate of 1.19 individuals per km^2), within the southern half of the site, including outer Dublin. Additional acoustic data plus casual and effort-related sighting rates from coastal observation stations are significant for the east coast of Ireland and, comparatively high group sizes (>5 individuals) have been recorded from this area. The species is present at the site in all seasons, while important cohorts within the harbour porpoise community such as adults, juveniles and new-born calves have also been recorded within the site, including during the calving/breeding season.

A visual and Passive Acoustic Monitoring (PAM) survey of harbour porpoises was carried out in the summer of 2013 at the Rockabill to Dalkey Island SAC by Berrow and O'Brien (2013) in order to derive local density and abundance estimates. The study concluded a population estimated to be between around 400 individuals within the SAC with average density varying from 1.13 to 2.61 km^2, with an overall average density of 1.44±0.09 porpoises per km^2. Observations included the sightings of juveniles and calves combined, making up approximately 7% of observations.

A comprehensive range of long–term land-based, vessel-based, and acoustic observations were carried out for marine mammals in the survey area by the Irish Whale and Dolphin Group (IIWDB) between March 2015 and March 2017. A summary of results, along with previous survey effort are summarised in

Land-based monitoring was carried out monthly from 18 March 2015 until 11 March 2017. Just under 144 hours of monitoring was conducted over 23 independent surveys. Marine mammals were sighted on 100% of survey days with harbour porpoise present on 83% of occasions with 167 sightings recorded made up of 293 animals. These were made up of approximately 80% adults with the remainder juveniles and calves. The calves were only recorded between September 2015 and November 2015, and in August 2016. Sighting rate were calculated based on sightings and number of animals per hour of effort with porpoise sighting rates consistently higher during late summer and autumn, between August 2015 and January 2015, and August 2016 and October 2016.

Eleven boat-based marine mammal surveys were conducted from April 2015 to January 2017. Track-lines were staggered to provide good coverage of the site and to ensure all habitats were surveyed. Harbour porpoise were recorded on 100% of survey days with the greatest number of sightings recorded in November 2015 and August 2016. Group sizes also increased between August 2015 and November in 2015, and in August 2016. The lowest numbers of sightings were recorded in June 2015, June 2016 and December 2016 however sea-state was higher during these surveys which would increase the likelihood of missed sightings, therefore these results must be treated with caution. Calves were only recorded in August 2015, November 2015 and August 2016. Harbour porpoise sightings were regularly distributed across the study area. The average density of animals was greatest in the summer with both August 2015 and August 2016 recording the highest numbers at 1.91ind/km^2 and 2.29ind/km^2. This fell to between 0.61ind/km^2 and 0.89ind/km^2 between January and April (2015-2017).

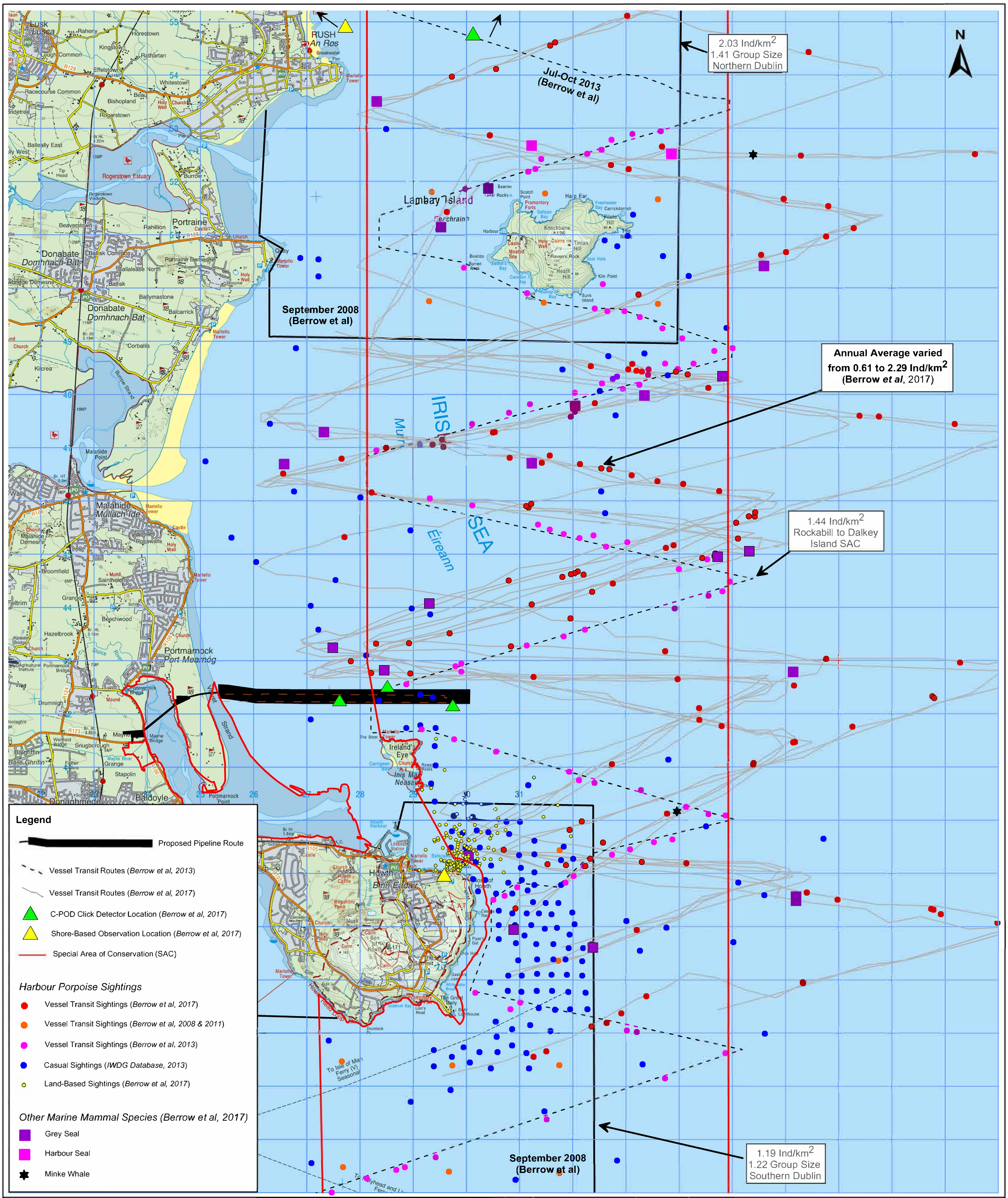
Static acoustic monitoring was carried out at three sites close to the proposed outfall pipeline using C-PODs for a duration of 750 days (between March 2015 and March 2017). Detections were recorded 96-99% of days on average at each site with the daily detection positive minutes ranging between 41.3 DPM/day to 94.3 DPM/day. Detections were categorised into the following categories:

- Season (spring, summer, autumn and winter);
- Diel cycle (day and night-time);
- Tidal state (ebb, flood, slack high, slack low) and;
- Tidal phase (spring, neap).

The acoustic data demonstrated that all three sites monitored along the proposed outfall pipeline route off Portmarnock are used consistently by harbour porpoise on a daily basis. However, presence was greater during autumn and winter, during hours of darkness and at slack high tides. When the data from Portmarnock are compared to Loughshinny data collected in 2015 (Meade *et al*. 2015) results were similar with autumn having the highest detections, however, only six months were monitored. Tidal cycle was not significant at Loughshinny in contrast to Portmarnock, where more detections were recorded during spring tidal phase. Monitoring index at Loughshinny was high at 9.8%, while at Portmarnock values ranged between 2.8% and 6.6% across sites, suggesting Loughshinny is the most important site for harbour porpoise to be monitored during the Proposed Project.

Trends in the presence of harbour porpoise with diel cycle on the east coast of Ireland have been found to differ geographically, but they are consistently more active at night. The reasons for increased nocturnal activity are uncertain but could be linked to an increase in prey abundance or activity in the absence of light, as suggested by Todd *et al.* (2009).

Overall, observations through all survey methods showed that harbour porpoise numbers increased in late summer during both 2015 and 2016 which coincided with the presence of calves and may be due to seasonally abundant food sources such as sprat, herring and *Trisopterus* and gadoid species. Reduced numbers were recorded during late spring/early summer which may be associated with an offshore movement of this species before calving. The density estimate of harbour porpoise was high and emphasizes the importance of this site for this species as these are some of the highest densities recorded in Ireland to date (Berrow *et al*. 2008, 2013 and 2015).



Greater Dublin Drainage

Rev.	Date	Purpose of Revision	Drawn	Check'd
4	09/04/18	Final	KT	IW
3	22/02/18	For Issue	KT	IW
2	19/10/17	For Issue	KT	IW
1	24/10/16	For Issue	KT	IW
0	05/04/16	Draft	KT	IW

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Project Greater Dublin Drainage Project

Drawing Title Figure 5.3 - Casual Sightings and Dedicated Surveys of the Harbour Porpoise

Drawing Status	FINAL
Scale @ A3	1:50,000
Job No.	32102902
Drawing No.	32102902-EIAR-904

5.2 Modelling

5.2.1 Airborne Noise Modelling at Microtunnelling Compounds

The potential for Likely Significant Effect as a result of piling noise during the construction of jacking shafts in the microtunnelling compounds has been considered further in the assessment by a noise specialist.

The maximum noise levels associated with the proposed works in each of the Marine Compounds will arise as a result of the proposed piling activities in each of the compounds. These noise emissions have been considered in more detail in order to assess the potential noise impact on the bird population of the Baldoyle Estuary. It is anticipated that sheet piling or secant piling will be will be undertaken at the launch and reception shafts at each microtunnelling compound. Typical noise levels associated with these works have been considered in this assessment. The piling works at both compounds are anticipated to be completed in less than two weeks.

5.2.1.1 Noise Model Results

It is anticipated that piling will be required at the two Marine Compounds during the construction of the launch and reception shafts required for the Tunnel Boring Machine (TBM) works. The launch shaft will be constructed in the compound located to the east of Baldoyle Estuary and piling works here will be completed at a distance of greater than 140m from the nearest boundary point of the estuary. The reception shaft will be constructed in the compound located to the west of Baldoyle Estuary and piling works here will be completed at a distance of greater than 50m from the nearest boundary point of the estuary. The maximum noise levels associated with the proposed works in each of these compounds will arise as a result of the proposed piling activities in each of the compounds. These noise emissions have been considered in order to assess the potential noise impact on the bird population of the Baldoyle Estuary.

Table 5-4 Magnitude of the Impact of the Piling Activity

Noise Level Range, dB $L_{Amax\ F}$	Magnitude of impact
≤ 65	Negligible
> 65 to ≤ 75	Minor
> 75 to ≤ 85	Moderate
> 85	Major

Table 5-4 is used to assess the magnitude of the impact of the piling activity on the receiving bird population. It is anticipated that sheet piling or secant piling will be will be undertaken in each of the two aforementioned compounds and typical noise levels associated with these works have been considered in this assessment.

Maximum noise levels as a result of the launch shaft piling works are anticipated to be ≤ 65dB L_{Amax} on all sections of the Baldoyle Estuary and consequently the magnitude of the impact is classified as Negligible for these works.

Maximum noise levels as a result of the reception shaft piling works are anticipated to fall into the > 65 and ≤ 75 dB L_{Amax} range for a 100m radius centred on the source of the piling noise within the proposed construction compound and maximum noise levels across all other areas of the estuary are anticipated to be ≤ 65dB L_{Amax}. Consequently, the magnitude of the noise impact associated with the piling activity in the western Marine Compound is classified as Minor for these works. It should also be noted that these impacts will be temporary in duration as the piling works at both compounds are anticipated to be completed in less than one week.

According to the data presented in BS 5228 the highest noise emission level associated with sheet piling is 88dB LAeq at 10m distance. There are many other sheet piling methods with much lower noise emissions than this and with newer technologies, it is likely that actual piling noise emissions will be much lower than this value. In any case, the input data used in the noise model was for this worst-case figure of 88dB LAeq at 10m distance. It is important to note that the model includes the 2.4m high site hoarding that will be around the site perimeter and the predicted noise levels are for ground level and not at 4m height where they will be higher. Also the closest distance from piling in the eastern compound and the Baldoyle estuary is 140m and the closest distance from piling in the western compound and the Baldoyle estuary is 50m. The model also accounted for the operation of piling occurring in both compounds at the same time and was continuous for 100% of the time to allow an LAmax value be determined.

With regard to the eastern microtunnelling compound, maximum noise levels as a result of the launch and reception shaft piling works are anticipated to be ≤65dB LA_{max} in all sections of the Baldoyle Bay SPA. An area of largely undesignated land approximately 100m in radius around the launch and reception shaft piling will be exposed to noise levels of between >65 and ≤75 dB LA_{max}. Approximately 0.21 hectares of the Baldoyle Bay SPA falls within this area. This was calculated by overlaying a circle of 100m radius in GIS software and assessing the area overlapping the Baldoyle Bay SPA

With regard to the western microtunnelling compound, a small area (approximately 1.79 hectares) within the Baldoyle Bay SPA will be subject to noise between >65 and ≤75 dB LA_{max}. This was calculated by overlaying a circle of 100m radius in GIS software and assessing the area overlapping the Baldoyle Bay SPA. An area of non-designated land approximately 100m in radius around the launch and reception shaft piling will be exposed to noise levels of between >65 and ≤75 dB LA_{max}.

Airborne noise impacts in the subsea environment (where activities will result in a sound power level of >65 dB LA_{max}) are restricted to the areas where piling will be carried out at the microtunnelling/subsea interface and fibre optic cable crossing. Noise levels with the potential to impact birds are predicted to propagate up to 100m from the piling source at both the microtunnelling/subsea interface (located approximately 2,600m from the Ireland's Eye SPA) and the fibre optic cable crossing (located approximately 500m from the Ireland's Eye SPA), and are expected to last for a maximum of two weeks. They will likely be sequential in nature rather than simultaneous. The result of these works would result in the loss of approximately three hectares of subtidal habitat for a period not exceeding four weeks during the construction phase of the proposed GDD project, none of which is designated.

5.2.2 Water Quality Modelling

5.2.2.1 Suspended Sediment Plume Analysis

Marcon Computations International was commissioned to inform the potential spread and extent of suspended sediment plumes arising from dredging works associated with the construction of the proposed Marine Outfall Pipeline. The computational models used in this study were based on the MIKE3 coastal process software using the 3D hydrodynamic flow model and a particle tracking (MIKE PT) modules. The model consisted of a regular 50m grid encompassing the general area of the proposed Marine Outfall Pipeline and expanded out into a flexible mesh model of varying grid sizes. This particle tracking model used the hydraulic flow regime from the MIKE3 hydrodynamic model to simulate the transport and fate of material discharged to the water column. The model included variable graded material along with temporally and spatially varying discharges.

The outfall will be constructed using a combination of a backhoe dredger, in shallower areas, and a trailer suction hopper dredger (TSHD) where the water depths are beyond the limits of the backhoe dredger. The back-hoe dredger or similar will be used for the dredging activity during 12 hour and daylight operations which gives a maximum dredging quantity of about 78 m^3 per hour while the dredger is working. It is estimated that the total volume of material to be excavated ranges between 200,000 to 400,000m^3 and that the dredging operation will take approximately 130 days.

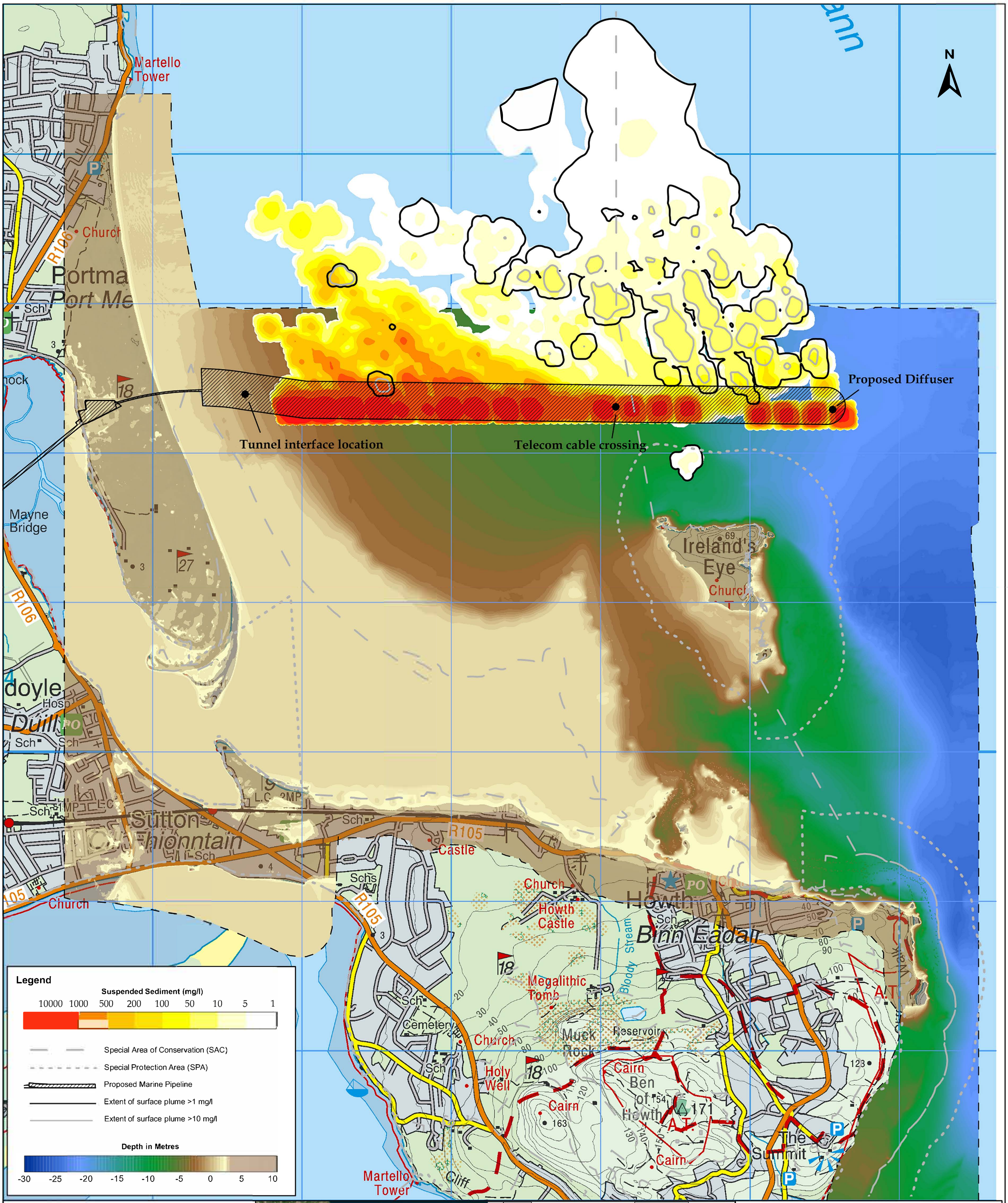
Details of the sediment characteristics were obtained from the surface and sub-surface sediments along the route from the vibrocoring and borehole data with calculations based on their proposed excavation locations along the outfall route (i.e. BH03, BH05, and BH08). These samples showed that sediments ranged from grey silty sand to grey sandy gravel. Whilst grey silty sand predominates along the entire route, the increase in gravel fraction over depth and towards the offshore end of the trench have largely been ignored for suspended sediment dispersion purposes as the heavier fractions settle out within a few metres of the dredger.

Material losses through suspension in the water column were assumed to be conservative. A 10% of total dredged volume, representing a 7.5% source at 1m above the seabed and a 2.5% source at the 1m below the surface were used. The MIKE model simulates the fate of the loss of material from the dredgers by releasing particles into the water column and tracking each particle throughout the simulation process. A range of grain sizes was used in order to cater for the variation in sediment grading of the bed sediment material. Assuming a density of 2000 kg/m^3 for in-site consolidated sand/gravel mix, the extraction rate equates approximately 1,852 kg/s and a 10% loss of 185.2kg/s occurring through sediment suspension. A dredging simulation was then run over the full 130 excavation period with the origin for dispersion and the source of the material moved to keep track with the dredgers simulated progress along the route.

The results of the dredging simulations were shown graphically by a series of model output diagrams based on operations from different borehole locations or different states of the tide. These have been summarised into a single chart (see Figure 5-4). At almost all locations, snapshots of suspended sediment concentrations were taken over the course of spring or neap tides with the majority observed within the 0-100 mg/l range. In only two of the snapshots were the suspended sediment concentrations predicted to be greater than 100 mg/l. The deposition depth of dredged material is greatest in the immediate vicinity (within 8m) of the trench (>300 mm) with deposition depths reducing to less than 3mm within a few hundred meters of the trench route.

The Construction Plume

The spread of the sediment plume shows the controlled release of spoil material by hopper barge every 7 hours producing a northerly plume drifting away from Ireland Eye with the greatest plume concentration recorded in the shallower first 2km of the route from landfall. The highest concentrations of suspended sediments >10,000 mg/l were recorded at bed level within 50-100m from the discharge point. The granular nature of these sediments results in a fast settlement of material to the bottom with seabed and mid-depth concentrations generally falling to below 1,000 mg/l within 200m from the discharge. Lower levels of sediment fines (silts and clays), recorded in the sub-surface layers of the corridor are modelled to travel further on discharge, and with concentration of between 10 and 100 mg/l recorded out to a maximum distance of around 1,400m north of the route when discharged during flooding tides. Most suspended material would be recorded just above bed level concentrations in the surface waters generally limited to discharges made only in the offshore half of the proposed route. Here, low level concentrations of between 5 and 10mg/l were recorded out to 1,500m from the corridor or remained just detectable out to 2600m. With the exception of the a small surface plume of 1-5 mg/l and 200-300m across caught in a small back-eddy 350m North of the Irelands Eye north coast, all of the suspended plume discharge are predicted to disperse to the North of the proposed route following a controlled discharge. None of the discharged sediment is predicted to impact the qualifying Annex I habitats of littoral and sublittoral reef features of the Rockabill to Dalkey Island SAC along the north and eastern coastline of Irelands Eye. Suspended sediments throughout the remainder of the SAC were limited to near bed impacts in the main part of the SAC area.



Greater Dublin Drainage

Project
Greater Dublin Drainage Project

Drawing Title
Figure 5.4 - Maximum Suspended Sediment Plume Concentrations arising from dredging over the duration of the dredging Works for the proposed outfall pipeline route (Marine Section)

4	02/11/17	Final	KT	IW
3	02/11/17	For issue	KT	IW
2	19/10/17	For issue	KT	IW
1	24/10/16	For issue	KT	IW
0	05/04/16	Draft	KT	IW
Rev.	Date	Purpose of Revision	Drawn	Check'd

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UISCE ÉIREANN : IRISH WATER

JACOBS

TOBIN
Patrick J. Tobin & Co. Ltd

Drawing Status	FINAL
Scale @ A3	1:25,000
Job No.	32102902
Drawing No.	32102902-EIAR-906

The Operational Plume

Details of the plume discharged into the Irish Sea by the outfall are discussed in Chapter 8 of the EIAR and the standards of the treated effluent summarised in section 3.2.1 and characterised in Table 3.1. The diffuser constructed for the end of the outfall is designed to enhance the dilution of the treated effluent into the receiving waters on discharge. A numerical model of the expected dilution was produced based on the Cornell Mixing Zone Expert System (CORMIX) to predict the near-field dilution characteristics of a proposed outfall discharging to the receiving waters. The CORMIX model predicted the plume development, dilution and effluent concentrations within the plume. Near the discharge port, the plume tends to behave as a coherent jet, dominated by its initial momentum and buoyancy. Eventually, these are dissipated by interaction with the surrounding medium, and the plume becomes a diffuse mass carried along by the ambient current. Mixing initially occurs by turbulent flows at the boundaries of the plume, and later primarily by pure diffusion processes.

Simulations were run using the CORMIX using hydrodynamic data applied for the tidal cycle, ambient water quality and structure and profiled currents recorded during an earlier survey campaign at the proposed outfall location. Hourly simulations were carried out over the full tidal cycle for both neap and spring tidal scenarios with results indicating a consistent 20 fold dilution recorded within the near field (50m) from the discharge point on both neap and spring tidal streams. Far field dilutions (500m) showed greater variability based on the tides but generally varied from a 33 fold dilution during slack events, to 100 fold dilution during mid flood or ebb tidal streams. Therefore, for total suspended solids, a 35 mg/l (95th percentile) discharge would therefore dissipate to an increased back ground of 1.75 mg/l within 50m at all states of the tide, but vary from 1.06 to 0.35 mg/l at 500m, subject to tidal stream.

Other water quality parameters assessed during the modelling were key treated effluent components or the potential discharge of untreated effluent for a very short duration owing to a pumping failure in the proposed WwTP. All components are subject to the same plume dispersion characteristics as outlined above. Comments on each component and their regulated water quality objective levels are as follows:

- Dissolved Inorganic Nitrogen (DIN). Following a prediction of the DIN plume throughout the tidal cycle and during a three day simulated process failure scenario showed no impact from the proposed outfall discharge point. The Environmental Objectives Regulations, 2009 sets the standard limit for DIN at 0.25mg/l-N in coastal waters (to achieve good status).

- Molybdate Reactive Phosphorus (MRP). Following a prediction of the MRP plume throughout the tidal cycle and during a three day simulated process failure scenario showed no impact from the proposed outfall discharge point. The Environmental Objectives Regulations, 2009 sets the standard limit for MRP at 0.04mg/l in transitional waters (to achieve good status).

- Biochemical Oxygen Demand (BOD). Following a prediction of the BOD plume throughout the tidal cycle and during a three day simulated process failure scenario showed no impact from the proposed outfall discharge point. The Environmental Objectives Regulations, 2009 sets the standard limit for BOD at 4mg/l in transitional waters (to achieve good status).

- Escherichia coli (COLI). Following a prediction of the COLI plume throughout the tidal cycle and during a three day simulated process failure scenario showed no impact from the proposed outfall discharge point. The Bathing Water Quality Regulations 2008 (SI No. 79 of 2008) require that the maximum values of *escherichia* coliforms should not exceed the mandatory value of 500 /100ml in 95% or more samples taken in the season to ensure ‘good’ classification of bathing water beaches.

The proposed Regional WwTP will require a waste water discharge licence to be granted by the EPA under the Waste Water Discharge (Authorisation) Regulations, 2007 (S.I No. 684 of 2007) prior to commissioning of the treatment plant, to which the discharge will comply.

5.2.2.2 Turbidity Monitoring

Suspended Sediments and Water quality results

Long term observations of turbidity recorded at the proposed outfall location throughout 2015 and 2016 (TML 2016) indicated a variable ambient suspended sediment load ranging from 4 to 120mg/l calculated from converted turbidity measurements (using Guillen *et al.,* 2000) or 15 to 160mg/l from sampled water quality measurements taken throughout the same survey period. The longer term observations in turbidity revealed significant variability in water clarity by season as well as by tidal state, with a regular semi-diurnal pattern recorded over a slow seasonal decreasing in turbidity (i.e. increased water clarity) recorded during the summer months. Spring and neap tidal cycles had a marked effect on the suspended sediment load, increasing ambient levels by between 7 and 25mg/l during the stronger spring tidal flows. Ambient suspended sediments were also affected by strong winds and poor weather periods.

5.2.3 Underwater Noise Modelling

5.2.3.1 Noise from Dredging and Piling

The noise created by backhoe dredgers is produced from a repetitive sequence of sounds generated by winches, bucket impact with the substrate, bucket closing, and bucket emptying (Dickerson et al. 2001; Robinson et al. 2012). Grab and backhoe dredgers are also characterised by sharp transients from operation of the mechanical parts. Suction dredgers produce a combination of sounds from relatively continuous sources including material passing through the suction pipe and the drag head moving across the substrate. However, it is the noise of the support vessel (engine and propeller noise) along with supporting vessels that can often be the most significant source of noise.

Noise levels produced by backhoe dredger operating around the Shetland Islands, UK, were recorded by Nedwell *et al.* (2008). He recorded a calculated source level of 163 dB re 1 μPa at 1 m (bandwidth = 20 Hz–100 kHz) although, Reine *et al.* (2012) calculated source levels of 179 dB re 1 μPa at 1 m (bandwidth = 3 Hz–20 kHz).

Noise produced by suction dredgers has been measured on a number of occasions. Robinson *et al.* (2011) measured six TSHDs, stating that sound the levels below 500 Hz were in line with those expected for a cargo ship travelling at modest speeds (8–16 kn). The maximum broadband source was 189.9 dB re 1 μPa at 1 metre (calculated based bandwidth 31.6 Hz to 39.8 kHz). Estimated source levels above 1 kHz were relatively high, probably a result of the coarse aggregate pumped through the dredge pipe. Using an identical approach, de Jong *et al.* (2010) found very similar results to Robinson *et al.* (2011), the source levels recorded a decline beyond 1 kHz when working sand rather than gravels. Consequently, the variation is sediment types from sands to mixed gravels encountered along the proposed route is expected to alter the source levels during dredging, particular at the higher frequencies.

A collation of dredger related noise profiles has previously been carried out by Subacoustech Environmental using their SPEAR model based on measured recording retained within their database. The SPEAR model gives unweighted source levels of 186 dB re 1 μPa for suction dredgers and 165 dB re 1 μPa for backhoe dredgers. Therefore the predicted noise from suction dredgers is expected to be approximately 20 dB above that of backhoe dredgers, this is due largely to the typical size difference between the two types of vessel as well as the increased size of plant necessary for suction dredging. A model of expected underwater noise created during the dredging exercise (see Appendix D) was based on Parvin (2008) and Robinson *et al* (2011) and estimated at 188 dB ref 1μPa in the 50Hz to 89 kHz range. The output using third octive bands of 125Hz, 1kHz and 8kHz were calculated to range between 172 and 176 dB ref 1μPa. The contouring of sound exposure levels (SEL) from a source along the proposed route at these three frequencies showed a propagation of sound to an SEL of around 100 dB re 1 μPa, within 1km at 125Hz, around 30km for 1kHz and 12km for 8 kHz.

The same model was used to assess the noise impact from an impact hammer source that might be used at the tunnel interface or at a telecom cable crossing, midway along the proposed corridor. The source was based on a piling of 600mm with the sounds generated impulsively. In order to translate the potential impacts more accurately, the SEL expressed is as dB 1μPa²@1m which corresponds to the acoustic energy received integrated over a given frequency band and over the significant duration of the sound pulse (100ms in this study; De Jong, *et al*., 2008). At two of the same lower third octive bands used for the dredging assessments, the sound pressure level of the piling was estimated to be 186 dB 1μPa²@1m at 125Hz dropping to 172 dB 1μPa²@1m at 1kHz. Contouring of sound exposure levels (SEL) from a source along the proposed route at these two frequencies showed a propagation of sound to an SEL of around 100 dB re 1 μPa, within 2km at 250Hz, around 12km for 1kHz.

All of these noise impacts will travel within the Rockabill to Dalkey Island SAC where they have the potential to impact the Annex II species *Phocoena phocoena* (harbour porpoise).

6. Assessment of Implications for European Sites

The findings of the Screening for Appropriate Assessment exercise identified likely significant effects could not be excluded from 18 sites (7 SACs and 11 SPAs) as outlined in Table 4-2 and Table 4-3. The potential impacts and key best practice and mitigation measures for these European sites, their qualifying interest, special conservation interests and conservation objectives are assessed in greater detail in this section.

The following sections discuss each of the 18 sites under one or more of the following impact pathways as identified in the screening assessment (see Section 4):

- Water quality and habitat deterioration;
- Airborne noise and visual disturbance;
- Underwater noise and disturbance; and
- Habitat Loss.

Baldoyle Bay SPA, Baldoyle Bay SAC, Rockabill to Dalkey Island SAC, Ireland's Eye SPA and Lambay Island SAC are located immediately next to or overlapping with the Proposed Project. Therefore, these are discussed first under each theme heading where relevant. The links to the site specific conservation objective lists used in the assessment for all 18 European sites are provided in Appendix E.

It should be noted that the land elements of the project i.e. WWtP, pumping station, orbital sewer pipeline, north fringe sewer pipeline and marine outfall pipeline (land section), access roads and compounds 1-8 as listed in Table 4-1 have the potential to give rise to Likely Significant Effects only through impact pathway theme 'water quality and habitat deterioration' in the event of a release of contaminated run off from spillages during construction stage. All other elements of the project can give rise to two or more impact pathways.

6.1 Impact Pathway - Airborne Noise and Visual Disturbance

6.1.1 Baldoyle Bay SPA

Based on the information contained in Section 4 there are two potential pathways for LSEs to occur on this SPA; airborne noise and visual disturbance which is discussed here in Section 6.1.1 and water quality and habitat deterioration, information on which is provided in Section 6.2.

6.1.1.1 Conservation Objectives

Baldoyle Bay SPA has seven SCIs, as described in Table 6-1, which also sets out the conservation objectives for each SCI.

Table 6-1: Conservation objectives for waterbird Special Conservation Interest species and wetland habitat at Baldoyle Bay SPA

Species	A046	Light-bellied brent Goose *Branta bernicla hrota*
Conservation objective	To maintain the favourable conservation condition of Light-bellied Brent Goose in Baldoyle Bay SPA, which is defined by the following list of attributes and targets	
Attribute	**Measure**	**Target**
Population trend	% change	Long term population trend stable or increasing
Distribution	Range, timing and intensity of use of areas	No significant decrease in the range, timing and intensity of use of areas by light-bellied brent goose, other than that occurring from natural patterns of variation
Species	A048	Shelduck *Tadorna tadorna*
Conservation objective	To maintain the favourable conservation condition of Shelduck in Baldoyle Bay SPA, which is defined by the following list of attributes and targets	

Attribute	**Measure**	**Target**
Population trend	% change	Long term population trend stable or increasing
Distribution	Range, timing and intensity of use of areas	No significant decrease in the range, timing and intensity of use of areas by Shelduck, other than that occurring from natural patterns of variation
Species	A137	Ringed Plover *Charadrius hiaticula*
Conservation objective	To maintain the favourable conservation condition of Ringed Plover in Baldoyle Bay SPA, which is defined by the following list of attributes and targets	
Attribute	**Measure**	**Target**
Population trend	% change	Long term population trend stable or increasing
Distribution	Range, timing and intensity of use of areas	No significant decrease in the range, timing and intensity of use of areas by Ringed Plover, other than that occurring from natural patterns of variation
Species	A140	Golden Plover *Pluvialis apricaria*
Conservation objective	To maintain the favourable conservation condition of Golden Plover in Baldoyle Bay SPA, which is defined by the following list of attributes and targets	
Attribute	**Measure**	**Target**
Population trend	% change	Long term population trend stable or increasing
Distribution	Range, timing and intensity of use of areas	No significant decrease in the range, timing and intensity of use of areas by Golden Plover, other than that occurring from natural patterns of variation
Species	A141	Grey Plover *Pluvialis squatarola*
Conservation objective	To maintain the favourable conservation condition of Grey Plover in Baldoyle Bay SPA, which is defined by the following list of attributes and targets	
Attribute	**Measure**	**Target**
Population trend	% change	Long term population trend stable or increasing
Distribution	Range, timing and intensity of use of areas	No significant decrease in the range, timing and intensity of use of areas by Grey Plover, other than that occurring from natural patterns of variation
Species	A157	Bar-tailed Godwit *Limosa lapponica*
Conservation objective	To maintain the favourable conservation condition of Bar-tailed Godwit in Baldoyle Bay SPA, which is defined by the following list of attributes and targets	
Attribute	**Measure**	**Target**
Population trend	% change	Long term population trend stable or increasing
Distribution	Range, timing and intensity of use of areas	No significant decrease in the range, timing and intensity of use of areas by Bar-tailed Godwit, other than that occurring from natural patterns of variation
Species	A999	Wetlands
Conservation objective	To maintain the favourable conservation condition of wetland habitat in Baldoyle Bay SPA, which is defined by the following list of attributes and targets	
Attribute	**Measure**	**Target**
Habitat area	Hectares	The permanent area occupied by the wetland habitat should be stable and not significantly less than the area of 263ha, other than that occurring from natural patterns of variation

6.1.1.2 Relevant Baseline Information

See Section 5.1.4 for relevant baseline information.

Noise impacts will occur within an area of habitat of Baldoyle Bay SPA comprising approximately 1.79 hectares. This is due to piling occurring at the western microtunnelling compound. Table 6-2 provides details on the SCIs of the Baldoyle Bay SPA recorded using the habitat within this area during the baseline surveys.

Table 6-2: Assessment of Baldoyle Bay SCIs present within predicted noise disturbance impact zone within the Baldoyle Bay SPA resulting from piling at the western microtunnelling compound during baseline surveys (frequency of observation, numbers, and predominant behaviour)

Species	Total Number of Records Within Impacted Habitat	Total Number of Birds Recorded Within Impacted Habitat	Maximum Number of Birds Recorded Within Impacted Habitat at Once	Predominant Behaviour Recorded Within Impacted Habitat
Shelduck	3	18	16	Feeding
Grey Plover	1	3	3	Loafing

No SCIs of the Baldoyle Bay SPA were recorded in the habitats within 100m of the western microtunnelling compound jacking shaft, and outside the Baldoyle Bay SPA boundary during the baseline surveys.

Noise impacts will occur within an area of habitat within the Baldoyle Bay SPA of approximately 0.21 hectares due to piling occurring at the eastern microtunnelling compound. No SCIs of the Baldoyle Bay SPA were recorded in this area during the estuarine baseline surveys. A small number of SCI's of the Baldoyle Bay SPA were recorded within habitat in the area likely to be impacted by noise disturbance outside the Baldoyle Bay SPA boundary. These are presented in Table 6-3.

Table 6-3: Assessment of Baldoyle Bay SPA SCIs present within predicted noise disturbance impact zone outside the Baldoyle Bay SPA resulting from piling at the eastern microtunnelling compound during baseline surveys (frequency of observation, numbers, and predominant behaviour)

Species	Total Number of Records Within Impacted Habitat	Total Number of Birds Recorded Within Impacted Habitat	Maximum Number of Birds Recorded Within Impacted Habitat at Once	Predominant Behaviour Recorded Within Impacted Habitat
Ringed Plover	2	10	9	Feeding, Roosting

The number of SCI observations recorded in habitat within published visual disturbance distances of both microtunnelling compounds (Cutts et al. 2013) was assessed. This is presented in Table 6-4.

Table 6-4: Assessment of Baldoyle Bay SPA SCIs present within predicted visual disturbance impact zone resulting from presence of eastern and western microtunnelling compound during baseline surveys (frequency of observation and numbers)

Species	Published Disturbance Distance (Cutts et al. 2013) (metres)	Number of Records Within Published Disturbance Distance to Microtunnelling Compounds	Number of Birds Within Published Disturbance Distance to Microtunnelling Compounds
Light-bellied brent Goose	205	17	475
Shelduck	500	338	1,506
Ringed Plover	50	0	0
Golden Plover	200	1	1,800
Grey Plover	200	7	17
Bar-tailed Godwit	200	4	27

In the subtidal environment, a number of SCI species were recorded, as reported in Section 5.1.4. The exact position of these birds is not considered to be a useful parameter in assessing any possible effects on them because they are mobile, but they are considered in the assessment below.

6.1.1.3 Assessment

The baseline environment around the Baldoyle Bay SPA contains numerous sources of potential disturbance stimuli for birds. The Baldoyle Bay estuary lies on the approach to Dublin Airport's main runway. Observations made during ornithological surveys revealed that aircraft overfly the northern section of the Baldoyle Bay SPA very frequently. The R106 Coast Road, running down the western side of the bay, passes between the SPA boundary and the proposed temporary western construction for microtunnelling. A cycle path runs parallel to the road. The Baldoyle residential area to the south-west of Baldoyle Bay, and the Portmarnock and Sutton Golf Clubs on the eastern and southeastern sides of the bay are other sources of disturbance. Velvet Strand to the east is also frequented by a range of recreational users. In general, this suggests that many of the birds using the Baldoyle Bay SPA and surrounding area are habituated to a degree of a range of general visual and/or noise stimuli, including the presence of vehicles.

In order for the construction or operation of the proposed GDD project to result in disturbance to the birds in the area (including SPA qualifying species), the noise/visual stimuli would have to substantially exceed those that are already present in some way.

Only one noise source will propagate into the Baldoyle Bay SPA at a sound power level of sufficient magnitude to potentially trigger disturbance within the SPA boundary. This is noise produced during piling of the jacking shaft at the microtunnelling compounds. This is a reversible impact that will occur for a maximum time period of two weeks, and could result in an impact on 1.79 hectares (see Section 5.2.1) of habitat within the SPA boundary on the western side of the SPA, and 0.21 hectares on the eastern side of the SPA . It is estimated that the sound power level reaching the Baldoyle Bay SPA boundary will be in the region of 75 dB LA_{max}.

Noise disturbance during the construction of the jacking shaft at both the microtunnelling compounds could impact terrestrial habitats outside the Baldoyle Bay SPA boundary used by SCI species. Piling will occur for a period of two weeks during the construction period and the resulting impact is reversible.

There is also potential for connectivity between the Baldoyle Bay SPA and the subtidal habitats in and adjacent to the outfall pipeline corridor, which baseline data showed were being used by low numbers of some SCI species.

Airborne noise impacts in the subsea environment (where activities will result in a sound power level of >65 dB LA_{max}) are restricted to the areas where piling will be carried out at the microtunnelling/subsea interface and fibre optic cable crossing. Noise levels with the potential to impact birds are predicted to propagate up to 100m from the piling source at both the microtunnelling/subsea interface (located approximately 1,100m from the Baldoyle Bay SPA) and the fibre optic cable crossing (located approximately 3,600m from the Baldoyle Bay SPA), and are expected to last for a maximum of two weeks. They will likely be sequential in nature rather than simultaneous. The result of these works would result in the loss of approximately 3 hectares of subtidal habitat for a period not exceeding four weeks during the construction phase of the proposed GDD project.

Visual disturbance resulting from the construction and presence of the microtunnelling compounds along with the activities associated with them could result in impacts within the Baldoyle Bay SPA. In addition, similar impacts to habitats outside the boundary which may have connectivity to the Baldoyle Bay SPA is possible. This is a reversible impact that would occur for the duration of the construction period. Visual disturbance can occur up to a distance of 205m from source for light-bellied brent goose, 500m for shelduck, 200m for golden plover, grey plover and bar-tailed godwit, and 50m for ringed plover (Cutts et al. 2013). This level of disturbance applies to work during daylight and darkness. Working at night would require artificial lighting, which has been shown to benefit estuarine birds by increasing foraging opportunity (Santos et al. 2010).

Vessel disturbance impacts are restricted to the subsea environment, beginning from the micro-tunnelling/subsea interface, located approximately 600m offshore from Velvet Strand beach, and terminating at the marine diffuser. Piling works at the micro-tunnelling/subsea interface are situated approximately 1km from the Baldoyle Bay SPA, and 600m offshore from the Velvet Strand beach. With regard to dredging, two groups of vessels will be present between April and October moving along the outfall pipeline corridor, with any disturbance impacts being restricted to an area around each group of vessels. With regard to pipeline assembly and installation, a floating jack up platform supported by tugs and multicat vessels would be used to assemble the pipe strings and place the concrete collars. Collars would be delivered on a daily basis by ship to platform. The exact distance at which birds may be disturbed is dependent on a range of factors, with different species possessing varying sensitivity as detailed in the sections below.

Light-bellied Brent Goose

The baseline survey data show that light-bellied brent geese do not regularly utilise habitats which fall within the zone of impact for the airborne noise disturbance impact pathway identified for the Baldoyle Bay SPA. Birds in flight are not predicted to be affected by this impact pathway because they are using the airspace and not the habitat, and are passing through the zone of impact rather than remaining within it. Small numbers of this species present in certain areas of highly restricted spatial extent could be subject to disturbance and displacement by the airborne piling noise, which would be temporary, reversible, and not result in any birds being lost from the Baldoyle Bay SPA population.

Larger numbers of birds were recorded using habitats which fall within the zone of impact for the visual disturbance impact pathway identified for the Baldoyle Bay SPA. This usage was recorded on 17 occasions by a total of 475 birds. Substantial numbers of this species present in habitats within 205m of the microtunnelling compounds could be subject to disturbance and displacement by visual disturbance, which would last for the duration of construction (approximately 18 months) and be reversible. The displacement of this number of birds could create knock on effects relating to competition and habitat availability, and could result in any birds being lost from the Baldoyle Bay SPA population. As a result, it is considered that the visual disturbance impact pathway of the proposed GDD project during construction and operation could compromise the targets of the conservation objective for this species.

None of the activities in the subtidal environment are predicted to result in the compromising of the targets of the conservation objectives for this species as it does not utilise these habitats and therefore does not occur within the potential zone of impact.

The construction of the proposed GDD project therefore could result in an adverse effect on site integrity for this species. Mitigation is required, which is discussed in Section 7.1.

Shelduck

The baseline survey data show that shelduck do not regularly utilise habitats which fall within the zones of impact for the airborne noise disturbance impact pathway for the Baldoyle Bay SPA. This species was not recorded in these areas during the estuarine survey programme. Small numbers of this species present in certain areas of highly restricted spatial extent could be subject to disturbance and displacement by the airborne piling noise, which would be temporary, reversible, and not result in any birds being lost from the Baldoyle Bay SPA population. As a result, it is considered that the airborne noise impact pathway of the proposed GDD project during construction and operation will not compromise the targets of the conservation objective for this species.

Shelduck was recorded in very small numbers in the subtidal environment. None of the activities in the subsea environment are predicted to result in the compromising of the targets of the conservation objectives for this species for this reason.

Larger numbers of shelduck were recorded using habitats which fall within the zone of impact for the visual disturbance impact pathway identified for the Baldoyle Bay SPA. This usage was recorded on 338 occasions by a total of 1,506 birds. Substantial numbers of this species present in habitats within 500m of the microtunnelling compounds could be subject to disturbance and displacement by visual disturbance, which would last for the duration of construction (approximately 18 months) and be reversible. The displacement of this number of birds could create knock on effects relating to competition and habitat availability, and could result in any birds being lost from the Baldoyle Bay SPA population. As a result, it is considered that the airborne noise and visual impact pathway of the proposed GDD project during construction and operation could compromise the targets of the conservation objective for this species.

The construction of the proposed GDD project therefore could result in an adverse effect on site integrity for this species. Mitigation is required, which is discussed in Section 7.1.

Ringed Plover

The baseline survey data show that ringed plover do not regularly utilise habitats which fall within the zones of impact for the airborne noise and visual disturbance impact pathway identified for the Baldoyle Bay SPA, being recorded only on a small number of occasions in these habitats during the estuarine survey programme (two observations, ten birds in total, within 100m of the eastern microtunnelling compound, which could be subject to noise disturbance). It was also recorded in the subtidal environment in small numbers, though not in areas, frequency or numbers which could result in the compromising of conservation objectives due to this impact pathway. Whilst small numbers of this species could be subject to disturbance and displacement, this effect would be restricted to a small spatial extent, temporary and reversible.

As a result, it is considered that the airborne noise and visual disturbance impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objective for this species. The construction of the proposed GDD project will therefore not cause an adverse effect on site integrity for this species.

Golden Plover

The baseline survey data show that golden plover do not regularly utilise habitats which fall within the zones of impact for the airborne noise and visual disturbance impact pathway identified for the Baldoyle Bay SPA. This species was observed on a single occasion in the noise disturbance impact zone, and was recorded once during the estuarine survey programme in the area predicted to be impacted by visual disturbance (within 200m of the microtunnelling compounds). This observation consisted of 1,800 birds. This data shows that if birds of this species do happen to be present in these areas during the construction phase, they can be present in large numbers. Any effects would be temporary and reversible, with visual disturbance effects lasting for the duration of the construction period (approximately 18 months). Golden plover were not observed in the subtidal habitats at any time during the surveys.

Whilst golden plover usage of these areas is infrequent, this species can occur in large flocks which would represent a large proportion of the Baldoyle Bay SPA population. The displacement of this number of birds could create knock on effects relating to competition and habitat availability, and could result in any birds being lost from the Baldoyle Bay SPA population. For this reason, it is considered that the airborne noise and visual disturbance impact pathway of the proposed GDD project during construction could compromise the targets of the conservation objective for this species.

The construction of the proposed GDD project therefore could result in an adverse effect on site integrity for this species. Mitigation is required, which is discussed in Section 7.1.

Grey Plover

The baseline survey data show that grey plover do not regularly utilise habitats which fall within the zones of impact for the airborne noise and visual disturbance impact pathway identified for the Baldoyle Bay SPA. This species was not recorded at all in the noise impact zones during the estuarine survey programme, with seven observations consisting of 17 birds in the visual impact zone (within 200m of the microtunnelling compounds). Grey plover was not recorded in subtidal habitats during baseline surveys. If birds of this species do happen to be present in these areas during the construction phase, it is likely they would be present in low numbers, and any effect would be temporary and reversible.

As a result, it is considered that the airborne noise and visual disturbance impact pathway of the proposed GDD project during construction and operation will not compromise the targets of the conservation objective for this species. The construction and operation of the Proposed Project will not cause an adverse effect on site integrity for this species.

Bar-tailed Godwit

The baseline survey data show that bar-tailed godwit do not regularly utilise habitats which fall within the zones of impact for the airborne noise and visual disturbance impact pathway identified for the Baldoyle Bay SPA. This species was not recorded at all in the noise impact zones, and only in small numbers (four records consisting of 27 birds) in the visual impact disturbance zone during the estuarine survey programme. It was also recorded in the subtidal environment in small numbers, though not in areas, frequency or numbers which could result in the compromising of conservation objectives due to this impact pathway. Whilst small numbers of this species could be subject to disturbance and displacement, this effect would be restricted to a small spatial extent, temporary and reversible.

As a result, it is considered that the airborne noise and visual disturbance impact pathway of the proposed GDD project during construction will not compromise the targets of the conservation objective for this species.

Wetlands

Due to the airborne noise and visual disturbance impact pathway, approximately 1.79 hectares of wetland habitat within the SPA boundary will be impacted due to piling noise from the jacking shaft of the western microtunnelling compound, and 0.21 hectares due to the same impact from the eastern microtunnelling compound, giving a total impact zone of 2 hectares. As a worst case scenario, it is considered that this habitat will be lost to birds for the duration of this activity, which is a maximum time period of two weeks. This impact is fully reversible.

Because no permanent loss of wetland habitat will occur during construction and operation of the Proposed Project by this impact pathway, it is considered that the airborne noise and visual disturbance impact pathway of the Proposed Project will not cause an adverse effect on site integrity for the wetland habitat of the Baldoyle Bay SPA.

6.1.2 Ireland’s Eye SPA

Based on the information contained in Section 4 there are two potential pathways for LSEs to occur on this SPA; airborne noise and visual disturbance which is discussed here in Section 6.1.2 and water quality and habitat deterioration, information on which is provided in Section 6.2.4.2.

6.1.2.1 Conservation Objectives

Table 6-5 sets out the five SCIs of the Ireland’s Eye SPA and their conservation objectives.

Table 6-5: Conservation objectives for Special Conservation Interest species at Ireland’s Eye SPA

Species	A017	Cormorant *Phalacrocorax carbo*
Conservation objective	To maintain the favourable conservation condition of Cormorant (currently excellent conservation status) in Ireland’s Eye SPA.	
The favourable conservation status of a species is achieved when:		
Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats		
The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future		
There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis		

Species	A184	Herring Gull *Larus argentatus*
Conservation objective	To maintain the favourable conservation condition of Herring Gull (currently unknown conservation status) in Ireland's Eye SPA.	
The favourable conservation status of a species is achieved when:		
Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats		
The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future		
There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis		

Species	A188	Kittiwake *Rissa tridactyla*
Conservation objective	To maintain the favourable conservation condition of Kittiwake (currently excellent conservation status) in Ireland's Eye SPA.	
The favourable conservation status of a species is achieved when:		
Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats		
The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future		
There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis		

Species	A199	Guillemot *Uria aalge*
Conservation objective	To maintain the favourable conservation condition of Guillemot (currently excellent conservation status) in Ireland's Eye SPA.	
The favourable conservation status of a species is achieved when:		
Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats		
The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future		
There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis		

Species	A200	Razorbill *Alca torda*
Conservation objective	To maintain the favourable conservation condition of Razorbill (currently excellent conservation status) in Ireland's Eye SPA.	
The favourable conservation status of a species is achieved when:		
Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats		
The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future		
There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis		

6.1.2.2 Relevant Baseline Information

Cormorant records were by far the most numerous in May, June and July (Graph A10.4, Appendix B), with a single monthly peak of 100 birds (Table A10.10, Appendix B). During the breeding season, 453 birds were recorded on the water and 783 in flight across 31 surveys (Table A10.9, Appendix B). Between March and October, birds were recorded on the water most frequently in distances bands 1 and 2 from both VPs (i.e. 0-1000m from the VPs) (Table A10.17, Appendix B). From the Ireland's Eye VP (VP2), a clear preference for the area of sea between Ireland's Eye and Velvet Strand was observed, with the majority of records occurring to the south of the outfall pipeline corridor (Figure A10.51, Appendix B). From the Velvet Strand VP (VP1), cormorants displayed a preference for remaining close to the shore to the south of Velvet Strand. Birds on the water across the VP survey area were recorded behaving in a variety of ways (feeding, preening, loafing and roosting). Whilst the species does utilise the outfall pipeline corridor, birds were not present within it in large numbers. This includes the subsea areas in the vicinity of the microtunnelling/subsea interface, and the fibre optic cable crossing. The baseline data suggests that this area of subsea habitat is not of critical importance to cormorant.

Cormorant was recorded throughout the year during the estuarine in relatively low numbers. Within the Baldoyle Bay SPA birds were observed in low numbers in wetted channels, but this species occurred predominantly within the subtidal area off Velvet Strand (Figure A10.43, Appendix B). The peak count was 42 birds (Appendix B, Table A10.4), which did not exceed the 1% national threshold of 120 birds.

Herring gulls were observed throughout the breeding season, with numbers peaking in July and high numbers reported in May and June. The peak single monthly count was 282 birds during the breeding season (Table A10.10, Appendix B). Across all 31 breeding season surveys, 2,889 birds were recorded on the sea, and 1,816 in flight (Table A10.9, Appendix B). Both VPs recorded a similar number of birds on the water during the breeding season, which were distributed quite evenly across the viewing arcs. The majority of birds recorded on the water were either roosting on the water or loafing (Table A10.16, Appendix B). A higher number of birds were observed within 0-1,000m of Ireland’s Eye in an area that lies to the south of the outfall pipeline corridor and marine diffuser (Figure A10.57, Appendix B). Whilst herring gulls were recorded on the sea in the outfall pipeline corridor, numbers were similar to those recorded in most of the rest of the study area. This includes the subsea areas in the vicinity of the microtunnelling/subsea interface, and the fibre optic cable crossing. This suggests that whilst birds do use it, the outfall pipeline corridor is not of high importance to this species.

Herring gull were commonly encountered across the entire Baldoyle Bay study area, including terrestrial, intertidal and subtidal habitats (Figure A10.37, Appendix B), with a peak count of 331 birds (Appendix B, Table A10.4). They are highly adaptable birds and will utilise a range of coastal, inland and offshore habitats. They were recorded twice in the area predicted to be subject to piling noise disturbance at the western microtunnelling compound, and three times in the corresponding area for the eastern microtunnelling compound.

Kittiwakes were observed throughout the breeding season, but in highest numbers in May and July (Table A10.10, Appendix B). In all survey years a substantial decrease in numbers of birds was observed in August (Graph A10.2, Appendix B). 2,977 of 3,412 kittiwakes observed on the sea (87.3%) between March and October were recorded from VP2 on Ireland’s Eye (Table A10.13, Appendix B). Of these, 2,258 birds (75.9%) were recorded loafing. Records of kittiwakes on the water were distributed more to the east of the Ireland’s Eye VP (VP2) viewing arc, with the sectors in which most bird records were made situated further away from Ireland’s Eye (Figure A10.58, Appendix B). Kittiwakes on the water were recorded most frequently in sectors that did not include parts of the outfall pipeline corridor or marine diffuser. 1,729 birds were recorded in flight from both VPs. Whilst birds were recorded in the outfall pipeline corridor in low numbers (including the subsea areas in the vicinity of the microtunnelling/subsea interface and the fibre optic cable crossing), the distribution of records across the wider VP study area suggests that it is not an important subtidal habitat for this species.

Kittiwake was recorded on a single occasion during the estuarine surveys (peak count of three birds; Appendix B, Table A10.4), with that record being made in the subtidal area off Velvet Strand (Figure A10.38, Appendix B). This species was absent from the Baldoyle Bay SPA.

The vast majority of guillemots (Table A10.14, Appendix B) and razorbills (Table A10.15, Appendix B) recorded on the sea between March and October were made from VP2 on Ireland’s Eye (7,869 of 8,576 (91.8%) guillemots, and 6,801 of 7,456 (90.1%) razorbills). Of these observations, 80.9% of guillemots and 79.5% of razorbills were observed loafing. Feeding behaviour accounted for only 13.0% of guillemots and 12.7% of razorbills recorded on the sea from the Ireland’s Eye VP, suggesting that feeding activity is conducted in areas beyond the outfall pipeline corridor. Both guillemots (Figure A10.55, Appendix B) and razorbills (Figure A10.60, Appendix B) were recorded in the main within 500m of the Ireland’s Eye VP, but also in relatively large numbers between 500-1000m away from the VP. The most frequently recorded location and behaviour of both species were non-feeding (generally loafing) birds recorded within 500m of the Ireland’s Eye VP (Figure 10.5 for guillemot and Figure 10.7 for razorbill). The distribution of feeding guillemot and razorbill records are illustrated in Figure 10.4 and Figure 10.6. Whilst guillemots and razorbills were recorded on the sea in the outfall pipeline corridor, including the subsea areas in the vicinity of the microtunnelling/subsea interface and the fibre optic cable crossing, they were present in smaller numbers than in the waters around Ireland’s Eye. This pattern of distribution suggests that whilst birds do use it, the outfall pipeline corridor is not of high importance to this species.

Boat-based surveys in July of 2016 and 2017 revealed that fledged auk chicks were present on cliffs and not in the water until mid-July. At this point, numbers of guillemots and razorbills on nests on the cliffs rapidly declined; however, no rafts of fledged chicks (or adults) were observed on the water around Ireland’s Eye at any time. By the final week of July, the majority of guillemots and razorbills had left the area without massing of large numbers of birds in the water being recorded. Survey observations suggest that rather than spending time on the water around the island, guillemots and razorbills leave the nest only when they intend to leave the area, and leave in small groups. Based on the lack of movements of large rafts of birds recorded it is possible that some movements may occur at night.

Guillemot were recorded on several occasions during the estuarine surveys, with a peak count of 20 birds (Appendix B, Table A10.4). Only two records of this species were made within the Baldoyle Bay SPA, with the remaining records made in the subtidal area off Velvet Strand (Figure A10.24, Appendix B).

Razorbills were only recorded in the subtidal area off Velvet Strand during the estuarine surveys (Figure A10.25, Appendix B), and not in the Baldoyle Bay SPA on any occasion. The peak count was five birds (Appendix B, Table A10.4).

6.1.2.3 Assessment

Due to the highly localised airborne noise impacts that are predicted (Section 5.2.1) there are no airborne noise impacts as a result of works in the subsea environment that will result in effects to SCI species inside the Ireland’s Eye SPA.

With regard to visual disturbance, it is possible that vessels operating in the easternmost 1km of the outfall pipeline corridor and marine diffuser have the potential to cause disturbance to the SCI species of the Ireland’s Eye SPA within its boundary. Vessels will be present in this area for up to three months. The will occur between April and October (see Section 3.2.9).

The Ireland’s Eye SPA encompasses a large expanse of designated waters (approximately 182 hectares). The exact distance at which birds may be disturbed is dependent on a range of factors, with different species possessing varying sensitivity. It is judged that a worst case scenario would be vessels being present at the marine diffuser, and another group being present approximately 1km to the west of this location at the southern extent of the working area. With regard to auks, if a theoretical 500m disturbance distance from the working area of the outfall pipeline corridor is applied, which is considered highly conservative based on the findings of Garthe and Hüppop (2004) and Furness and Wade (2012), the marine diffuser vessel group would result in approximately 0.45 hectares of designated subtidal habitat being subject to possible visual disturbance. The second vessel group would result in approximately 21.05 hectares of designated subtidal habitat being subject to possible visual disturbance. This represents 11.8% of the total subtidal habitat of the Ireland’s Eye SPA. This level of disturbance actually occurring is unlikely, but if it did occur this would be for a period of several days to several weeks. More realistic disturbance levels, based on possible vessel positions within the outfall pipeline corridor, will be approximately half of the worst case based on the possible vessel positions in the outfall pipeline corridor.

There is potential for connectivity between the Ireland’s Eye SPA and the surrounding subtidal habitats. Activities in the outfall pipeline corridor could result in disturbance effects on the SCI species using subtidal habitats beyond the Ireland’s Eye SPA boundary. Each element of this impact pathway will be considered in turn.

Vessel disturbance impacts could occur in non-designated water from the micro-tunnelling/subsea interface, located approximately 600m offshore from Velvet Strand beach, and terminating at the marine diffuser. With regard to dredging, two groups of vessels will be present between April and October moving along the outfall pipeline corridor, with any disturbance impacts being restricted to an area around each group of vessels. For pipeline assembly, a floating jack up platform supported by tugs and multicat vessels would be used to assemble the pipe strings and place the concrete collars. Collars would be delivered on a daily basis by ship to platform. The exact distance at which birds may be disturbed is dependent on a range of factors, with different species possessing varying sensitivity. The subsequent assessment assumes that these activities could occur simultaneously.

There is potential for connectivity between the Ireland’s Eye SPA and the terrestrial and intertidal habitats in the vicinity of Baldoyle Bay, resulting in potential disturbance effects on SCI species using habitats beyond the SPA boundary. The pathways through which an effect can occur during the construction phase is through airborne noise disturbance during the construction of the jacking shaft at both the microtunnelling compounds, and visual disturbance from the microtunnelling compounds. Piling will occur for a period of two weeks during the construction period and the resulting impact is reversible. Visual disturbance will occur in the vicinity of both microtunnelling compounds for the duration of construction. The exact distance is dependent on the species of bird in question.

The SCIs of the Ireland’s Eye SPA are considered in turn below.

Cormorant

Cormorant is considered to be of above average sensitivity to vessel traffic (Garthe and Hüppop, 2004; Furness and Wade, 2012). Despite this, evidence from Burbo Bank (CMACS, 2008) and Robin Rigg (E.ON / Natural Power, 2012) offshore wind farms has shown that densities of cormorant increased during the construction phase. Cormorant is relatively flexible with respect to habitat use (Garthe and Hüppop, 2004; Furness and Wade, 2012).

Usage of the subsea habitat in the vicinity of the proposed GDD project regularly by cormorant suggests that disturbance and displacement will occur from waters in the vicinity of the outfall pipeline corridor and marine diffuser during construction. This will occur on a short term, localised and reversible basis due to the presence of two groups of dredging vessels and a jack-up pipe laying vessel and associated support vessels (visual disturbance) and piling at the microtunnelling/subsea interface and fibre optic cable crossing (noise disturbance occurring sequentially at each location). The flexible habitat usage of this species means that birds are capable of utilising areas of sea that will be beyond the zone of influence of the (visual) vessel disturbance and (noise) piling disturbance impact pathways, and that they are not heavily dependent on the area directly within or adjacent to the outfall pipeline corridor or the marine diffuser. For any birds that are displaced, the high local availability of subtidal and coastal habitat means there is likely to be substantial alternative habitat beyond the zone of influence of the proposed GDD project which birds can continue to utilise throughout construction.

Within the Baldoyle Bay study area no birds were recorded within the zone of influence of the impact pathways identified.

No birds would be lost from the Ireland’s Eye SPA population as a result of the above impacts.

On this basis, it is considered the conservation objectives of the Ireland’s Eye SPA will be unaffected for this species and there is no adverse effect on the integrity of the site.

Herring Gull

Herring gull is a highly mobile species that spend a significant amount of time in flight (Garthe and Hüppop, 2004; Furness and Wade, 2012), and have large foraging ranges (Thaxter *et al.*, 2012). It is considered that herring gull will not be susceptible to visual vessel disturbance impacts for this reason.

Usage of the subtidal habitat in the vicinity of the proposed GDD project suggests that disturbance and displacement of herring gull could occur from waters in the vicinity of the microtunnelling/subsea interface and fibre optic cable crossing during piling. This will occur on a short term (two weeks), localised (within 100m of each location, occurring sequentially) and reversible basis. The total area of subtidal habitat affected is approximately 3 hectares.

The flexible habitat usage and highly mobile nature means that birds are capable of utilising areas of sea that will be beyond the zone of influence of the piling disturbance impact pathways, and that they are not heavily dependent on the area directly within or adjacent to these areas. For any birds that are displaced, the high local availability of subtidal habitat beyond the zone of influence of the proposed GDD project which birds can continue to utilise throughout construction.

No birds would be lost from the Ireland's Eye SPA population as a result of the above impacts.

Within the Baldoyle Bay study area birds were recorded within the zone of influence of the airborne noise and visual disturbance impact pathway. For the same reasons described above, the highly localised, temporary and reversible nature of the impact pathway could result in a temporary redistribution of a these birds, none of which would be lost from the SPA population. Indeed, it is highly likely that many of these birds will not belong to the Ireland's Eye SPA population in any case.

On this basis, it is considered the conservation objectives of the Ireland's Eye SPA will be unaffected for this species and there is no adverse effect on the integrity of the site.

Kittiwake

Kittiwake is a highly mobile species that spend a significant amount of time in flight (Garthe and Hüppop, 2004; Furness and Wade, 2012), and have large foraging ranges (Thaxter *et al.*, 2012). It is considered that kittiwake will not be susceptible to visual vessel disturbance impacts for this reason.

Usage of the subsea habitat in the vicinity of the proposed GDD project suggests that disturbance and displacement of kittiwake could occur from waters in the vicinity of the microtunnelling/subsea interface and fibre optic cable crossing during piling. This will occur on a short term (two weeks), localised (within 100m of each location, occurring sequentially) and reversible basis. For any birds that are displaced, the high local availability of subtidal habitat beyond the zone of influence of the proposed GDD project which birds can continue to utilise throughout construction. The total area of subtidal habitat affected is approximately 3 hectares.

No birds would be lost from the Ireland's Eye SPA population as a result of the above impacts.

No birds were recorded within the Baldoyle Bay study area within the zone of influence of these impact pathways. No birds would be lost from the Ireland's Eye SPA population.

On this basis, it is considered the conservation objectives of the Ireland's Eye SPA will be unaffected for this species and there is no adverse effect on the integrity of the site.

Guillemot

Guillemot is a species of medium vulnerability to vessel traffic (Garthe and Hüppop, 2004; Furness and Wade, 2012). They were the most frequently recorded bird species on the sea during the time of the year where construction vessels will be active in the outfall pipeline corridor and marine diffuser (April to October). Birds were most commonly recorded within 500m of Ireland's Eye and much less so in the outfall pipeline corridor (see Figures 6.1 and 6.2).

Usage of the subsea habitat in the vicinity of the proposed GDD project regularly by guillemot means that disturbance and displacement will occur from waters in the vicinity of the outfall pipeline corridor and marine diffuser during construction. This will occur on a short term, localised and reversible basis due to the presence of two groups of dredging vessels and a jack-up pipe laying vessel and associated support vessels (visual disturbance) and piling at the microtunnelling/subsea interface and fibre optic cable crossing (noise disturbance occurring sequentially at each location). Based on the lower numbers of birds observed in the majority of the outfall pipeline corridor, these areas of subtidal habitat are not considered to be critical to the population of this species, and there are substantial areas of alternative subtidal habitat in the local area beyond the zone of influence of these impact pathways of the proposed GDD project which birds can continue to utilise throughout the construction phase.

Survey data suggests that guillemots feed in areas beyond the zone of the influence of the Proposed Project. This is supported by the published mean foraging distance of 37.8km from colonies (Thaxter et al. 2012). Outwith the time period where guillemots leave the breeding colony (mid July to the end of July) no birds would be lost from the SPA population as a result of this impact pathway. However, within this time period birds are potentially more sensitive to disturbance and displacement impacts, and if vessel activity is not appropriately managed in this time period birds could be lost from the SPA population.

Within the Baldoyle Bay study area no birds were recorded within the zone of influence of the impact pathways identified. No birds would be lost from the Ireland’s Eye SPA population.

On this basis, it is considered the conservation objectives of the Ireland’s Eye SPA will be unaffected for this species and there is no adverse effect on the integrity of the site outwith the time period of mid July to the end of July. During this time, mitigation is required and is discussed in Section 7.2.

Razorbill

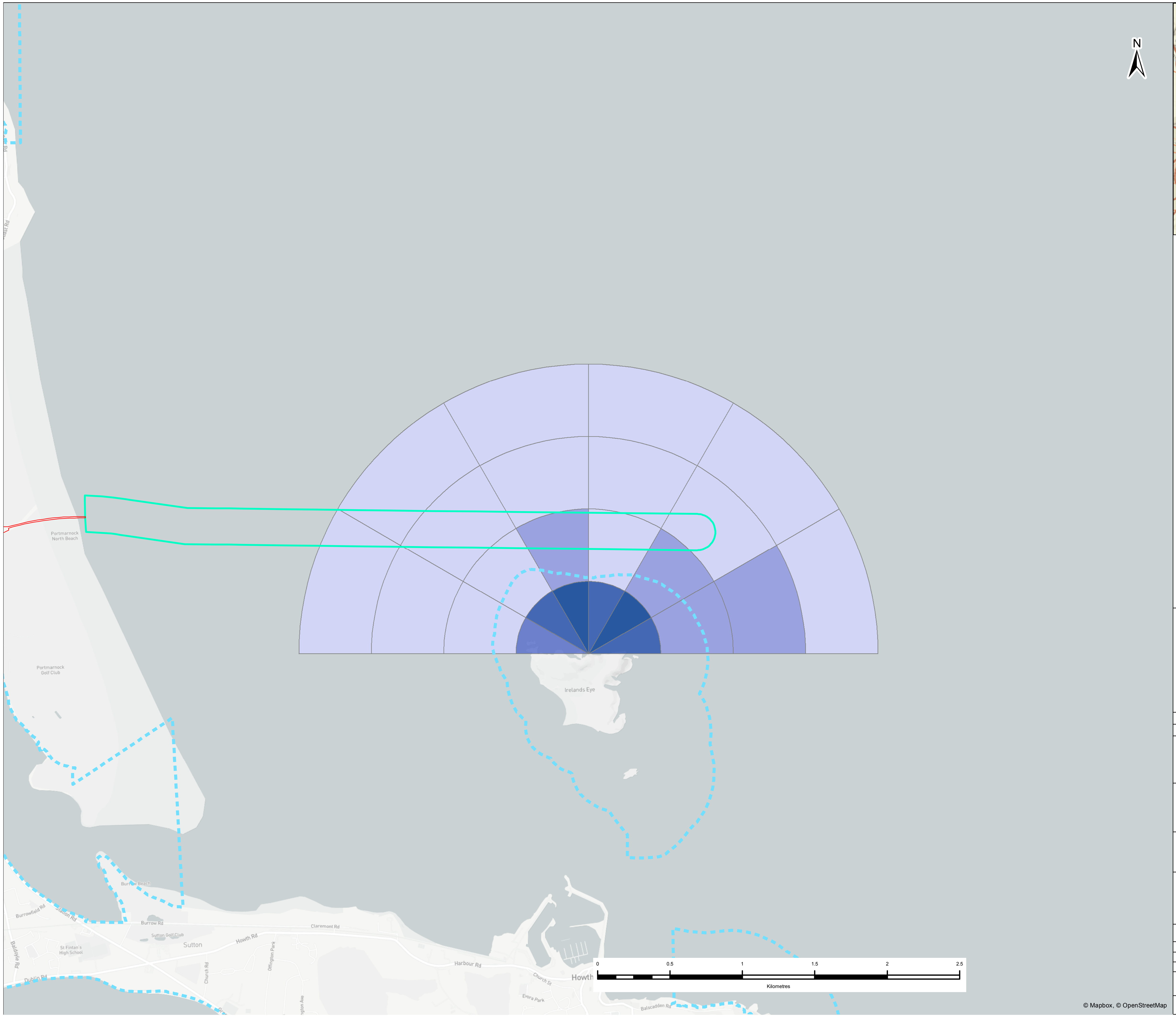
Razorbill is a species of medium vulnerability to vessel traffic (Garthe and Hüppop, 2004; Furness and Wade, 2012). They were the most frequently recorded birds on the sea during the time of the year where vessels are likely to be active in the outfall pipeline corridor and marine diffuser (April to October). Birds were most commonly recorded within 500m of Ireland’s Eye and much less so in the outfall pipeline corridor (Figures 6.3 and 6.4).

Usage of the subsea habitat in the vicinity of the proposed GDD project regularly by razorbill means that disturbance and displacement will occur from waters in the vicinity of the outfall pipeline corridor and marine diffuser during construction. This will occur on a short term, localised and reversible basis due to the presence of two groups of dredging vessels and a jack-up pipe laying vessel and associated support vessels (visual disturbance) and piling at the microtunnelling/subsea interface and fibre optic cable crossing (noise disturbance occurring sequentially at each location). Based on the lower numbers of birds observed in the majority of the outfall pipeline corridor, these areas of subtidal habitat are not considered to be critical to the population of this species, and there are substantial areas of alternative subtidal habitat in the local area beyond the zone of influence of these impact pathways of the proposed GDD project which birds can continue to utilise throughout the construction phase.

Survey data suggests that razorbills feed in areas beyond the zone of the influence of the Proposed Project. This is supported by the published mean foraging distance of 23.7km from colonies (Thaxter et al. 2012). Outwith the time period where razorbills leave the breeding colony (mid July to the end of July) no birds would be lost from the SPA population as a result of this impact pathway. However, within this time period birds are potentially more sensitive to disturbance and displacement impacts, and if vessel activity is not appropriately managed in this time period birds could be lost from the SPA population.

Within the Baldoyle Bay study area no birds were recorded within the zone of influence of the impact pathways identified. No birds would be lost from the Ireland’s Eye SPA population.

On this basis, it is considered the conservation objectives of the Ireland’s Eye SPA will be unaffected for this species and there is no adverse effect on the integrity of the site outwith the time period of mid July to the end of July. During this time, mitigation is required and is discussed in Section 7.2.



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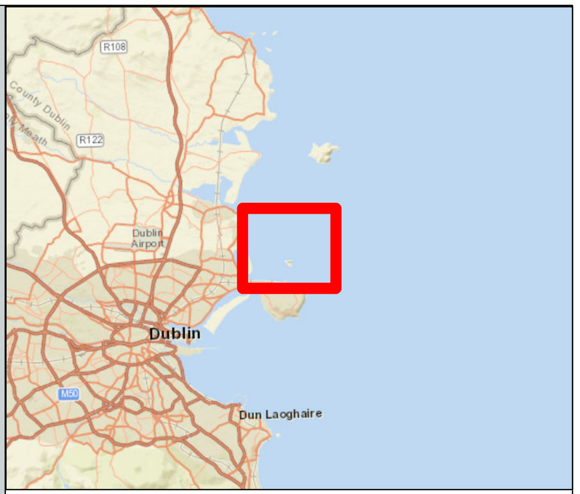

Key

🟥 Proposed Project Boundary

🟩 Proposed Outfall Pipeline Route (Marine Section)

▨ Special Protection Area

Index of Abundance

Razorbill - Not Feeding

▨	3 - 175
▨	176 - 350
▨	351 - 525
▨	526 - 700
▨	701 - 875

Greater Dublin Drainage

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
c	10/04/2018	Revision 1; infrastructure updated	CH	RI	KAG	RI

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Project

Greater Dublin Drainage Project

Drawing Title

Figure 6-1 - Distribution of Non-Feeding Razorbill Records from Ireland's Eye Vantage Point during Breeding Season (March to October)

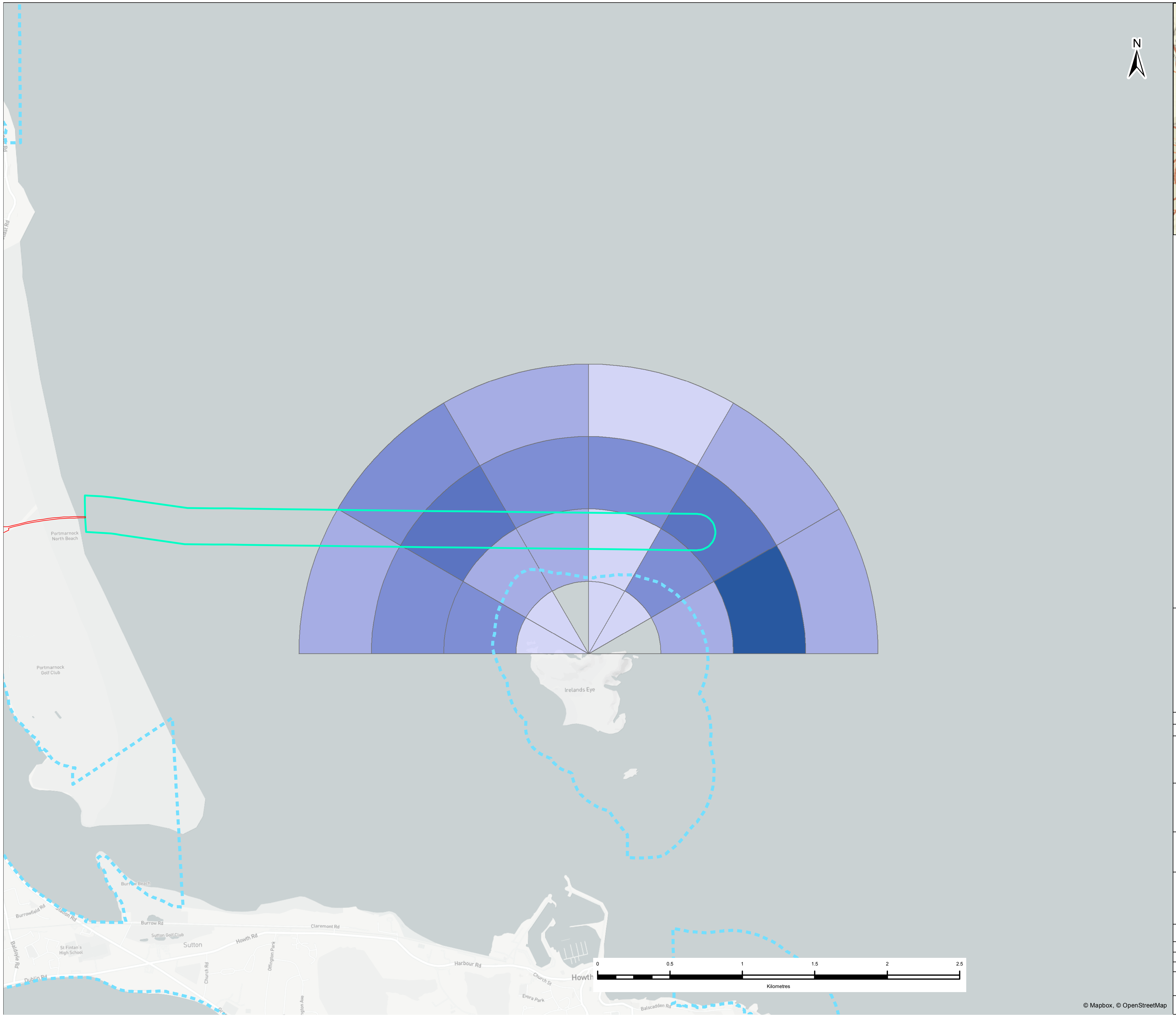
Drawing Status

Final

Scale @A3 1:25,000

Filepath W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Graphics\GIS\mxd\figures\ES_ornith\NIS\sec7909_61_RA_onWaterMarToOct_VP2_NFE.mxd

Drawing No. 32102902-EIAR-1007



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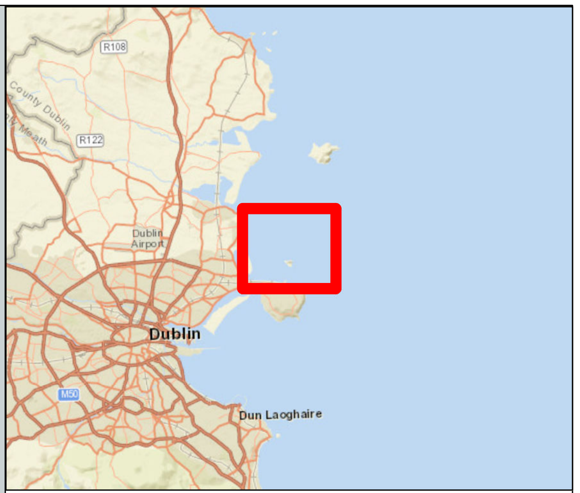

Key

▭ Proposed Project Boundary

▭ Proposed Outfall Pipeline Route (Marine Section)

▭ Special Protection Area

Index of Abundance

Guillemot - Feeding

▨ 1 - 25

▨ 26 - 50

▨ 51 - 75

▨ 76 - 100

▨ 101 - 125

▨ 126 - 150

Greater Dublin Drainage

c	10/04/2018	Revision 1; infrastructure updated	CH	RI	KAG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Project

Greater Dublin Drainage Project

Drawing Title

Figure 6-2 - Distribution of Feeding Guillemot Records from Ireland's Eye Vantage Point during Breeding Season (March to October)

Drawing Status
Final

Scale @A3 1:25,000

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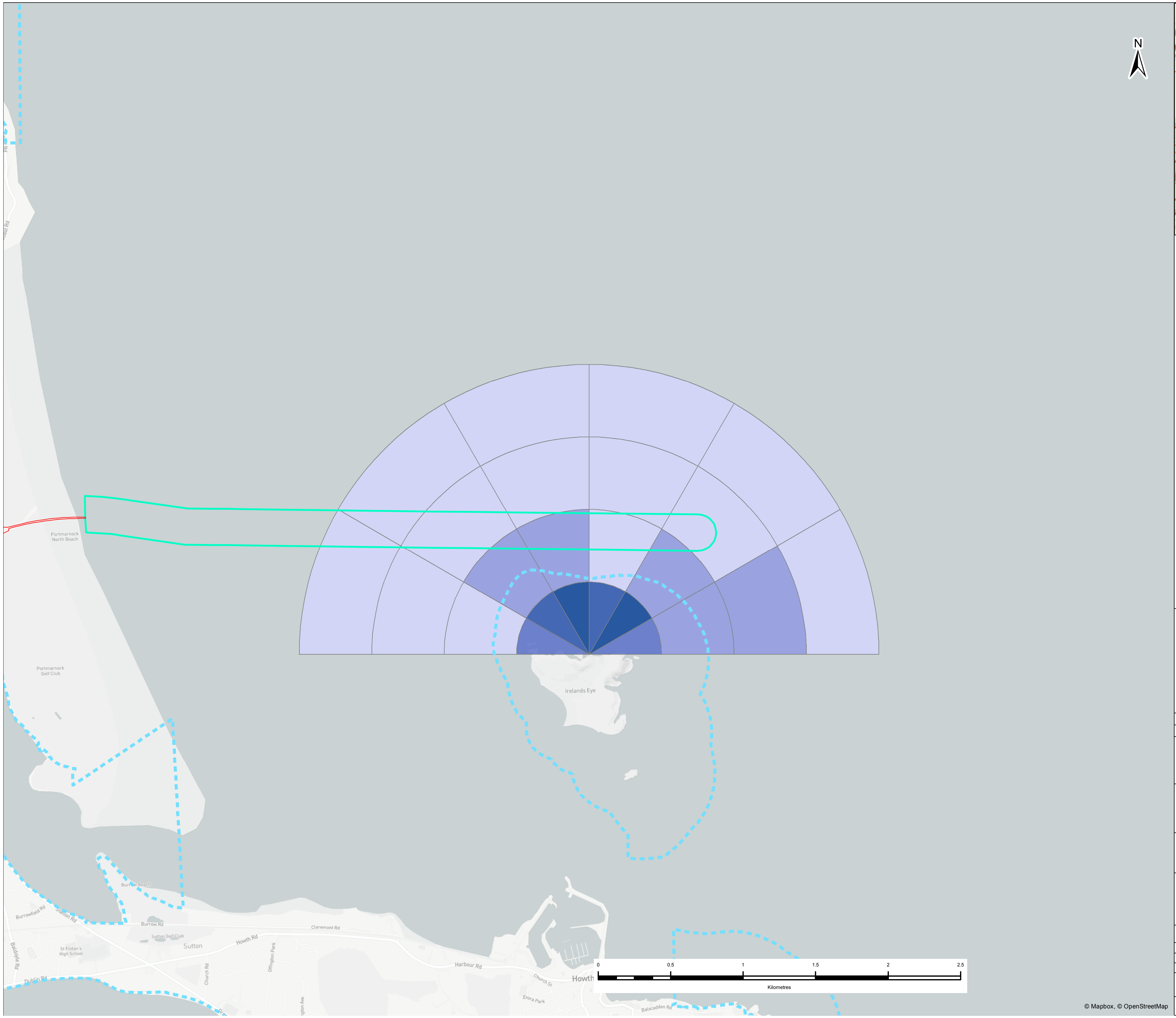
Drawing No. 32102902-EIAR-1004



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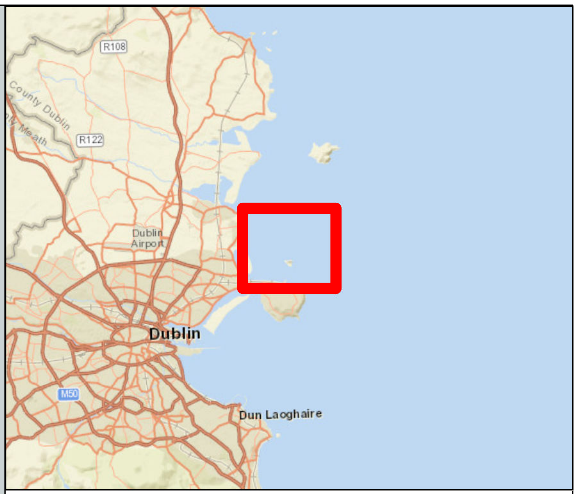

Key

- ▭ Proposed Project Boundary
- ▭ Proposed Outfall Pipeline Route (Marine Section)
- ⬚ Special Protection Area

Index of Abundance

Guillemot - Not Feeding

- ▨ 5 - 200
- ▨ 201 - 400
- ▨ 401 - 600
- ▨ 601 - 800
- ■ 801 - 1000

Greater Dublin Drainage

c	10/04/2018	Revision 1; infrastructure updated	CH	RI	KAG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Greater Dublin Drainage Project

Drawing Title

Figure 6-3 - Distribution of Non-feeding Guillemot Records from Ireland's Eye Vantage Point during Breeding Season (March to October)

Drawing Status

Final

Scale @A3 1:25,000

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Drawing No. 32102902-EIAR-1005

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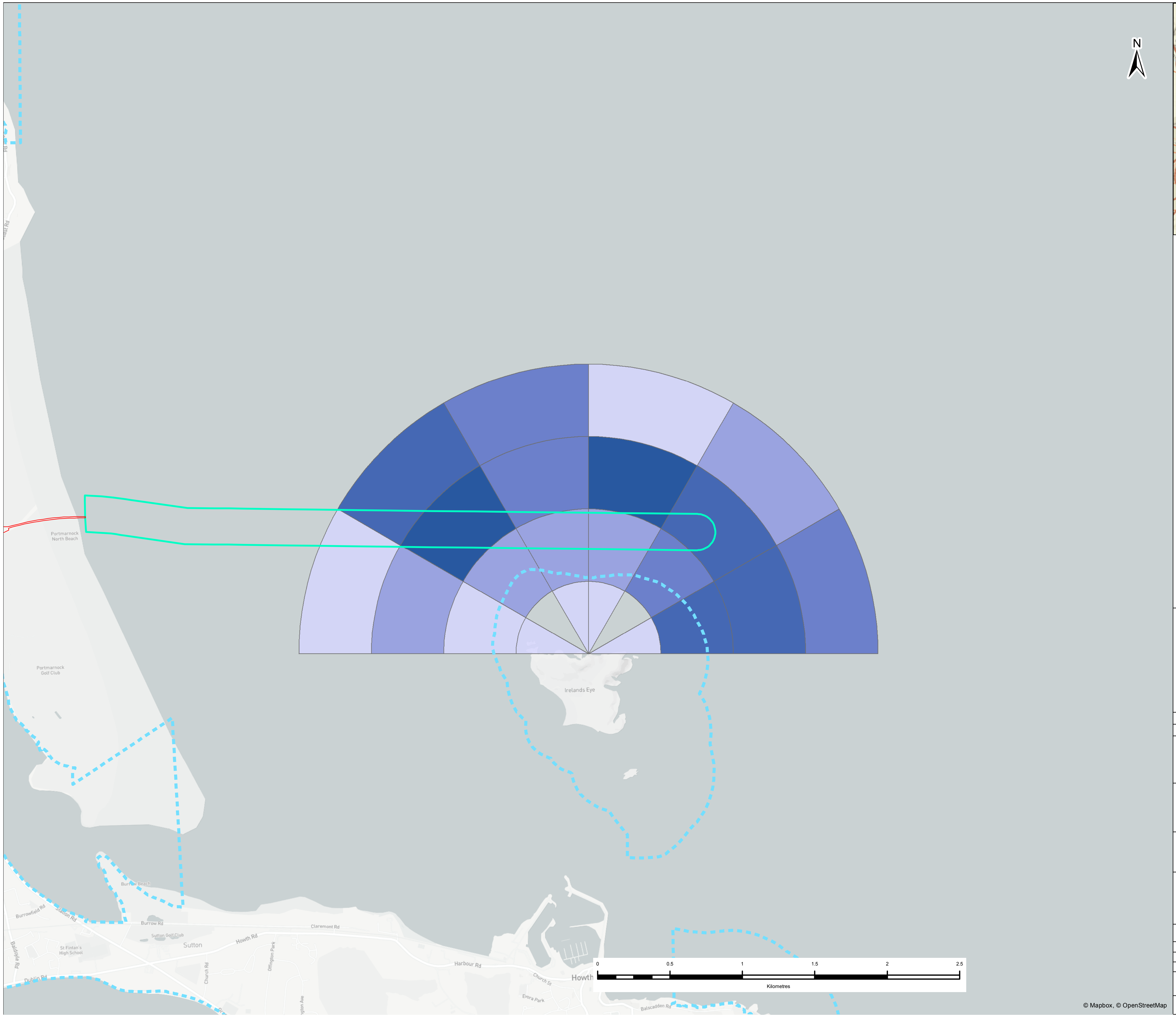

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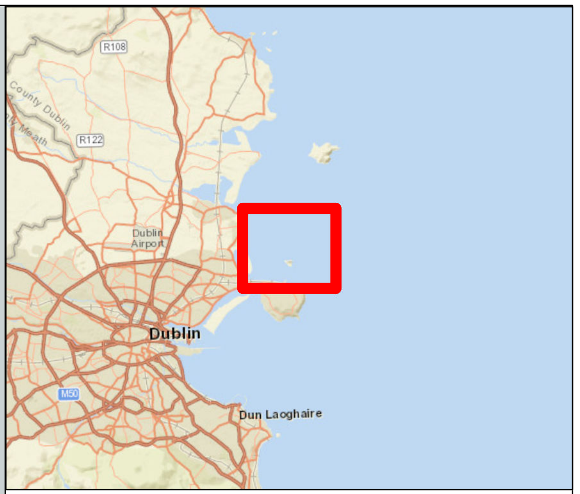

Key

🟥 Proposed Project Boundary

🟩 Proposed Outfall Pipeline Route (Marine Section)

▨ Special Protection Area

Index of Abundance

Razorbill - Feeding

▢ 1 - 20

▨ 21 - 40

■ 41 - 60

■ 61 - 80

■ 81 - 100

Greater Dublin Drainage

c	10/04/2018	Revision 1; infrastructure updated	CH	RI	KAG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Project

Greater Dublin Drainage Project

Drawing Title

Figure 6-4 - Distribution of Feeding Razorbill Records from Ireland's Eye Vantage Point during Breeding Season (March to October)

Drawing Status **Final**

Scale @A3 1:25,000

Filepath W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Graphics\GIS\mxd\figures\ES_ornith\NIS\sec7909_64_RA_onWaterMarToOct_VP2_FE.mxd

Drawing No. 32102902-EIAR-1006

6.1.3 Other European Sites

The following European Sites are all located at a minimum distance of 2.3km and maximum distance of 16.9km from the Proposed Project.

6.1.3.1 North Bull Island SPA

This SPA lies 2.3km to the south of the marine outfall (see Figure 1-1).

No noise source will propagate into this SPA at a sound power level of sufficient magnitude to potentially trigger disturbance within the SPA boundary. This includes noise from all construction activities in the terrestrial, intertidal and subtidal environments, and encompasses all activities including piling. Visual disturbance distances published by Cutts et al. (2013) indicate that these impacts will not occur at or near this SPA.

Whilst there is potential for connectivity between the North Bull Island SPA, Baldoyle Bay SPA and the surrounding terrestrial habitats, and the subtidal habitats in and adjacent to the outfall pipeline corridor, the possibility of significant numbers of birds from this SPA being impacted by the proposed GDD project by this impact pathway is considered to be remote. The reasoning for this is the fact that the birds recorded in and around the Baldoyle Bay SPA are overwhelmingly likely to be birds of the Baldoyle Bay SPA as opposed to be birds from other sites. SCI species of the North Bull Island SPA are more likely to utilise habitat within this SPA and the adjacent South Dublin Bay and River Tolka Estuary SPA, and the subsea habitats in the vicinity of these SPAs.

On this basis it is concluded that the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.1.3.2 Malahide Estuary SPA

This SPA lies 2.5km to the north of the marine outfall (see Figure 1-1).

Regarding airborne noise, no noise source will propagate into this SPA at a sound power level of sufficient magnitude to potentially trigger disturbance within the SPA boundary. This includes noise from all construction activities in the terrestrial, intertidal and subtidal environments, and encompasses all activities including piling. Visual disturbance distances published by Cutts et al. (2013) indicate that these impacts will not occur at or near this SPA.

Whilst there is potential for connectivity between the Malahide Estuary SPA, Baldoyle Bay SPA and the surrounding terrestrial habitats, and the subtidal habitats in and adjacent to the outfall pipeline corridor, the possibility of significant numbers of birds from this SPA being impacted by the proposed GDD project by this impact pathway is considered to be remote. The reasoning for this is the fact that the birds recorded in and around the Baldoyle Bay SPA are overwhelmingly likely to be birds of the Baldoyle Bay SPA as opposed to be birds from other sites. SCI species of the Malahide Estuary SPA are more likely to utilise habitat within this SPA and the adjacent subsea habitats.

On this basis it is concluded that the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.1.3.3 Howth Head Coast SPA

This SPA lies 2.6km to the south of the marine outfall (see Figure 1-1).

There are no airborne noise or visual disturbance impacts as a result of works in the subsea environment that will result in effects to SCI species inside this SPA due to the distance between this SPA and the proposed GDD project.

There is potential for connectivity between the Howth Head Coast SPA and the subtidal habitats in the vicinity of the outfall pipeline corridor. This could result in disturbance effects on the SCI species using subtidal habitats beyond the SPA boundary. Each element of this impact pathway will be considered in turn.

Airborne noise impacts in the subsea environment (where activities will result in a sound power level of >65 dB LA_{max}) are restricted to the areas where piling will be carried out at the microtunnelling/subsea interface and fibre optic cable crossing. Noise levels with the potential to impact birds are predicted to propagate up to 100m from the piling source to encompass an approximate area of 3 hectares, and are expected to last for a maximum of two weeks. They will likely be sequential in nature rather than simultaneous. The result of these works would result in the loss of approximately 3 hectares of subtidal habitat for a period not exceeding four weeks during the construction phase of the proposed GDD project.

Vessel disturbance impacts could occur from the micro-tunnelling/subsea interface, located approximately 600m offshore from Velvet Strand beach, and terminating at the marine diffuser. This will occur on a short term, localised and reversible basis due to the presence of two groups of dredging vessels and a jack-up pipe laying vessel and associated support vessels (visual disturbance), with any disturbance impacts being restricted to an area around each group of vessels. The exact distance at which birds may be disturbed is dependent on a range of factors, with different species possessing varying sensitivity.

There is no potential for connectivity between the Howth Head Coast SPA and the terrestrial and intertidal habitats in the vicinity of Baldoyle Bay due to the fact that the only SCI species is kittiwake. No birds were recorded within the Baldoyle Bay study area within the zone of influence of the impact pathways identified. No birds would be lost from the Howth Head Coast SPA population.

Kittiwake is a highly mobile species that spend a significant amount of time in flight (Garthe and Hüppop, 2004; Furness and Wade, 2012), and have large foraging ranges (Thaxter *et al.*, 2012). It is considered that kittiwake will not be susceptible to visual vessel disturbance impacts for this reason.

Usage of the subsea habitat in the vicinity of the proposed GDD project suggests that disturbance and displacement of kittiwake could occur from waters in the vicinity of the microtunnelling/subsea interface and fibre optic cable crossing during piling. This will occur on a short term (two weeks in each location), localised (within 100m of each location, occurring sequentially) and reversible basis. For any birds that are displaced, there is high local availability of subtidal habitat beyond the zone of influence of the proposed GDD project which birds can continue to utilise throughout construction.

No birds would be lost from the Howth Head Coast SPA population as a result of the above impacts.

On this basis, it is considered the conservation objectives of the Howth Head Coast SPA will be unaffected for this species and there is no adverse effect on the integrity of the site.

6.1.3.4 South Dublin Bay and River Tolka Estuary SPA

This SPA lies 7.6km to the south of the marine outfall (see Figure 1-1).

No component of the Proposed Project located north of Dublin Bay shall generate any noise source capable of propagating into this SPA at a sound power level of sufficient magnitude to potentially trigger disturbance within the SPA boundary. This includes noise from all construction activities in the terrestrial, intertidal and subtidal environments, and encompasses all activities including piling. Visual disturbance distances published by Cutts et al. (2013) indicate that these impacts will not occur at or near this SPA.

Pipeline stringing assembly and ballasting activities are proposed to be carried out at a location in Dublin Port or at adjacent river berths of the River Liffey. This activity will not occur within 100m of the SPA which includes the Tolka Estuary and marine waters between the shipping channel and the North Bull Wall, and adjacent to North Bull Island SPA.

Tern species are SCIs of this SPA and do breed in the Port. Common Terns and Arctic Terns have been known to breed in the Dublin Port area since at least 1949 (Merne 2004). Each year since 1994, they have nested on two isolated mooring dolphins situated on the south side of the port, with Common Terns almost exclusively on the ESB dolphin and Arctic Terns on the CDL dolphin. They typically arrive in April and remain within the area up until their nesting period has ended, usually around late July. The ESB dolphin comprises a wooden platform and a concrete one, which are connected by a gangway. This serves as the principal breeding site for Common Terns in Dublin Port and is included in the South Dublin Bay and River Tolka Estuary SPA. This dolphin has been managed to facilitate breeding terns since 1995, when the nesting substrate was improved by adding a layer of gravel and chick shelters, and a wooden perimeter barrier was installed. Subsequent maintenance has been undertaken on several occasions, with the most recent occurring in spring 2014. However, since 2014, there has been significant deterioration to the structural integrity of the dolphin. Due to subsidence, it was deemed unsafe to alight on the wooden section of this dolphin in 2015 and 2016, and the wooden section was demolished on safety grounds after the 2016 breeding season.

The CDL dolphin is regularly used for mooring ships, but in 2016 a wooden perimeter was affixed to the edge of the structure to prevent chicks from falling into the water when vessels were being secured. In 2013, a specially modified pontoon was floated in the Tolka Estuary and this structure (known as Pontoon No. 1) has been used by nesting terns in each year since deployment. Then, in 2015, a second, larger modified pontoon (Pontoon No. 2) was floated at the Great South Wall at Poolbeg. In spring 2016, it was relocated and moored alongside the ESB dolphin for the duration of the breeding season. This means that there are currently four structures available for nesting terns within the port.

The terns which breed in the Port area are habituated to frequent shipping traffic and smaller boats passing close to the colony locations. Monitoring of breeding success shows no significant effects of this activity on the long-term viability of the colony which has been increasing during the period 1995-2014. This is a busy and noisy operational Port. Pipe stringing activities are to be prohibited within 100m of a tern nesting site. Therefore it is considered reasonable to conclude that due to the nature of the activity (floating and fixing pipe sections in the water using work boats and operatives in an operational port context), and distance of the activity (>100m) from any tern nesting location or wading and waterbird feeding or roosting area, that there will not be any aerial noise or visual stimuli generating behavioural changes amounting to:

- disturbance in any wading or waterbird in the SPA,
- disturbance to any tern at their breeding site, or
- loss of attractiveness of the tern nesting sites.

Whilst there is potential for connectivity between the South Dublin Bay and River Tolka Estuary SPA, Baldoyle Bay SPA and the surrounding terrestrial habitats, and the subtidal habitats in and adjacent to the outfall pipeline corridor, the possibility of significant numbers of birds from this SPA being impacted by the Proposed Project by this impact pathway is considered to be remote. The reasoning for this is the fact that the birds recorded in and around the Baldoyle Bay SPA are overwhelmingly likely to be birds of the Baldoyle Bay SPA as opposed to be birds from other sites. SCI species of the South Dublin Bay and River Tolka Estuary SPA are more likely to utilise habitat within this SPA and the adjacent subsea habitats.

On this basis it is concluded that the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.1.3.5 Rogerstown Estuary SPA

This SPA lies 8.5km to the north of the marine outfall (see Figure 1-1).

Regarding airborne noise, no noise source will propagate into this SPA at a sound power level of sufficient magnitude to potentially trigger disturbance within the SPA boundary. This includes noise from all construction activities in the terrestrial, intertidal and subtidal environments, and encompasses all activities including piling. Visual disturbance distances published by Cutts et al. (2013) indicate that these impacts will not occur at or near this SPA.

Whilst there is potential for connectivity between the Rogerstown Estuary SPA, Baldoyle Bay SPA and the surrounding terrestrial habitats, and the subtidal habitats in and adjacent to the outfall pipeline corridor, the possibility of significant numbers of birds from this SPA being impacted by the proposed GDD project by this impact pathway is considered to be remote. The reasoning for this is the fact that the birds recorded in and around the Baldoyle Bay SPA are overwhelmingly likely to be birds of the Baldoyle Bay SPA as opposed to be birds from other sites. SCI species of the Rogerstown Estuary SPA are more likely to utilise habitat within this SPA and the adjacent subsea habitats.

On this basis it is concluded that the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.1.3.6 Lambay Island SPA

This SPA lies 9.3km to the northeast of the marine outfall (see Figure 1-1).

There are no airborne noise or visual disturbance impacts as a result of works in the subsea environment that will result in effects to SCI species inside this SPA due to the distance between this SPA and the proposed GDD project.

There is potential for connectivity between the Lambay Island SPA and the subtidal habitats in the vicinity of the outfall pipeline corridor. This could result in disturbance effects on the SCI species using subtidal habitats beyond the SPA boundary. Each element of this impact pathway will be considered in turn.

Airborne noise impacts in the subsea environment (where activities will result in a sound power level of >65 dB LA_{max}) are restricted to the areas where piling will be carried out at the microtunnelling/subsea interface and fibre optic cable crossing. Noise levels with the potential to impact birds are predicted to propagate up to 100m from the piling source to encompass an approximate area of 3 hectares, and are expected to last for a maximum of two weeks. They will likely be sequential in nature rather than simultaneous. The result of these works would result in the loss of approximately 3 hectares of subtidal habitat for a period not exceeding four weeks during the construction phase of the proposed GDD project.

Vessel disturbance impacts could occur from the micro-tunnelling/subsea interface, located approximately 600m offshore from Velvet Strand beach, and terminating at the marine diffuser. This will occur on a short term, localised and reversible basis due to the presence of two groups of dredging vessels and a jack-up pipe laying vessel and associated support vessels (visual disturbance), with any disturbance impacts being restricted to an area around each group of vessels. The exact distance at which birds may be disturbed is dependent on a range of factors, with different species possessing varying sensitivity.

There is no potential for connectivity between the Lambay Island SPA and the terrestrial and intertidal habitats in the vicinity of Baldoyle Bay. This is due to the distance between this SPA and the proposed GDD project, meaning that the possibility of SCI species present in the zones of impact being birds of this SPA is highly remote.

No birds would be lost from the Lambay Island SPA population as a result of the above impacts.

On this basis, it is considered the conservation objectives of the Lambay Island SPA will be unaffected for this species and there is no adverse effect on the integrity of the site.

6.1.3.7 Dalkey Island SPA

This SPA lies 14.9km to the south of the marine outfall (see Figure 1-1).

There are no airborne noise or visual disturbance impacts as a result of works in the subsea environment that will result in effects to SCI species inside this SPA.

There is potential for connectivity between the Dalkey Island SPA and the subtidal habitats in the vicinity of the outfall pipeline corridor. This could result in disturbance effects on the SCI species using subtidal habitats beyond the SPA boundary. Each element of this impact pathway will be considered in turn.

Airborne noise impacts in the subsea environment (where activities will result in a sound power level of >65 dB LA_{max}) are restricted to the areas where piling will be carried out at the microtunnelling/subsea interface and fibre optic cable crossing. Noise levels with the potential to impact birds are predicted to propagate up to 100m from the piling source to encompass an approximate area of 3 hectares, and are expected to last for a maximum of two weeks. They will likely be sequential in nature rather than simultaneous. The result of these works would result in the loss of approximately 3 hectares of subtidal habitat for a period not exceeding four weeks during the construction phase of the proposed GDD project.

Vessel disturbance impacts could occur from the micro-tunnelling/subsea interface, located approximately 600m offshore from Velvet Strand beach, and terminating at the marine diffuser. This will occur on a short term, localised and reversible basis due to the presence of two groups of dredging vessels and a jack-up pipe laying vessel and associated support vessels (visual disturbance), with any disturbance impacts being restricted to an area around each group of vessels. The exact distance at which birds may be disturbed is dependent on a range of factors, with different species possessing varying sensitivity.

There is no potential for connectivity between the Dalkey Island SPA and the terrestrial and intertidal habitats in the vicinity of Baldoyle Bay. This is due to the distance between this SPA and the proposed GDD project, meaning that the possibility of SCI species present in the zones of impact being birds of this SPA is highly remote.

No birds would be lost from the Dalkey Island SPA population as a result of the above impacts.

On this basis, it is considered the conservation objectives of the Dalkey Island SPA will be unaffected for this species and there is no adverse effect on the integrity of the site.

6.1.3.8 Skerries Islands SPA

This SPA lies 16.7km to the north of the marine outfall (see Figure 1-1).

Regarding airborne noise, no noise source will propagate into this SPA at a sound power level of sufficient magnitude to potentially trigger disturbance within the SPA boundary. This includes noise from all construction activities in the terrestrial, intertidal and subtidal environments, and encompasses all activities including piling. Visual disturbance distances published by Cutts et al. (2013) indicate that these impacts will not occur at or near this SPA.

Whilst there is potential for connectivity between the Skerries Islands SPA, Baldoyle Bay SPA and the surrounding terrestrial habitats, and the subtidal habitats in and adjacent to the outfall pipeline corridor, the possibility of significant numbers of birds from this SPA being impacted by the Proposed Project by this impact pathway is considered to be remote. The reasoning for this is the fact that the birds recorded in and around the Baldoyle Bay SPA are overwhelmingly likely to be birds of the Baldoyle Bay SPA as opposed to be birds from other sites. SCI species of the Skerries Islands SPA are more likely to utilise habitat within this SPA and the adjacent subsea habitats.

On this basis it is concluded that the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.1.3.9 Rockabill SPA

This SPA lies 16.9km to the north of the marine outfall (see Figure 1-1).

Regarding airborne noise, no noise source will propagate into this SPA at a sound power level of sufficient magnitude to potentially trigger disturbance within the SPA boundary. This includes noise from all construction activities in the terrestrial, intertidal and subtidal environments, and encompasses all activities including piling. Visual disturbance distances published by Cutts et al. (2013) indicate that these impacts will not occur at or near this SPA.

Whilst there is potential for connectivity between the Rockabill SPA, Baldoyle Bay SPA and the surrounding terrestrial habitats, and the subtidal habitats in and adjacent to the outfall pipeline corridor, the possibility of significant numbers of birds from this SPA being impacted by the proposed GDD project by this impact pathway is considered to be remote. The reasoning for this is the fact that the birds recorded in and around the Baldoyle Bay SPA are overwhelmingly likely to be birds of the Baldoyle Bay SPA as opposed to be birds from other sites. SCI species of the Rockabill SPA are more likely to utilise habitat within this SPA and the adjacent subsea habitats.

On this basis it is concluded that the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.2 Impact Pathway - Water Quality and Habitat Deterioration

6.2.1 Baldoyle Bay SAC

Based on the information contained in Section 4 there are three potential pathways for LSEs to occur on this SAC; water quality and habitat deterioration, which is discussed here in Section 6.2.1, underwater noise and disturbance, information on which is provided in Section 6.3.1. and habitat loss (see Section 6.4.1).

The proposed marine outfall pipeline passes directly through Baldoyle Bay SAC in a tunnel. The Bay is also discharged into by the Mayne River. This river, along with its tributary the Cuckoo stream, will both be crossed by the orbital sewer just north of the M50 and south of Ballystruan. A satellite compound will be located at the Old Airport Road / R132 Swords Road junction (the Collinstown Crossroads) and will be located approximately 650m from the Mayne River, and approximately 235m from the Cuckoo Stream. The WwTP lies directly south of the Cuckoo Stream.

6.2.1.1 Conservation Objectives

Baldoyle Bay SAC has four SCIs. Table 6-6 sets out the conservation objectives for each SCI.

Table 6-6: Conservation objectives for Baldoyle Bay SAC (NPWS, 2012a)

Habitat	Habitat Code	Conservation objective
1310,	1140	Maintain the favourable conservation condition.
Attribute	**Measure**	**Target**
Area	Habitat area was estimated as 409ha using OSi data	The permanent habitat area is stable or increasing, subject to natural processes.
Distribution	The site exhibits the following community complexes: Fine sand dominated by *Angulus tenuis* and Estuarine sandy mud with *Pygospio elegans* and *Tubificoides benedii.*	Conserve these community types in a natural condition:
Salicornia and other annuals colonising mud and sand	1310	Maintain the favourable conservation condition.
Attribute	**Measure**	**Target**
Area	Mosaic of habitat 0.383 Ha	The area should be stable or increasing, subject to natural processes, including erosion and succession.
Distribution	There are five main areas of saltmarsh in the SAC. Several patches of *Salicornia* habitat located on both sides, towards the lower end of the estuary.	No decline or change in the distribution of these saltmarsh habitats, unless it is the result of natural processes, including erosion, accretion and succession.
Atlantic salt meadows *Glauco-Puccinellietalia maritimae (ASM)*	1330	Maintain the favourable conservation condition.
Attribute	**Measure**	**Target**
Area	Mosaic of habitat 11.976 Ha	The area should be stable or increasing, subject to natural processes, including erosion and succession.
Distribution	There are five main areas of saltmarsh in the SAC. The main area occurs in the north-west corner of the estuary and to the south of the estuarine river channel. This area contains the largest area of ASM. ASM habitat dominates the older area and is covered by spring tides in Baldoyle Estuary.	No decline or change in the distribution of these saltmarsh habitats, unless it is the result of natural processes, including erosion, accretion and succession.
Mediterranean salt meadows *Juncetalia maritime* (MSM)	1410	Maintain the favourable conservation condition.
Attribute	**Measure**	**Target**
Area	Mosaic of habitat 2.636 Ha	The area should be stable or increasing, subject to natural processes, including erosion and succession.

Habitat	Habitat Code	Conservation objective
1310,	1140	Maintain the favourable conservation condition.
Attribute	**Measure**	**Target**
Area	Habitat area was estimated as 409ha using OSi data	The permanent habitat area is stable or increasing, subject to natural processes.
Distribution	The site exhibits the following community complexes: Fine sand dominated by *Angulus tenuis* and Estuarine sandy mud with *Pygospio elegans* and *Tubificoides benedii.*	Conserve these community types in a natural condition:
Salicornia and other annuals colonising mud and sand	1310	Maintain the favourable conservation condition.
Distribution	There are five main areas of saltmarsh in the SAC. The main area occurs in the north-west corner of the estuary and to the south of the estuarine river channel. This area contains a band of MSM on its landward side. The MSM habitat is characterised by clumps of sea rush (*Juncus maritimus*) and is found in small scattered clumps along the landward side of most of the saltmarsh.	No decline or change in the distribution of these saltmarsh habitats, unless it is the result of natural processes, including erosion, accretion and succession.

6.2.1.2 Relevant Baseline Information

Information on the habitat mapping for Baldoyle Estuary is provided in Section 5.1.4. Section 5.2.2 provides details on water quality and the construction and operational plumes.

6.2.1.3 Assessment

The following Likely Significant Effects were identified as part of the screening assessment.

6.2.1.3.1 Pollution Incidents & Elevated Suspended Sediments from Upstream Activities

The potential for LSEs to the SAC are limited to indirect impacts where deterioration occurs through the accidental release of contaminated run-off into the estuary from the tunnelling compounds or construction works upstream, surface water drainage of which flows into the Mayne River catchment and eventually into Baldoyle Bay.

The three saltmarsh related qualifying habitats within the estuary (i.e. Salicornia and other annuals colonizing mud and sand; Atlantic and Mediterranean salt meadows) are all located on the upper parts of the estuary and are surrounded by existing erosion channels below the level of the habitat. The main channel, fed by the Sluice River in the north, and met by the Mayne River along the western shoreline, meanders along the central part of the estuary below the main vegetation zone. The tidal range within the estuary is 4.1m during spring high waters, with the saltmarsh only surrounded by water during the upper third of the tidal cycle, and only covered by estuarine waters during high water spring events. Consequently, the main saltmarsh is largely unaffected by the water quality during the majority of the tidal cycle and from riverine inputs for significant period of time. When a spring high water event occurs, the overall volume of Baldoyle Bay increases by approximately 1.5 million cubic meters due to the additional 80cm rise in tidal height, increasing the dilution effect of any pollutant within the estuary during this period.

Pollution events that may occur upstream during construction or from the adjacent compounds are deemed to be of low risk, with mitigation applied within the CEMP to trap or isolate discharges where they are likely to occur. However, in the event that a small pollution event does occur, the likely route for this material into the estuary would be the existing eroded riverine flow channels within the estuary which remain away from the main saltmarsh areas. In the event that the estuary is at high water during a spring event suspended sediment material may be dispersed onto qualifying saltmarsh habitats but the high volume of seawater within the estuary will produce significant mixing and dilute this material to a negligible level of impact. Consequently there would be no risk from a smothering impact. Should a pollution event include hydrocarbons, then these would remain at the surface of the river input which will remain within the freshwater riverine flow away from the saltmarsh during low water periods. As with suspended sediments, this material will be widely dispersed and diluted during high water periods.

Overall the risk of impact from the compound to the three qualifying saltmarsh habitats is expected to be negligible because any run-off during low water periods would drain quickly into the central channels away from the salt marsh habitat, or be diluted significantly during high water periods where it would be diluted quickly by the increased volume of water in the estuary. On this basis, it is considered the conservation objectives of maintaining a stable habitat (subject to natural processes) and to prevent decline or change in the distribution of these saltmarsh habitats within the Baldoyle Bay SAC will be unaffected and there would be no adverse effect on the integrity of the site.

In addition to the saltmarsh habitats, Baldoyle Bay SAC is also designated for Mudflats and sandflats not covered by seawater at low tide (1140), located throughout the whole of the Bay and a section of coastline named the Velvet Strand along the Portmarnock coastline. The properties of supporting sediments within this habitats varies from fine sand dominated by *Angulus tenuis* and *Tubificoides benedii* in the mouth and along the eastern shoreline and Estuarine sandy mud with *Pygospio elegans* within the bay, based on changes in the hydrodynamic regime within the SAC.

The pathway of possible discharges described above would be directly over this qualifying interest, but the permanent habitat area is stable or increasing, subject to natural processes. As stated in section 2 of the Conservation Objectives supporting document – Marine Habitats for the Baldoyle Bay SAC, "Some activities may cause significant disturbance but may not necessarily represent a continuous or ongoing source of disturbance over time and space. This may arise for intermittent or episodic activities for which the receiving environment would have some resilience and may be expected to recover within a reasonable timeframe relative to the six-year reporting cycle (as required under Article 17 of the Directive)". As the nature and scale of possible contamination to the site from upstream activities is deemed to be rare, minor and very short lived, it is concluded that the resilience of the receiving habitat is such that that this potential would have a negligible impact within the designated site. Consequently, the qualifying interest and conserving the community type in a natural condition will not be impacted by any likely pollution events and therefore will not impact the integrity of the Baldoyle Bay SAC.

6.2.1.3.2 Suspended Sediment arising from Dredging or Piling Plume

Details of the plume created during the dredging and piling at the interface and cable crossing points for the construction of the marine outfall are outlined in section 5.2.2. Results indicate that the plume created by the controlled discharge of dredged spoil does not impact the Baldoyle Estuary or the coastal area along Velvet Strand within the SAC. There will therefore be no impact from dredging on the Baldoyle Bay SAC.

6.2.1.3.3 Bentonite Release

The risk of a surface breakout by bentonite drilling fluid cannot be negated completely due to variability in the underlying geology. Bentonite is used during the drilling operation to lubricate during micro-tunnelling or TBM progress during construction and is pumped into the cuttings annulus during operations at the ambient pressure at the rock face. A detailed geophysical survey has been carried out along the proposed route in order to anticipate the risk of weak formations and possible faults that may increase the risk of a bentonite breakout. However, should the TBM encounter voids within the formation (such as a fissure or weathered area of rock), and then material can be forced to the surface under pressure to create a breakout. In the littoral and sub-littoral environments, the presence of bentonite at the surface can have a notable impact on sediment turbidity and suspended load. This increase in turbidity could result in increased siltation and the smothering of sediments and organisms accompanied by a reduction in the light available to the seabed for photosynthesis.

The use of bentonite is outlined in the CEMP (see Volume 2 Part B Appendices). All bentonite usage will be monitored though materials balance calculations, pressure monitoring in the lines and above ground visual assessment of the works to ensure that should breakout occur the volume is minimised. This will limit the volume of any bentonite losses significantly. The depth of the micro-tunnelling route beneath the estuary means that the likelihood of a bentonite breakout making it to the surface of the estuary is very low; however the result of a breakout may result in a small discharge to the surface. If this occurs in the channel or open water environments, then this material will disperse harmlessly. If this occurs within the saltmarsh vegetation, then this material is unlikely to disperse quickly due to the lack of tidal flow in these areas, and may require some intervention to recover and disperse to avoid any significant deposit completely smothering a small area of vegetation. Mitigation is proposed Section 7.

The impacts of increased turbidity are likely to be minimal in the overall context of Baldoyle Bay as the water depth is extremely shallow and the natural suspended sediment very fine in nature. Bentonite is naturally occurring and non-toxic to marine benthic fauna. In the unlikely event of a bentonite breakout, a small quantity of this suspended clay escaping into the water course may produce a localised plume of limited size and duration which may induce some avoidance behaviour by some non-qualifying species (i.e. fish and seals,) within the area, but will have a negligible impact on benthic communities found within the SAC. The fine sand dominated by *Angulus tenuis* community below the exposed beach of the outer estuary and along Velvet Strand contains little fines (<1%) due to sediment mobility through wave action along the beach and shallow waters. This will prevent the settlement of any suspended sediment fines released within a bentonite plume. The estuarine sandy mud with *Pygospio elegans* and *Tubificoides benedii* are naturally high in sediment fines (>50%) and naturally found in high turbidity and organically enriched sedimentary environments. Any additional settlement from a bentonite plume will be temporary within the tidal areas through erosion from currents and as residual material is reworked into the sediments through benthic bioturbation (i.e. the disturbance of deposits by living organisms).

Exposure to a possible bentonite breakout to the *Salicornia* and other annuals colonising mud and sand; Atlantic and Mediterranean salt meadows (1310, 1330 and 1410) is very small, with any impact likely to be very localised (1-2m radius). Bentonite is highly viscous and where breakouts have occurred, have vented through fissures or localised weaknesses in the soil overburden to create an isolated dome shaped patch of limited size both above or below the water line. If lower enough on the shorelines, then this material will harmlessly disperse into the estuary during part of the tidal flow, but may remain in a localised areas where the tidal waters do not reach. In this instance, should the bentonite cover the foliage of the saltmarsh, then the site may require intervention to mitigate on any lasting impacts through smothering. This may involve partial recovery of bentonite or enhanced dispersion through washing the bentonite clear of the surface vegetation, subject to the size of the breakout. As the saltmarsh naturally relies heavily on the presence of suspended sediments routinely washing over the vegetation and accretion of the marsh surface. The occurrence of sediment-loaded water seawards of the saltmarsh is thus the prerequisite for the continued growth and survival of the marsh (Boorman, 2003). Therefore, this environment is routinely exposed to naturally high turbidity on a tidal and seasonal basis, the vegetation would not be prone to impact in all but significant breakout events where the vegetation itself is completely covered. Through the mitigation activities outlined above the avoidance of a smothering impact can be achieved so as not to impact on the integrity of the saltmarsh and therefore not compromise the conservation objective for these qualifying habitats to maintaining a stable habitat (subject to natural processes) and to prevent decline or change in the distribution of these saltmarsh habitats.

As stated in section 2 of the Conservation Objectives supporting document – Marine Habitats for the Baldoyle Bay SAC, *“Some activities may cause significant disturbance but may not necessarily represent a continuous or ongoing source of disturbance over time and space. This may arise for intermittent or episodic activities for which the receiving environment would have some resilience and may be expected to recover within a reasonable timeframe relative to the six-year reporting cycle (as required under Article 17 of the Directive)”.* As the nature and scale of possible contamination to the site from a bentonite release to the surface is deemed to be rare, minor and very short lived, it is concluded that the resilience of the receiving habitat is such that that this potential would have a negligible impact within the designated site. Consequently, the qualifying interest and conserving the community type in a natural condition will not be impacted by any likely pollution events and therefore not impact the integrity of the Baldoyle Bay SAC.

6.2.1.3.4 Surface Venting (Air Breakout)

The proposed Tunnel Boring Machine (TBM) to be used in the micro-tunnelling is expected to be 2m in diameter with a standard arrangement employed in the construction of this tunnel. As compressed air is used within the TBM to maintain an slight positive pressure, this can occasionally escape to the surface through trickle of air bubbles and create a small areas of surface sediment loss through liquefaction and winnowing of fines in prevailing marine currents. Whilst this does not have a chemical impact on the surrounding sediments, this can create a small area of physical impact to the SAC and qualifying interests of shallow sand and mudflats habitat (1140) in the form of a small pock mark or shallow crater. This may have a very localised impact on the sediments, particularly where they have limited cohesion (i.e. sands and silts making up the main part of the estuary). This is not the case in and around saltmarsh areas (1310, 1330 and 1410) that have significant sediment cohesion and are strengthened by the vegetation itself.

Should this unlikely event occur, it may create some temporary minor depression in a very small area (<1-3m^2) in the main part of the estuary, but an imperceptible impact if located within the area of saltmarsh vegetation.

There will be no net loss in habitat or impact on the integrity of any of the qualifying habitats. The pathway of possible discharges described above would be directly beneath these qualifying interests, but the permanent habitat area is stable or increasing, subject to natural processes and the natural condition will not be impacted by this unlikely event.

6.2.1.3.5 Discharge Plume – Operational Stage

Details of the effluent discharge qualities modelled during the operational phase are outline in section 5.2.2. Results indicate that the plume created by the effluent discharge will be subject to significant dispersion with a 20 fold dilution obtained within 50m of the diffuser and between 33 and 100 fold dilution within 500m of the diffuser. This means that the effluent will not impact Baldoyle Bay SAC.

6.2.1.3.6 Overall Assessment Findings

On the basis of the above assessments, it is concluded that the conservation objectives for the SCIs of this SAC are not compromised, and there is no adverse effect on site integrity.

6.2.2 Rockabill to Dalkey Island SAC

The Rockabill to Dalkey Island SAC The marine outfall pipeline passes into 1,300m of the SAC and the marine diffuser lies within the SAC.

Based on the information contained in Section 4 there are three potential pathways for LSEs to occur on this SAC; water quality and habitat deterioration, which is discussed here in Section 6.2.2, underwater noise and disturbance, information on which is provided in Section 6.3.2. and habitat loss (see Section 6.4.2).

6.2.2.1 Conservation Objectives

Intertidal and Subtidal Reef Communities

The targets set for the conservation objectives for the qualifying interest of subtidal and intertidal reef habitats found in Rockabill to Dalkey Island SAC, are listed below in Table 6-7. These have defined attributes and targets along with the estimated areas of each community type within the Annex I habitat, based on interpolation.

Table 6-7: Conservation objective for reefs within the Rockabill to Dalkey Island SAC (NPWS, 2013d)

Habitat	1170	Intertidal reef community complex
Conservation objective	To maintain the favourable conservation condition of Reefs in Rockabill to Dalkey Island SAC, which is defined by the following list of attributes and targets	
Attribute	**Measure**	**Target**
Area	The current area is highly interpolated as Intertidal (10ha) and subtidal (172ha) reef community complex. Activities or operations that permanently remove habitat from the site Significant continuous or ongoing disturbance of communities should not exceed 15% of the interpolated area of each community type.	The permanent area is stable or increasing, subject to natural processes.
Distribution		The distribution of reefs is stable or increasing, subject to natural processes.

Harbour Porpoises (Annex II)

The targets set for the conservation objectives for the qualifying interest of Annex II species found in Rockabill to Dalkey Island SAC, are listed below in Table 6-8. These have defined attributes and targets along with the estimated areas of each community type within the Annex I habitat, based on interpolation.

Table 6-8: Conservation objective for harbour porpoise within the Rockabill to Dalkey Island SAC

Species	Annex II species	Harbour porpoise (*Phocoena phocoena*)
Conservation objective	To maintain the favourable conservation condition of harbour porpoise in Rockabill to Dalkey Island SAC, which is defined by the following list of attributes and targets	
Attribute	**Measure**	**Target**
Range	Prevent permanent access for the species to suitable habitat and does not refer to short-term or temporary restriction of access or range.	Species range within the site should not be restricted by artificial barriers to site use.
Anthropogenic Activities	Activities that introduce man-made energy (i.e. noise, light etc.) that could result in a significant negative impact or operations that may result in the deterioration of key resources (e.g. water quality, feeding, etc.).	Human activities should occur at levels that do not adversely affect the harbour porpoise community at the site.

6.2.2.2 Relevant Baseline Information

Baseline data relating to the two qualifying interest are summarised in Section 5.1.5 for the Annex I habitat of Reefs (1170) found at Ireland's Eye, or Section 5.1.6 the presence of Annex II species of harbour porpoise found within close vicinity of the proposed marine outfall route. Section 5.2.2 provides details on water quality and the construction and operational plumes.

6.2.2.3 Assessment

The following Likely Significant Effects were identified as part of the screening assessment.

6.2.2.3.1 Pollution Incidents

There is a risk of a release of pollutants during construction as a result of accidental spillages and site run-off. During construction activities, vessel operations and movements may increase risk of pollution incidents. During the construction, the most significant level of vessel activity would be during the dredging, piling, stringing and deployment of the outfall pipeline to the seafloor.

This risk will be managed though the CEMP to ensure the likelihood is low. There will be effective measures in place in the event that a pollution incident does occur to prevent any wide reaching or long term adverse effects. Unmanaged, these effects could prevent the maintenance of the favourable conservation condition of *the Annex I habitats* in the SAC. Mitigation is required, and an adverse effect on the integrity of the Site is not predicted as a result of pollution incidents from marine plant with suitable mitigation in place.

6.2.2.3.2 Suspended Sediment Arising from Dredging or Piling Plume

Intertidal and Subtidal Reef Communities

Scientific investigations of the Reefs within the SAC in 2015 identified diverse biological populations, consistent with this habitat type and area. However, no species of particular conservation interest were noted during the studies with any rare or particularly fragile biotopes recorded. The natural siltation levels were high in the sublittoral environment, a fact that has not appeared to have had a significant impact to the biological diversity around the island. Whilst, siltation levels are already high in the sublittoral environment, a significant increase in suspended sediment over a prolonged period, particularly during the summer months during peak algal growth, could potentially cause some damage to the algal biotopes present through reduced light penetration and availability. A model of the plume created along the marine section of the proposed route during dredging is outlined in Section 5.2.2. This is based on a discharge schedule limited to a discharge during a flooding tide so as to limit the initial settlement of material towards the north and away from the reef features within the SAC. These results indicate that the resulting suspended sediments created by the discharge of spoil has been limited to a northern deposition and generally localised elevation when discharged in a controlled manner during the flooding part of the tidal cycle. This has resulted in no significant plume being recorded close to the reef related qualifying interest of the SAC recorded around the Ireland's Eye northern and eastern coastlines. One small exception relates to a small localised eddy of slightly elevated surface suspended sediments recorded just to the north of the island. This is created by the flow of tides around the island itself during the flooding tides. However, the maximum concentration of this patch was between 5 and 10mg/l and well below the natural variability of the waters surrounding the island throughout the year (which varied from 15-162mg/l and a median of 23mg/l). The conservation objective for the sublittoral reefs along the northern coast of Ireland Eye is to maintain favourable conservation conditions and to prevent permanent removal of the habitat. Moderately strong tidal currents experienced in this area are sufficient to prevent the deposition of significant silt material on these reef habitats and thereby prevent a degradation of the sublittoral benthic biotopes through smothering and burial of the infralittoral and circalittoral communities. On this basis, it is considered the conservation objectives of the Rockabill to Dalkey Island SAC will be unaffected for this habitat as a result of construction stage suspended sediment plumes and there is no adverse effect on the integrity of the site.

Harbour Porpoises (Annex II)

As presented in section 5.1.6, the presence of the harbour porpoise has been well documented in the area. Comprehensive survey activities in 2015-2017 showed that harbour porpoises were present throughout the year with lower numbers 0.61 - 0.89ind/km^2 recorded between January and April (possibly associated with an offshore movement of this species before calving) and increased numbers 1.91 - 2.29 ind/km^2 in the late summer which coincided with the presence of calves and may be due to seasonally abundant food sources such as sprat, herring and gadoid species. Acoustic recordings indicated that the species were also more common within the survey area during slack high water tides and during the hours of darkness. This increased nocturnal activity is consistent with the species observed in other areas. The reason for this is uncertain but potentially linked to an increase in prey abundance or activity in the absence of light (Todd et al., 2009). The overall density estimate of the harbour porpoise was high and emphasized the importance of this site to this species, as indicated by some of the highest densities recorded in Ireland to date (Berrow et al. 2008, 2013 and 2015).

Sediment plumes from the discharge of dredge spoil may present habitat disturbance to local cetacean foraging in the area. The combined surface and seabed plume created during the dredging process recorded a maximum area with elevated suspended sediment above 5mg/l of 4.5km^2, of which approximately 1.5km^2 is currently inside Rockabill to Dalkey Island SAC. This is equivalent to only 0.55% of the total SAC area (of 273km^2). The duration of the dredging is expected to be 60 days (see Section 3.1.8).

This plume is expected to have a temporary but localised impact on the foraging behaviour of the harbour porpoises due to the reduced visibility in the vicinity of the dredging. It should be noted that the noise created during the dredging in the waters surrounding the dredgers (see section 5.2.3.1) are likely to induce avoidance behaviour by this species prior to species encountering the discharge plume itself. Porpoises feed mainly on small shoaling fish, such as herring, but may also feed upon prey taken at or close to the benthos. As harbour porpoises use a series of high frequency clicks for echo-location during navigation and hunting, they are less susceptible to the impacts of suspended sediment plumes during foraging and are routinely found in inshore areas of high natural turbidity (e.g. southern North Sea, Liverpool Bay in the Irish Sea).

The conservation objective relate to the prevention of permanent access to suitable habitat or activities that introduce man-made energy (i.e. noise, light etc.) that could result in a significant negative impact or operations that may result in the deterioration of key resources (e.g. water quality, feeding, etc.). The harbour porpoise often inhabits turbid environments and evidence that turbidity affects these species directly is not evident in the literature. The impact from the dredging plume will have a temporary loss of habitat area within the SAC due to the detrimental effect on the water quality which may cause a secondary impact on potential prey species such as fish. However, as the harbour porpoise covers a very large foraging range the limited area of the plume (<0.55% of the SAC), and short term duration (< 60 days within the SAC) will not significantly deteriorate resources within the range of this species. Therefore, no significant impact is expected from the dredging plume to this qualifying interest.

On this basis, it is considered that the conservation objectives of the Rockabill to Dalkey Island SAC will be affected indirectly as a result of the construction stage suspended sediment plume, within the foraging area of the harbour porpoise, but as this impact will cover a relatively small proportion of the site available to the species and be only for the short-term duration of the works in this area, there will be no adverse effect on the integrity of the site.

6.2.2.3.3 Discharge Plume – Operational Stage

The operational period of the outfall will create a plume of nutrient enriched waters which will disperse naturally on the prevailing tidal currents over a large area. The siting of the outfall has been undertaken based on modelling of the oceanography to maximise the dilutions and spread of this material so that localised enrichment will not occur. However, as the levels of dissolved inorganic nitrogen (DIN) will increase slightly close the site, there is a possibility of increased organic enrichment to the seabed through increased primary productivity and organic flux to the seabed via the food chain, particularly during the summer months, when sea temperature and light conditions are suitable for photosynthesis.

Details of the effluent discharge qualities modelled during the operational phase are outlined in section 5.2.2. Results indicate that the plume created by the effluent discharge will be subject to significant dispersion with a 20 fold dilution achieved within 50m of the diffuser and between a 33 and 100 fold dilution within 500m of the diffuser. The specification of the discharge is to remain below 35mg/l (95 percentile) and not to exceed a maximum suspended sediment load of 89mg/l, a worst case scenario would show a minimum dilution rate of 33 fold within 500m of the diffuser. This is an increase of only 2.7mg/l above a minimum background concentration of between 4 mg/l and 15 mg/l. This is an almost imperceptible increase in the background turbidity at this distance. The majority of effluent diluting will occur to below 5 mg/l within 50m of the outfall. A radius of 500m is equivalent to an area of approximately $0.2km^2$ or 0.07% of the total SAC area. If the discharge levels of other water quality parameters are applied to this modelled plume dispersion, the resulting elevation of DIN, MRP and BOD will all remain below the Environmental Objectives Regulations, 2009 require to achieve a 'Good' water quality status. For a BOD discharge of between 25mg/l O_2 (95 percentile) and 50mg/l O_2 (Table 3-1), the modelled dilution of the plume would result in a maximum elevation of 2.5mg/l O_2 within 50m and 1.5-0.5mg/l O_2 within 500m and maintain an ambient background below 4mg/l O_2 for these transitional waters.

The modelling of the discharge shows that the discharge from the Marine Diffuser will disperse and dissipate over a large area. The dispersed discharge is not predicted to directly impact the reefs features within the Ireland Eye SAC which is approximately 900m from the diffuser location. Therefore the overall impact is predicted to be none or negligible and have no impact on the conservation objectives of the Reefs within the SAC.

Whilst the plume from the effluent discharge is located within the SAC, the concentration of suspended sediments is predicted during the operational phase to be below that detectable by this Annex II species and no impact to this qualifying species is expected.

On this basis, it is considered the conservation objectives of the Rockabill to Dalkey Island SAC will be unaffected for this habitat as a result of operational stage suspended sediment plumes and there is no adverse effect on the integrity of the site.

6.2.3 Lambay Island SAC

Lambay Island SAC (site code: 00204) is a large (250ha) island lying 4km off Portrane and 9.3km north east of the proposed marine outfall.

Based on the information contained in Section 4 and Table 4-3 there are two potential pathways for LSEs to occur on this SAC; water quality and habitat deterioration, which is discussed here in Section 6.2.3 and underwater noise and disturbance, information on which is provided in Section 6.3.3.

6.2.3.1 Conservation Objectives

The two target qualifying interests that relate to Annex I habitats (i.e. vegetated sea cliffs and the reefs) are outside the influence from the outfall during both construction and operation. However the foraging range of the two remaining Annex II qualifying interests falls within the vicinity of the proposed Outfall. The targets set for the conservation objectives listed within the Lambay Island SAC are listed below in Table 6-9. These are defined attributes and targets.

Table 6-9: Conservation objective for grey or harbour seal within Lambay Island SAC (NPWS, 2013e)

Species	Annex II species	Grey seal (*Halichoerus grypus*) Harbour seal (*Phoca vitulina*)
Conservation objective	To maintain the favourable conservation condition of Grey or Harbour Seal in Lambay Island SAC, which is defined by the following list of attributes and targets	
Attribute	**Measure**	**Target**
Range	Prevent permanent access for the species to suitable habitat and does not refer to short-term or temporary restriction of access or range.	Species range within the site should not be restricted by artificial barriers to site use.
Anthropogenic Activities	Activities that introduce man-made energy (i.e. noise, light etc.) that could result in a significant negative impact or operations that may result in the deterioration of key resources (e.g. water quality, feeding, etc.).	Human activities should occur at levels that do not adversely affect the grey seal population at the site

6.2.3.2 Relevant Baseline Information

Section 5.2.2 provides details on water quality and the construction and operational plumes.

The marine qualifying interests relating to the Lambay Island SAC relates to the seals (pinnipeds). There are two species of seal native to Irish waters, both of which are found within the proposed outfall pipeline. These are the grey seal (*Halichoerus grypus*) and the smaller and slightly rarer harbour seal (also known as the common seal; *Phoca vitulina*). Breeding sites exist for both species here, although the grey seal also has breeding sites on Ireland’s Eye (approximately 1km south) and on Dalkey Island (approximately 14.9km south). Given the proximity and size of these populations, it is extremely likely that both seals currently forage within and around the proposed discharge site.

The grey seal is present at the site throughout the year including its breeding (around August to December) and moulting seasons (around December to April). During the breeding season, the relationship between pup production and total population size is not well known. An estimated 56 pups were born in Lambay Island SAC in 2005. The corresponding minimum population estimate for the site numbered between 196 and 252 grey seals of all ages. Harbour seal are also present on Lambay Island throughout the year including its breeding (around May to July) and moulting seasons (around August to September). A total of 31 harbour seal were recorded ashore within Lambay Island SAC in August 2003 during a national aerial survey for the species, while maximum counts of 38-47 harbour seal were recorded more recently during the moult season. The haul-out groups of harbour seals have tended historically to be found among inshore bays and islands, coves and estuaries (Lockley 1966; Summers 1980), particularly around the hours of lowest tide. The grey seal breeds on exposed rocky shores, on sand bars or in sea caves with ready access to deep water. Other haul-out areas for the grey seal are located on exposed rocky areas or steeply shelving sandbanks.

Results from the recent IWDG study of harbour porpoise (see Section 5.1.6) revealed the presence of seals within the survey. This survey clearly demonstrated that the area off Portmarnock is important for both grey seals which were recorded throughout the year in small numbers and distributed throughout the survey area. Peaks in sightings from Howth Head occurred during spring and autumn, coinciding with pupping and post-moult periods at the local well-known breeding and haul out sites at Lambay Island, Skerries and Irelands Eye. In all, 260 sightings of grey seal were recorded during the survey totalling 325 animals made up of all but 2 adults. Sighting rates was more consistent over the survey period with the highest sightings in April 2015, although high numbers were also recorded in September 2015, January 2016 and October 2016. Group size also increased during this time. Grey seal were often recorded feeding within close proximity to the northern cliffs of Howth Head.

6.2.3.3 Assessment

The following Likely Significant Effects were identified as part of the screening assessment.

6.2.3.3.1 Suspended Sediment arising from Dredging or Piling Plume

A predictive model of the plume created along the marine section of the proposed route during dredging is outlined in Section 5.2.2. These results indicate that the predicted suspended sediment plumes created by the discharge of spoil is limited to a northward deposition of generally localised elevated concentrations when discharged in a controlled manner during the flooding part of the tidal cycle. The plume does not reach and therefore does not directly impact Lambay island SAC. Highly mobile pinnipeds that are an Annex II qualifying interest of the SAC frequently use marine waters to the south of the SAC and as such, indirect effects remain possible as the pinniped species forage in areas where the plume will occur.. The overall plume footprint above 5mg/l covers an area of 4.5km^2. The highest concentrations of suspended sediments >10,000 mg/l were recorded at bed level within 50-100m from the discharge point but the fast settlement rate of this granular material means that seabed and mid-depth concentrations generally fall below 1,000 mg/l within 200m from the discharge. Lower levels of sediment fines (silts and clays), recorded in the sub-surface layers of the corridor are modelled to travel further on discharge, and with concentration of between 10 and 100mg/l recorded out to a maximum distance of around 1,400m north of the route. These values are similar to the natural background levels of suspended sediments recorded within the region throughout the year, but particularly during the winter months.

For visual hunters, such as pinnipeds, the impact of the plume is likely to induce an avoidance reaction when not feeding, or potentially encourage predation within or close to the plume, with fish feeding on suspended benthos and the seals feeding upon the fish. In a captive environment, Weiffen *et al*. (2006) showed that the visual acuity of harbour seals decreased substantially as turbidity increased, but testing of the natural North Sea environment where these seals reside were naturally very high ranging from approximately 11-68 mg/l (Guillen *et al*, 2000) suggesting that it is likely that other senses are used instead of, or in combination with, vision (e.g. Dehnhardt *et al*., 2001). Some researchers have reported apparent blindness in harbour seals without any noticeable deterioration of their conditions (Newby *et al*., 1970), or foraging behaviour when tracked by satellites (McConnell *et al*., 1999). These results indicate that vision is not essential to pinnipeds' survival, or ability to forage. Consequently, increased turbidity, is unlikely to have a substantial direct impact on marine mammals that often inhabit naturally turbid or dark environments. This is likely because other senses are utilised, and vision is not relied upon solely.

The maximum concentration of the plume is predicted by the model to be around 50mg/l near the surface, which is approximately within the range expected for natural suspended sediment loads recorded in the vicinity of the Marine Diffuser (15-162mg/l, and a median of 23mg/l). Seals are expected to show either indifference or a simple avoidance reaction if a plume is encountered. The size of the plume in the marine area outside of the SAC is not likely to be significant at any given time, and of negligible consequence when the full foraging range of the qualifying interest mobile pinniped species of Lambay Island SAC is taken into consideration.

The duration of the whole of the dredging works is expected to take <6 months and analysis of the pre-dredged sediments results indicated natural uncontaminated sediments throughout the route based on the samples analysed.

The construction stage plume may introduce minor behavioural changes for the construction period through noise and short-term disruption to foraging areas and prey species.

The conservation objective relate to the prevention of permanent access to suitable habitat or activities that introduce man-made energy (i.e. noise, light etc.) that could result in a significant negative impact or operations that may result in the deterioration of the key resources (e.g. water quality, feeding, etc.). As the direct impact by the plume will be very localised (within 1,500m of the source), short term (< 60 days) and will not deteriorate any resources within the range of the species, the impact to Annex II species from Lambay Island SAC from the construction dredging plume will be negligible. No significant impact is expected from the dredging plume to this qualifying interest and will not cause an adverse effect on site integrity.

On this basis, it is considered the conservation objectives of the Lambay Island SAC will be unaffected for seal species as a result of construction stage suspended sediment plumes and there is no adverse effect on the integrity of the site.

6.2.3.3.2 Operational Plume

Details of the effluent discharge qualities modelled during the operational phase are outlined in section 5.2.2. Results indicate that the plume created by the effluent discharge will be subject to significant dispersion with a 20 fold dilution achieved within 50m of the diffuser and between a 33 and 100 fold dilution within 500m of the diffuser. The specification of the discharge is to remain below 35mg/l (95 percentile) and not to exceed a maximum suspended sediment load of 89mg/l, a worst case scenario would show a minimum dilution rate of 33 fold within 500m of the diffuser. This is an increase of only 2.7mg/l above a minimum background concentration of between 4mg/l and 15mg/l. This is an almost imperceptible increase in the background turbidity at this distance. The majority of effluent diluting will occur to below 5mg/l within 50m of the outfall. If the discharge levels of other water quality parameters are applied to this modelled plume dispersion, the resulting elevation of DIN, MRP and BOD will all remain below the Environmental Objectives Regulations, 2009 require to achieve a ‘Good’ water quality status. For a BOD discharge of between 25mg/l O_2 (95 percentile) and 50mg/l O_2 (Table 3-1), the modelled dilution of the plume would result in a maximum elevation of 2.5mg/l O_2 within 50m and 1.5-0.5mg/l O_2 within 500m and maintain an ambient background below 4mg/l O_2 for these transitional waters. This discharge is expected to provide a localised plume visible to marine mammals at certain time of the year, particularly for visual hunters such as pinnipeds and may attract these species to around the Marine Diffuser in search of prey species, that themselves might be attracted to the outfall discharge or the increased productivity surrounding it.

The impact of the discharged plume into the waters south of Lambay Island SAC will be long term (the lifetime of the outfall). However, the magnitude of this impact will be negligible for the Annex II species of the grey and harbour seals as this area constitutes a small fraction of the animal’s habitat range, and would be imperceptible above background conditions for the majority of the time with no significant effect on the animals foraging ability or behaviour. This results in a negligible significance for the two seal species and will not impact on the conservation objectives for the Lambay Island SAC or the integrity of the site.

6.2.4 Other European Sites

6.2.4.1 Baldoyle Bay SPA

With regard to water quality and habitat deterioration, there are several mechanisms by which LSEs on the Baldoyle Bay SPA could occur during construction. These are pollution incidents and elevated suspended sediments occurring upstream of the SPA, bentonite release, surface venting and suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume could also result in LSEs (see Section 5.2.2).

It has been predicted that any impacts caused by upstream pollution incidents represent a negligible level of impact on Baldoyle Bay (Section 6.2.1.3). Details of the plume created during the dredging part of the construction phase are outlined in Section 5.2.2. Results indicate that the plume created by the controlled discharge of dredged spoil does not impact the Baldoyle Bay SPA. Assessment of bentonite release and surface venting has concluded that any impacts are likely to be minimal in the overall context of the Baldoyle

Bay SPA (Section 6.2.1.3). On this basis, it is considered that there will be no effect on the prey species of the SCIs of the Baldoyle Bay SPA by these impact pathways.

Results of the effluent discharge qualities modelled during the operational phase indicate that the plume created by the effluent discharge will be subject to significant dispersion, with a 20 fold dilution obtained within 50m of the diffuser and between 33 and 100 fold dilution within 500m of the diffuser (Section 5.2.2). The Baldoyle Bay SPA is located approximately 5km from the marine diffuser. The effluent plume will therefore not impact prey species of the Baldoyle Bay SPA SCIs.

For all of these impact pathways, it has been concluded that the conservation objectives the Baldoyle Bay SAC will be unaffected and there would be no adverse effect on the integrity of the site (Section 6.2.1.3). On this basis, it is concluded that any prey species of the Baldoyle Bay SPA SCI species will also be unaffected. No birds would be lost from the Ireland's Eye SPA population as a result of the above impact pathways.

These impact pathways therefore do not compromise any of the conservation objectives of the Baldoyle Bay SPA SCIs. It is considered the conservation objectives of all SCIs of the Baldoyle Bay SPA will be unaffected for this species and there is no adverse effect on the integrity of the site.

6.2.4.2 Ireland's Eye SPA

With regard to water quality and habitat deterioration, there are several mechanisms by which LSEs on the Ireland's Eye SPA could occur during construction. These are pollution incidents and elevated suspended sediments occurring upstream of the SPA, bentonite release, surface venting and suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume could also result in LSEs (see Section 5.2.2).

It has been predicted that any impacts caused by upstream pollution incidents represent a negligible level of impact on Baldoyle Bay (Section 6.2.1.3). The Ireland's Eye SPA is located approximately 6km from this location, so it is not possible for this impact pathway to cause LSE at the Ireland's Eye SPA. Assessment of bentonite release and surface venting has concluded that any impacts are likely to be minimal in the overall context of the Baldoyle Bay SPA (Section 6.2.1.3), and because the Ireland's Eye SPA is located 5km from this location, this impact pathway cannot cause LSE at this SPA.

Details of the plume created during the dredging part of the construction phase are outlined in Section 5.2.2. With the exception of a small surface plume of 1-5 mg/l and 200-300m across caught in a small back-eddy 350m north of the Irelands Eye north coast (which falls within the Ireland's Eye SPA boundary), all of the plume discharge are predicted to disperse to the north of the outfall pipeline corridor following a controlled discharge. None of the discharged sediment is predicted to impact the qualifying Annex I habitats of littoral and sublittoral reef features of the Rockabill to Dalkey Island SAC along the north and eastern coastline of Irelands Eye. On this basis, it is not predicted that there will be any impacts to the prey species of the SCIs of the Ireland's Eye SPA due to the sediment plume produced by dredging activity.

The operational period of the outfall will create a plume of nutrient enriched waters which will mostly disperse naturally on the prevailing tidal currents over a large area. The siting of the outfall has been undertaken based on modelling of the oceanography to maximise the dilutions and spread of this material so that localised enrichment will not occur. However, as the levels of dissolved inorganic nitrogen (DIN) will increase slightly close the site, there is a possibility of increased organic enrichment to the seabed through increased primary productivity and organic flux to the seabed via the food chain, particularly during the summer months, when sea temperature and light conditions are suitable for photosynthesis.

Results indicate that the plume created by the effluent discharge will be subject to significant dispersion with a 20 fold dilution achieved within 50m of the diffuser and between a 33 and 100 fold dilution within 500m of the diffuser. Based on a maximum suspended sediment load of 89 mg/l, a worst case scenario would show a minimum dilution rate of 33 fold within 500m of the diffuser. This is an increase of up only 2.7 mg/l above a minimum background concentration of between 4 mg/l and 15 mg/l. This is an almost imperceptible increase in the background turbidity at this distance. The majority of effluent diluting will occur to below 5 mg/l within 50m of the outfall.

The modelling of the operational discharge shows that the discharge from the marine diffuser will disperse and dissipate over a large area. The dispersed discharge is not predicted to impact the reefs features within the Ireland's Eye SAC which is approximately 900m from the diffuser location. Therefore the overall impact is predicted to be none or negligible and have no impact on the conservation objectives of the Reefs within the SAC. On this basis, it is judged there will be no impact on the prey species of the Ireland's Eye SPA SCIs through this impact pathway.

These impact pathways therefore do not compromise any of the conservation objectives of the Ireland's Eye SPA SCIs. It is considered the conservation objectives of all SCIs of the Ireland's Eye SPA will be unaffected and there is no adverse effect on the integrity of the site.

6.2.4.3 North Dublin Bay SAC

The North Dublin Bay SAC (000206) is located 2.3km south of the marine outfall. Table 4-3 lists the site's marine qualifying interests. The following Likely Significant Effects were identified as part of the screening assessment.

Suspended Sediment arising from Dredging or Piling Plume

The spread of the sediment plume (see Section 5.2.2) shows the controlled release of spoil material by hopper barge every 7 hours on flooding tides over the duration of the construction phase. The granular nature of these sediments results in a fast settlement of material to the bottom with seabed and mid-depth concentrations generally falling within 200m from the discharge. Low level concentrations of between 5 and 10mg/l were recorded out to 1500m from the corridor or remained just detectable out to 2600m. None of the discharged sediment is predicted to reach the boundary of the SAC or qualifying habitats and therefore no impact is expected within this SAC.

Operational Plume

Details of the effluent discharge qualities modelled during the operational phase are outline in section 5.2.2. Results indicate that the plume created by the effluent discharge will be subject to significant dispersion with a 20 fold dilution obtained within 50m of the diffuser and between 33 and 100 fold dilution within 500m of the diffuser. This means that the effluent will not to reach the boundary of the SAC or qualifying habitats and therefore no impact is expected within this SAC.

6.2.4.4 North Bull Island SPA

This SPA lies 2.3km to the south of the marine outfall (see Figure 1-1). Table 4-3 lists the site's Special Conservation Interests.

There are several mechanisms by which LSEs on this SPA could occur during construction from water quality and habitat deterioration. These are pollution incidents and suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume could also result in LSEs (see Section 5.2.2).

These impact pathways do not compromise any of the conservation objectives of the Ireland's Eye SPA (Section 6.2.4.2) or Baldoyle Bay SPA (Section 6.2.4.1) SCIs, and there is no adverse effect on the integrity of either site. These impact pathways are judged to produce highly localised effects and/or produce no/imperceptible impact.

On this basis it is concluded that because this SPA is located at a substantially greater distance from the marine outfall than either the Baldoyle Bay SPA or Ireland's Eye SPA, the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.2.4.5 Malahide Estuary SPA

This SPA lies 2.5km to the north of the marine outfall. Table 4-3 lists the site's Special Conservation Interests.

There are several mechanisms by which LSEs on this SPA could occur during construction from water quality and habitat deterioration. These are pollution incidents and elevated suspended sediments from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume could also result in LSEs (see Section 5.2.2).

These impact pathways do not compromise any of the conservation objectives of the Ireland's Eye SPA (Section 6.2.4.2) or Baldoyle Bay SPA (Section 6.2.4.1) SCIs, and there is no adverse effect on the integrity of either site. These impact pathways are judged to produce highly localised effects and/or produce no/imperceptible impact.

On this basis it is concluded that because this SPA is located at a substantially greater distance from the marine outfall than either the Baldoyle Bay SPA or Ireland's Eye SPA, the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.2.4.6 Malahide Estuary SAC

The Malahide Estuary SAC (000205) is located 2.5km north of the marine outfall. Table 4-3 lists the site's marine qualifying interests. The following Likely Significant Effects were identified as part of the screening assessment.

Suspended sediment arising from dredging or piling plume

The spread of the sediment plume (see Section 5.2.2) shows the controlled release of spoil material by hopper barge every 7 hours on flooding tides over the duration of the construction phase. The granular nature of these sediments results in a fast settlement of material to the bottom with seabed and mid-depth concentrations generally falling within 200m from the discharge. Low level concentrations of between 5 and 10mg/l were recorded out to 1,500m from the corridor or remained just detectable out to 2600m. None of the discharged sediment is predicted to reach the boundary of the SAC or qualifying habitats and therefore no impact is expected within this SAC.

Operational Plume

Details of the effluent discharge qualities modelled during the operational phase are outlined in section 5.2.2. Results indicate that the plume created by the effluent discharge will be subject to significant dispersion with a 20 fold dilution obtained within 50m of the diffuser and between 33 and 100 fold dilution within 500m of the diffuser. This means that the effluent will not to reach the boundary of the SAC or qualifying habitats and therefore no impact is expected within this SAC.

6.2.4.7 Howth Head Coast SPA

This SPA lies 2.6km to the south of the marine outfall (see Figure 1-1). Table 4-3 lists the site's Special Conservation Interests.

There are several mechanisms by which LSEs on this SPA could occur during construction from water quality and habitat deterioration,. These are pollution incidents suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume could also result in LSEs (see Section 5.2.2).

These impact pathways do not compromise any of the conservation objectives of the Ireland's Eye SPA (Section 6.2.4.2) or Baldoyle Bay SPA (Section 6.2.4.1) SCIs, and there is no adverse effect on the integrity of either site. These impact pathways are judged to produce highly localised effects and/or produce no/imperceptible impact.

On this basis it is concluded that because this SPA is located at a substantially greater distance from the marine outfall than either the Baldoyle Bay SPA or Ireland's Eye SPA, the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.2.4.8 South Dublin Bay and River Tolka Estuary SPA

This SPA lies 7.6km to the south of the marine outfall (see Figure 1-1). Table 4-3 lists the site's Special Conservation Interests.

With regard to water quality and habitat deterioration, there are several mechanisms by which LSEs on this SPA could occur during construction. These are pollution incidents and suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume could also result in LSEs (see Section 5.2.2)

These impact pathways do not compromise any of the conservation objectives of the Ireland's Eye SPA (Section 6.2.4.2) or Baldoyle Bay SPA (Section 6.2.4.1) SCIs, and there is no adverse effect on the integrity of either site. These impact pathways are judged to produce highly localised effects and/or produce no/imperceptible impact.

On this basis it is concluded that because this SPA is located at a substantially greater distance from the marine outfall than either the Baldoyle Bay SPA or Ireland's Eye SPA, the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.2.4.9 Rogerstown Estuary SPA

This SPA lies 8.5km to the north of the marine outfall (see Figure 1-1). Table 4-3 lists the site's Special Conservation Interests.

With regard to water quality and habitat deterioration, there are several mechanisms by which LSEs on this SPA could occur during construction. These are pollution incidents and elevated suspended sediments occurring upstream of the SPA, bentonite release, surface venting and suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume could also result in LSEs (see Section 5.2.2).

These impact pathways do not compromise any of the conservation objectives of the Ireland's Eye SPA (Section 6.2.4.2) or Baldoyle Bay SPA (Section 6.2.4.1) SCIs, and there is no adverse effect on the integrity of either site. These impact pathways are judged to produce highly localised effects and/or produce no/imperceptible impact.

On this basis it is concluded that because this SPA is located at a substantially greater distance from the marine outfall than either the Baldoyle Bay SPA or Ireland's Eye SPA, the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.2.4.10 Rogerstown Estuary SAC

The Rogerstown Estuary SAC (000208) is located 8.5km north of the marine outfall.Table 4-3 lists the site's marine qualifying interests. The following Likely Significant Effects were identified as part of the screening assessment.

Suspended sediment arising from dredging or piling plume

The spread of the sediment plume (see Section 5.2.2) shows the controlled release of spoil material by hopper barge every 7 hours on flooding tides over the duration of the construction phase. The granular nature of these sediments results in a fast settlement of material to the bottom with seabed and mid-depth concentrations generally falling within 200m from the discharge. Low level concentrations of between 5 and 10mg/l were recorded out to 1500m from the corridor or remained just detectable out to 2600m. None of the discharged sediment is predicted to reach the boundary of the SAC or qualifying habitats and therefore no impact is expected within this SAC.

Operational Plume

Details of the effluent discharge qualities modelled during the operational phase are outlined in section 5.2.2. Results indicate that the plume created by the effluent discharge will be subject to significant dispersion with a

20 fold dilution obtained within 50m of the diffuser and between 33 and 100 fold dilution within 500m of the diffuser. This means that the effluent will not to reach the boundary of the SAC or qualifying habitats and therefore no impact is expected within this SAC.

6.2.4.11 South Dublin Bay SAC

The North Dublin Bay SAC (000210) is located 9.7km south of the marine outfall. Table 4-3 lists the site's marine qualifying interests. The following Likely Significant Effects were identified as part of the screening assessment.

Suspended sediment arising from dredging or piling plume

The spread of the sediment plume (see Section 5.2.2) shows the controlled release of spoil material by hopper barge every 7 hours on flooding tides over the duration of the construction phase. The granular nature of these sediments results in a fast settlement of material to the bottom with seabed and mid-depth concentrations generally falling within 200m from the discharge. Low level concentrations of between 5 and 10mg/l were recorded out to 1500m from the corridor or remained just detectable out to 2600m. None of the discharged sediment is predicted to reach the boundary of the SAC or qualifying habitats and therefore no impact is expected within this SAC.

Operational Plume

Details of the effluent discharge qualities modelled during the operational phase are outlined in section 5.2.2. Results indicate that the plume created by the effluent discharge will be subject to significant dispersion with a 20 fold dilution obtained within 50m of the diffuser and between 33 and 100 fold dilution within 500m of the diffuser. This means that the effluent will not to reach the boundary of the SAC or qualifying habitats and therefore no impact is expected within this SAC.

6.2.4.12 Lambay Island SPA

This SPA lies 9.3km to the northeast of the marine outfall (see Figure 1-1). Table 4-3 lists the site's Special Conservation Interests.

There are several mechanisms by which LSEs on this SPA could occur during construction from water quality and habitat deterioration,. These are pollution incidents and suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume could also result in LSEs (see Section 5.2.2).

These impact pathways do not compromise any of the conservation objectives of the Ireland's Eye SPA (Section 6.2.4.2) or Baldoyle Bay SPA (Section 6.2.4.1) SCIs, and there is no adverse effect on the integrity of either site. These impact pathways are judged to produce highly localised effects and/or produce no/imperceptible impact.

On this basis it is concluded that because this SPA is located at a substantially greater distance from the marine outfall than either the Baldoyle Bay SPA or Ireland's Eye SPA, the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.2.4.13 Dalkey Island SPA

This SPA lies 14.9km to the south of the marine outfall (see Figure 1-1). Table 4-3 lists the site's Special Conservation Interests.

There are several mechanisms by which LSEs on this SPA could occur during construction from water quality and habitat deterioration,. These are pollution incidents and suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume could also result in LSEs (see Section 5.2.2).

These impact pathways do not compromise any of the conservation objectives of the Ireland's Eye SPA (Section 6.2.4.2) or Baldoyle Bay SPA (Section 6.2.4.1) SCIs, and there is no adverse effect on the integrity of either site. These impact pathways are judged to produce highly localised effects and/or produce no/imperceptible impact.

On this basis it is concluded that because this SPA is located at a substantially greater distance from the marine outfall than either the Baldoyle Bay SPA or Ireland’s Eye SPA, the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.2.4.14 Skerries Islands SPA

This SPA lies 16.7km to the north of the marine outfall (see Figure 1-1). Table 4-3 lists the site’s Special Conservation Interests.

There are several mechanisms by which LSEs on this SPA could occur during construction from water quality and habitat deterioration,. These are pollution incidents and suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume could also result in LSEs (see Section 5.2.2).

These impact pathways do not compromise any of the conservation objectives of the Ireland’s Eye SPA (Section 6.2.4.2) or Baldoyle Bay SPA (Section 6.2.4.1) SCIs, and there is no adverse effect on the integrity of either site. These impact pathways are judged to produce highly localised effects and/or produce no/imperceptible impact.

On this basis it is concluded that because this SPA is located at a substantially greater distance from the marine outfall than either the Baldoyle Bay SPA or Ireland’s Eye SPA, the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.2.4.15 Rockabill SPA

This SPA lies 16.9km to the north of the marine outfall (see Figure 1-1). Table 4-3 lists the site’s Special Conservation Interests.

There are several mechanisms by which LSEs on this SPA could occur during construction from water quality and habitat deterioration,. These are pollution incidents and suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume could also result in LSEs (see Section 5.2.2).

These impact pathways do not compromise any of the conservation objectives of the Ireland’s Eye SPA (Section 6.2.4.2) or Baldoyle Bay SPA (Section 6.2.4.1) SCIs, and there is no adverse effect on the integrity of either site. These impact pathways are judged to produce highly localised effects and/or produce no/imperceptible impact.

On this basis it is concluded that because this SPA is located at a substantially greater distance from the marine outfall than either the Baldoyle Bay SPA or Ireland’s Eye SPA, the conservation objectives for the SCIs of this SPA are not compromised, and there is no adverse effect on site integrity.

6.3 Impact Pathway - Underwater Noise and Disturbance

6.3.1 Baldoyle Bay SAC

Conservation objectives for the Baldoyle Bay SAC and the four SCIs are outlined in Table 6-6 (see Section 6.2.1.1).

6.3.1.1 Relevant Baseline Information

Details of the underwater noise modelling completed for the proposed construction works are included in Section 5.3.

6.3.1.2 Assessment

The micro-tunnelling operation will produce low level noise emissions into the sediments and water column above the route of the Outfall Pipeline. Noise levels from micro-tunnelling and TBM operations are created from a slowly rotating cutter head which will produce a low level ground vibration through the sediments and water column above the route of the Outfall Pipeline. Different micro-tunnelling machines will rotate at different speeds but the likely vibration produced from a similar TBM in a shallow marine estuary, compared to other similar projects (Sruwaddacon Bay, Hamburg to Elbe and Boston MWWST tunnels), typically produced 160 dB re. 1 µPa in the range from 20 Hz to 100 Hz, but max peak decreasing to 149.5 dB re. 1 µPa within a 30m distance from the TBM.

The marine habitats are not affected by noise but will be exposed to ground vibration as the TBM travels below. Operation at other similar tunnel construction sites has been modelled in the range of 0.1- 0.6 mm/s/meter TBM diameter. Recent measurements of vibration above a very similar TBM for the Corrib project in county Mayo, west of Ireland has shown that the actual peak particle velocity was found almost an order of magnitude below this when the seabed was exposed at low tide (c. 0.06 - 0.12 mm/s; Nedwell unpublished). All of these measurements are predictions that are far below a minimum perception level for humans of 0.3 mm/s in a residential environment (BS5228, 2009), where this vibration may also be perceived by passing fauna such as birds (within the SPA) or hauled out seals from the neighbouring Lambay Island SAC.

The conservation objectives for the SAC are to conserve the exposed mudflats and sandflat communities in a natural condition and prevent decline or change in the distribution of the saltmarsh habitats, unless it is the result of natural processes (including erosion, accretion and succession).

Expected noise/vibration from the micro-tunnelling is below that perceived by fauna inhabiting the SAC. None of the four SCIs listed within the SAC are susceptible to impact from low level ground noise (or in this case vibration). The expected level of vibration will be insufficient to create any instability within the saltmarsh or the benthic organisms recorded within mudflat or sandflats exposed at low water are not sensitive to this level of ground vibration. The effect of tunnelling on the intertidal fauna was measured on the Corrib pipeline project, when a comprehensive benthic survey was carried out along the pipeline route and failed to find any impact relative to the proximity of the pipeline, either directly through low level vibration, or indirectly through increased or decreased predation by over-wintering birds, a qualifying interest within the SAC (BSL, 2013).The Corrib tunnel was for 4.9km in length and ran under Sruwaddacon Bay in Broadhaven Bay SAC (472) and was over twice the diameter of the proposed outfall pipeline, at 4.2m in diameter and cut at a depth around 6-8 metres from the surface of the estuary.

6.3.2 Rockabill to Dalkey SAC

The marine outfall pipeline passes into 1,300m of the SAC and the marine diffuser lies within the SAC. The marine outfall pipeline will be constructed using dredging operations. Two piling locations are also identified at the proposed tunnel/dredge interception pit approximately 2.6km west of the SAC and the fibre optic cable crossing point, approximately 120m west of the SAC.

6.3.2.1 Conservation Objectives

Harbour Porpoises (Annex II)

The targets set for the conservation objectives for the qualifying interest of Annex II species found in Rockabill to Dalkey Island SAC, are listed below in Table 6-10. These have defined attributes and targets along with the estimated areas of each community type within the Annex I habitat, based on interpolation.

Table 6-10: Conservation Objective for harbour porpoise within the Rockabill to Dalkey Island SAC

Species	Annex II species	Harbour porpoise (*Phocoena phocoena*)
Conservation objective	To maintain the favourable conservation condition of harbour porpoise in Rockabill to Dalkey Island SAC, which is defined by the following list of attributes and targets	
Attribute	**Measure**	**Target**

Species	Annex II species	Harbour porpoise (*Phocoena phocoena*)
Range	Prevent permanent access for the species to suitable habitat and does not refer to short-term or temporary restriction of access or range.	Species range within the site should not be restricted by artificial barriers to site use.
Anthropogenic Activities	Activities that introduce man-made energy (i.e. noise, light etc.) that could result in a significant negative impact or operations that may result in the deterioration of key resources (e.g. water quality, feeding, etc.).	Human activities should occur at levels that do not adversely affect the harbour porpoise community at the site.

6.3.2.2 Relevant Baseline Information

Refer to Section 5.1.6 for surveys relating to the presence of the qualifying Annex II species within and close to the SAC and Section 5.2.3 for details on underwater noise modelling during construction.

Background noise levels recorded during a baseline survey indicated a mean sound pressure level of 103dB re 1µPa at 125Hz, falling to 98dB re 1µPa at 1 kHz and 92dB re 1µPa at 5.04 kHz (the highest frequency recorded during the study; TML, 2017).

6.3.2.3 Assessment

A model of expected underwater noise created during the dredging exercise (section 5.2.3) was estimated at 188 dB ref 1µPa in the 50Hz to 89 kHz range. The output using third octave bands of 125Hz, 1kHz and 8kHz were calculated to range between 172 and 176 dB ref 1µPa. The contouring of sound exposure levels (SEL) from a source along the proposed route at these three frequencies showed a propagation of sound to an SEL of around 100 dB re 1 µPa, within 1km at 125Hz, around 30km for 1kHz and 12km for 8 kHz.

The same model was used to assess the noise impact from an impact hammer source that might be used at the tunnel interface or at the fibre optic cable crossing. The source was based on a piling of 600mm with the sounds generated impulsively. At two of the same lower third octave bands used for the dredging assessments, the sound pressure level of the piling was estimated to be 186 dB 1µPa²@1m at 125Hz dropping to 172 dB 1µPa²@1m at 1kHz. Contouring of sound exposure levels (SEL) from a source along the proposed route at these two frequencies showed a propagation of sound to an SEL of around 100 dB re 1 µPa, within 2km at 125Hz, around 12km for 1kHz.

Knowledge about the hearing range of cetacean species is not fully understood, although it is assumed that whales and dolphins hear over similar frequency ranges to the sounds they produce, noting that hearing ranges can extend beyond that of frequencies used for vocalisations (Southall *et al.* 2007). If anthropogenic noise, such as that produced during dredging operations, coincides with species' hearing ranges, it has the potential to affect individuals and populations of cetaceans present within the area at the time. Following Southall et al., (2007) and Lucke et al. (2009), the sound thresholds of behaviour disturbance for harbour porpoises in the frequency range 0.2 – 180kHz is 145 dB re 1 µPa^{2}s for single burst over 1 second, but increases to 162 dB re 1 Pa^{2}s over a 24 hour period. A temporary threshold shift (TTS), a temporal elevation of the hearing threshold, can be induced by prolonged or loud noises in the environment. For the harbour porpoise a TTS can be induced over 24 hours with an SEL of 181 dB re 1 µPa^{2}s, with a permanent threshold shift (PPS), the permanent elevation of an animals hearing threshold, caused by a SEL of 215 dB re 1 µPa^{2}s (Southall *et al* 2007). An animals sensitivity to noise sources may alter significantly with the frequency, and resulting behavioural responses may depend on many factors including the age, condition, sex, season, social state and existing behaviour (Richardson *et al.* 1995). Based on these criteria, the majority of sounds produced by dredgers will be at frequencies within the lower frequencies of the cetacean's auditory range. The levels expected will not be sufficient to cause any damage, but may alter the species behaviour either through avoidance or curiosity, particularly when in close proximity. The propagation plots modelled for the dredger noise following 1/3rd octave frequencies indicated that the greatest impact would be found at the low frequency of 1kHz frequency, but potentially can be heard 20km from the site. The harbour porpoise has a relatively high sensitivity to low frequency noise, although the overall amplitude is relatively low and not dissimilar to large shipping activity within a busy port. The noise created by the piling was higher and above the TTS for the harbour porpoise when in close proximity to the source.

The overall level of dredging noise is expected to be low but to induce some behavioural responses by harbour porpoises when in close proximity (<1km). Although the majority of these works are carried out outside the SAC, the impact pathway is open and additional mitigation methods are required to ensure that effects on this Annex II species do not compromise the conservation objectives for the SAC. The noise impacts from piling are significantly greater and whilst both potential piling locations are located outside the boundary of the SAC a high level of mitigation will be required to ensure that these Annex II species are not found within close proximity to piling when it is started. Details of this mitigation are outlined in Section 7.4. These mitigation methods will avoid any significant impact to harbour porpoises within the SAC.

6.3.3 Lambay Island SAC

Lambay Island SAC (site code: 000204) is a large (250 ha) island lying 4km off Portrane and 9.3km north east of the proposed marine outfall. Conservation objectives for the two Annex II qualifying interests are outlined in Section 6.2.3.1.

6.3.3.1 Relevant Baseline Information

Details of the seal population are discussed in Section 6.2.3.2. Section 5.9 provides details on underwater noise modelling during construction.

6.3.3.2 Assessment

A model of expected underwater noise created during the dredging exercise (section 5.2.3) was estimated at 188 dB ref 1µPa in the 50Hz to 89 kHz range. The output using third octave bands of 125Hz, 1kHz and 8kHz were calculated to range between 172 and 176 dB ref 1µPa. The contouring of sound exposure levels (SEL) from a source along the proposed route at these three frequencies showed a propagation of sound to an SEL of around 100 dB re 1 µPa, within 1km at 125Hz, around 30km for 1kHz and 12km for 8 kHz.

The same model was used to assess the noise impact from an impact hammer source that might be used at the tunnel interface or at a telecom cable crossing, midway along the proposed corridor. The source was based on a piling of 600mm with the sounds generated impulsively. At two of the same lower third octave bands used for the dredging assessments, the sound pressure level of the piling was estimated to be 186 dB 1µPa²@1m at 125Hz dropping to 172 dB 1µPa²@1m at 1kHz. Contouring of sound exposure levels (SEL) from a source along the proposed route at these two frequencies showed a propagation of sound to an SEL of around 100 dB re 1 µPa, within 2km at 125Hz, around 12km for 1kHz.

The sensitivity of hearing in seals, in particular the harbour seal (*Phoca vitulina*), was tested by Kastelein *et al* (2009) under laboratory conditions using a tonal signals between 0.2 and 80kHz using 1/3rd octave bands. The results are presented in the audiogram in Figure 6.5 and show a sensitive hearing ability at low frequencies below 40KHz, and in particularly between 1kHz and 4KHz. The grey seal (*Halichoerus grypus*) indicated a similar hearing audiogram (Figure 6.5) although slightly less sensitive at the lower frequencies and an optimum sensitivity at 12kHz (Erbe *et al,* 2015). These audiograms confirm that the hearing range of seals overlaps in frequency with the loudest and most common anthropogenic noise sources found in the marine environment. The effect of anthropogenic noise on marine mammals is highly variable in type and magnitude (Richardson *et al*., 1995), with these animals showing avoidance behaviour to certain sounds in certain contexts (Kastelein *et al*.,2008). This sensitivity to anthropogenic noise might reduce the time they can forage in particular areas close to loud sources with the distance of avoidance and/or disturbance zones surrounding a noise sources dependant on several other factors such as background noise level, water depth, ocean floor sediment properties, the spectrum, level and duration of the anthropogenic source noise.

A temporary threshold shift (TTS), a temporal elevation of the hearing threshold, can be induced by prolonged or loud noises in the environment. For the harbour and grey seals a TTS can be induced over 24 hours with an SEL of 188 dB re 1 µPa^{2}s, with a permanent threshold shift (PTS), the permanent elevation of an animals hearing threshold, caused by a SEL of 203 dB re 1 µPa^{2}s (Southall *et al* 2007). Based on these criteria, the majority of sounds produced by dredgers will be at frequencies within the lower frequencies well within the seals auditory range and sensitivity. The levels expected will not be sufficient to cause any damage, but may alter the species behaviour either through avoidance or curiosity, particularly when in very close proximity. The propagation plots modelled for the dredger noise following 1/3rd octave frequencies indicated that the greatest impact would be found at the low frequency of 1kHz frequency, but potentially can be heard 25km from the site. The noise created by the piling was higher and above the TTS for both seal species when in close proximity to the source.

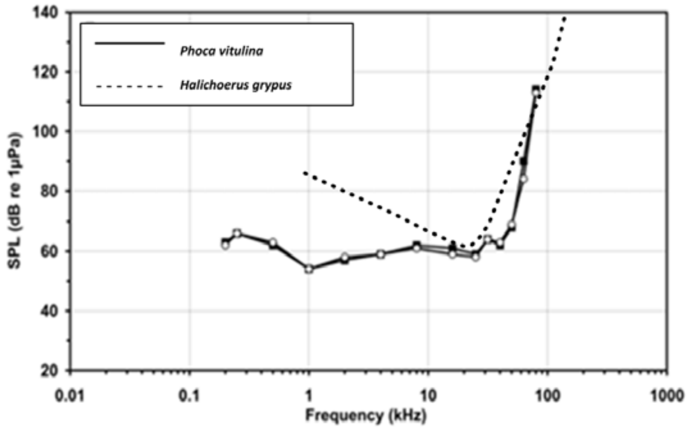

Figure 6-5: The mean detection thresholds (dB re 1 µPa, rms) for 1/3-octave noise bands for a Harbour Seal (Phoca vitulina) compared to a Grey Seal (Halichoerus grypus) between 0.2 and 80KHz ((Kastelein *et al.,* 2008 and Erbe *et al.,* 2015).

The overall level of dredging noise is expected to be low but to induce some behavioural responses in seals when in close proximity (< 1km). Although these works are carried out outside the SAC, the impact pathway is open and additional mitigation methods are required to ensure that effects on this Annex II species do not compromise the conservation objectives for the SAC. The noise impacts from piling are significantly greater and a high level of mitigation will also be required to ensure that these Annex II species are not found within close proximity to piling when it is started. Details of this mitigation are outlined in Section 7.4.

6.4 Impact Pathway – Habitat Loss

6.4.1 Baldoyle Bay SAC

Conservation objectives for the Baldoyle Bay SAC and the four SCIs are outlined in Table 6-6 (see Section 6.2.1.1).

6.4.1.1 Assessment

Section 6.2.1.3 describes the Likely Significant Effects arising from bentonite release and surface venting (air breakout) on water quality. Whilst both would affect water quality, there remains a small potential for habitat loss to occur through damage or disruption to the saltmarsh vegetation or benthos. These are discussed as follows:

Bentonite Release

Following the discussion of risk from bentonite breakout in Section 6.2.1.3., there are two main habitat types that exist above the proposed micro-tunnelling route that may be impacted by a bentonite breakout. Should this occur in the inter-tidal or sub-littoral zones within the main part of the estuary where the designated habitat of mudflats and sandflats not covered by seawater at low tide (1140) exists, then this discharge will result in a temporary localised area of pollution that will subsequently be broken down and dispersed by the prevailing tidal flow within or outside the estuary. In this area there will be no habitat loss encountered within the SAC.

Where a bentonite breakout occurs within the saltmarsh vegetation (habitats 1310, 1330 and 1410), then this material is unlikely to disperse naturally or quickly due to the lack of tidal flow in these areas, and may require some intervention to a smothering effect. The size of the impact would be dictated by the amount of bentonite that is received at the surface; however because the use of bentonite is controlled during construction, it can be estimated that this release, should it occur, is unlikely to be <1m^3 which would produce a discharge impact area of <6m^2. This is equivalent to 0.004% of the combined area of the qualifying saltmarsh habitats within the SAC. As previously stated, bentonite is a viscous, naturally occurring, non-toxic clay-based fluid that can potentially smother a localised area of saltmarsh vegetation. In the unlikely event of an incident, surface mitigation would prevent the bentonite causing habitat loss. Details of this mitigation are outlined in Section 7.2.

Surface Venting (Air Breakout)

Following the discussion of risk from air breakout in Section 6.2.1.4., there are two main habitat types that exist above the proposed micro-tunnelling route that may be impacted by an air breakout. Should this occur in the saltmarsh vegetation (habitats 1310, 1330 and 1410), then the cohesive nature of the substrate and surrounding vegetation and the limited influence from significant tidal flow would result in a minor and temporary area of venting, but this is unlikely to create any persistent damage. In this area there will be no habitat loss encountered within the SAC.

Should this occur in the inter-tidal or sub-littoral zones within the main part of the estuary or the coastal area of Velvet Strand where the designated habitat of mudflats and sandflats not covered by seawater at low tide (1140) exists, then this discharge can create a small but temporary depression at the site in the region of 1-3m^2. There will be no net loss in habitat or impact on the integrity of the substrate as this impact would be short lived and naturally infill on subsequent tidal cycles. As the permanent habitat area is stable or increasing, subject to natural processes, the natural condition will not be impacted by this unlikely event. There will therefore be no habitat loss encountered within the SAC.

6.4.2 Rockabill to Dalkey Island SAC

The Rockabill to Dalkey Island SAC The marine outfall pipeline passes into 1,300m of the SAC and the marine diffuser lies within the SAC.

Conservation objectives for the Rockabill to Dalkey Island SAC and the two SCIs are outlined in Section 6.2.2.1. and listed in Table 6 8.

6.4.2.1 Relevant Baseline Information

Baseline data relating to the two qualifying interest are summarised in Section 5.1.5 for the Annex I habitat of Reefs (1170) found at Ireland's Eye, or Section 5.1.6 the presence of Annex II species of harbour porpoise found within close vicinity of the proposed marine outfall route.

6.4.2.2 Assessment

Intertidal and Subtidal Reef Communities

The route of the pipeline and diffuser does not connect with the qualifying interest within the SAC. There will be no habitat loss as a result of this project.

Harbour Porpoises (Annex II)

A 1,300m section of marine outfall pipeline will be laid within the boundary of the SAC, along with the diffuser. Construction along the marine pipeline corridor requires dredging and subsequent burial of the main pipeline which will disrupt the benthos over a temporary period as well as create a source of anthropogenic noise through vessel activity and dredging operations during the period of construction. However, on completion of the outfall, the benthos will return to its natural state with only the addition of the diffuser remaining within the site. This will be a hard structure that will replace approximately 3.5m^2 of granular seabed.

The physical presence of the diffuser at the seabed is not anticipated to create a habitat loss to the harbour porpoise. In this instance, the perception of habitat has been interpreted as a suitable environment in which the species has full access and can forage for food. The harbour porpoise is a highly mobile species with ranges that far exceeds the influence from outfall or the boundaries of the SAC. Porpoises feed on pelagic, demersal and benthic species although they are believed to feed mainly close to or on the seabed. The dredging can disrupt large areas of seafloor sediments and their benthic communities with the potential loss of foraging, although this material is not actually removed from the system altogether. Following completion of the dredging activities there may be a slight reduction in the density of benthos and resulting fish until the seabed recovers, probably within one larval settlement, but the impact to the seabed will only be temporary (i.e. <1year).

The residual structure of the diffuser will create a hard structure on the seabed in an area that is currently made up of mixed sands and gravels. This will introduce some epibenthic faunal assemblages to the site, similar to the species recorded at the nearby sub-littoral reefs recorded around Ireland Eye, 1km to the south. The structure will also attract small fish which may become prey species to the porpoises.

During the operational phase of the works, the outfall will pump out treated effluent based on standards outlined in Section 3.2.1. The volume of discharge into the SAC will be variable, based on weather conditions due to rain input but the average dry weather flow (ADWF) for the system is estimated as 1.46 m^3/s with a full flow to treatment (FFT) capacity of 2.93 m^3/s. The dispersion characteristics during the operational phase was modelled (Chapter 8 of the EIAR) but are summarised in Section 5.2.2. This indicated a positively buoyant plume which will reach the surface layers within 50m of the discharge and remain near the surface until dissipating in the surface waters. Minor level of suspended sediments will also be discharged but as these will remain below a maximum of 8 mg/l and the average discharge below 35mg/l (95th percentile); this is within the natural turbidity range recorded within the area (15 to 162mg/l). This will dilute by 20 times within 50m of discharge or between 33 and 100 times within 500m (subject to neap or spring tides). It is expected that the plume itself will visibly be imperceptible to porpoises within 50-100m of the diffuser. The presence of organically enriched waters through slightly elevated levels of dissolved inorganic nitrogen (DIN), may enhance plankton productivity over the larger area which itself may encourage feeding from prey species in the vicinity, but the impact of this is expected to be negligible, as DIN along with all other water quality variables, are predicted to disperse and maintain a ‘Good’ environmental status subject to Environmental Objectives Regulations, 2009.

Overall, the impact to the foraging area within the SAC will be very small and for the short-term during construction works. The size and location of the plume created during the dredging part of the construction has been assessed and plotted in section 5.2.2, following mitigation that limits discharge during the flooding tide only. As a species often associated with low turbidity environments, the direct impact to the harbour porpoise by limiting foraging capacity is expected to be negligible, although a slight reduction in prey species within the vicinity of the dredging may result as an indirect impact over the 6 month duration of the construction works, or <60 days for operations within the SAC. The total size of the dredging plume with suspended sediment above 5mg/l was modelled as 1.5km^2, equivalent to only 0.55% of the SAC area.

Following completion of the outfall, the site will be fully accessible by the species for foraging, with a possibly slightly enhanced capacity to support small prey species targeted by the porpoises. The location of the outfall has been modelled to provide a significant level of dispersion so as to dilute processed effluent to below levels suitable to maintain a ‘Good’ environmental status subject to Environmental Objectives Regulations, 2009. These predictions will result in no impact upon the conservation objectives for the SAC through habitat loss.

6.4.3 Baldoyle Bay SPA

The conservation objectives for the Baldoyle Bay SPA are provided in Section 6.1.1.1.

6.4.3.1 Relevant Baseline Information

Within the areas affected by direct habitat loss (i.e. land where the microtunnelling compounds will be constructed), a single record of one ringed plover (eastern compound) was the only SCI species of the Baldoyle Bay SPA recorded during the baseline surveys.

No habitat within the Baldoyle Bay SPA will be impacted due to habitat loss.

6.4.3.2 Assessment

Habitat loss due to the Proposed Project is confined to the areas outside the Baldoyle Bay SPA, where there is potential for connectivity between the Baldoyle Bay SPA and the surrounding terrestrial habitats. This could result in potential disturbance effects on SCI species using habitats beyond the SPA boundary. The habitat subject to land take will be occupied by the microtunnelling compounds and 125m of access track associated with the western microtunnelling compound (see Figure 1-2). Habitat loss will occur from the commencement of construction to the completion of site restoration (approximately 18 months), and will be restricted to the footprint of the microtunnelling compounds and the access track. Habitat loss impacts are reversible.

There is no habitat loss as a result of construction or operation of the Proposed Project in the subsea environment either inside or outside the Baldoyle Bay SPA.

Because ringed plover was the only SCI recorded in the habitats where the microtunnelling compounds will be constructed, and these impacts occur outside the SPA boundary, it is judged that all other SCIs (light-bellied brent goose, shelduck, golden plover, grey plover and bar-tailed godwit). It is considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for these SCIs. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity for these species.

The baseline survey data show that ringed plover do not regularly utilise habitats which fall within the zones of impact for the habitat loss impact pathway identified for the Baldoyle Bay SPA, being recorded only once in these areas during the estuarine survey programme. Whilst small numbers of this species could be subject to disturbance and displacement, this effect would be restricted to a small spatial extent, temporary and reversible. As a result, it is considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objective for this species. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity for this species.

6.4.4 Irelands Eye SPA

The conservation objectives for the Ireland's Eye SPA are provided in Section 6.1.2.1.

6.4.4.1 Relevant Baseline Information

The only SCI of the Ireland's Eye SPA recorded in areas impacted by habitat loss was herring gull. Herring gull were commonly encountered across the entire Baldoyle Bay study area, including terrestrial, intertidal and subtidal habitats (Figure A10.37, Appendix B), with a peak count of 331 birds (Appendix B, Table A10.4). They are highly adaptable birds and will utilise a range of coastal, inland and offshore habitats. At the eastern microtunnelling compound herring gulls were recorded within the footprint on five occasions (peak count of five birds).

6.4.4.2 Assessment

Within the Baldoyle Bay study area small numbers of birds were recorded within the zone of influence of the habitat loss impact pathway. Herring gull is a highly mobile species that spend a significant amount of time in flight (Garthe and Hüppop, 2004; Furness and Wade, 2012), and have large foraging ranges (Thaxter *et al.*, 2012).

The highly localised, temporary and reversible nature of the habitat loss impact pathway could result in a temporary redistribution of a small number of birds, none of which would be lost from the Ireland's Eye SPA population.

Construction activities will result in highly localised, temporary and reversible effects that are not of sufficient magnitude or duration to affect the maintenance of the Ireland's Eye SPA herring gull population, the natural range of the population, or the amount of habitat available to the population. On this basis, it is considered the conservation objectives of the Ireland's Eye SPA will be unaffected for this species and there is no adverse effect on the integrity of the site.

6.4.5 Other European Sites

Habitat loss due to the Proposed Project is confined to the areas outside the other European sites identified in Section 4. However, there is potential for connectivity between these sites and terrestrial habitats that will be occupied by the proposed GDD project. This could result in potential disturbance effects on SCI species using habitats beyond the SPA boundary. The habitat subject to land take will be occupied by the microtunnelling compounds and 125m of access track associated with the western microtunnelling compound (see Figure 1.2). Habitat loss will occur from the commencement of construction to the completion of site restoration (approximately 18 months), and will be restricted to the footprint of the microtunnelling compounds and the access track. Habitat loss impacts are reversible.

6.4.5.1 North Bull Island SPA

The assessment carried out in Section 6.4.1 covers the Baldoyle Bay SPA SCIs bar-tailed godwit, golden plover, grey plover, light-bellied brent goose and shelduck. It states that because these SCIs were not recorded where the microtunnelling compounds will be constructed during the estuarine survey programme, it is considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for these SCIs. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity for these species. It is considered that this is also the case for these SCIs of this SPA.

This SPA has some additional SCIs. Of these, black-tailed godwit, dunlin, knot, oystercatcher, pintail, redshank, sanderling, shoveler, teal and turnstone were not recorded where the microtunnelling compounds will be constructed. It is considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for these SCIs. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity for these species.

Black-headed gull was recorded in small numbers (nine records consisting of 31 birds) within the footprint of the eastern microtunnelling compound. This species is highly mobile and opportunistic with respect to the habitats it utilises. It is considered that the highly localised, temporary and reversible nature of the habitat loss impact pathway could result in a temporary redistribution of a small number of birds, none of which would be lost from the North Bull Island SPA population.

Curlew were also recorded roosting and loafing in small numbers (two records consisting of 33 birds) within the footprint of the western microtunnelling compound. The habitat loss impact pathway will result in the displacement of these birds to alternative habitat. It is considered that this redistribution of birds will not result in the loss of any birds to the SPA population.

It is therefore considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for any of its SCIs. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity.

6.4.5.2 Malahide Estuary SPA

The assessment carried out in Section 6.4.1 covers the Baldoyle Bay SPA SCIs bar-tailed godwit, golden plover, grey plover, light-bellied brent goose and shelduck. It states that because these SCIs were not recorded where the microtunnelling compounds will be constructed during the estuarine survey programme, it is considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for these SCIs. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity for these species. It is considered that this is also the case for these SCIs of this SPA.

This SPA has some additional SCIs. Of these, black-tailed godwit, dunlin, knot, oystercatcher, pintail, redshank, sanderling, shoveler, teal and turnstone were not recorded where the microtunnelling compounds will be constructed. It is considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for these SCIs. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity for these species.

Curlew were also recorded roosting and loafing in small numbers (two records consisting of 33 birds) within the footprint of the western microtunnelling compound. The habitat loss impact pathway will result in the displacement of these birds to alternative habitat. It is considered that this redistribution of birds will not result in the loss of any birds to the SPA population.

It is therefore considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for any of its SCIs. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity.

6.4.5.3 Howth Head Coast SPA

No SCIs of this SPA (kittiwake only) were recorded within habitats where the microtunnelling compounds will be constructed. It is there considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for the single SCI of this SPA. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity.

6.4.5.4 South Dublin Bay and River Tolka SPA

The only SCIs of this SPA recorded within habitats where the microtunnelling compounds will be constructed was black headed gull. Black-headed gull was recorded in small numbers (nine records consisting of 31 birds) within the footprint of the eastern microtunnelling compound. This species is highly mobile and opportunistic with respect to the habitats it utilises. It is considered that the highly localised, temporary and reversible nature of the habitat loss impact pathway could result in a temporary redistribution of a small number of birds, none of which would be lost from the South Dublin Bay and River Tolka SPA population.

The SCIs Arctic tern, bar-tailed godwit, common tern, dunlin, grey plover, knot, light-bellied brent goose, oystercatcher, redshank, ringed plover, roseate tern and sanderling were not recorded within habitats where the microtunnelling compounds will be constructed.

It is there considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for the SCIs of this SPA. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity.

6.4.5.5 Rogerstown Estuary SPA

The only SCIs of this SPA recorded within habitats where the microtunnelling compounds will be constructed was ringed plover (Section 6.4.1). It is considered beyond reasonable doubt that these birds originated from the Ireland's Eye SPA, where it is also an SCI.

No other SCIs of this SPA (black-tailed godwit, dunlin, grey plover, greylag goose, knot, light-bellied brent goose, oystercatcher, redshank, ringed plover, shelduck and shoveler were not recorded within habitats where the microtunnelling compounds will be constructed.

It is there considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for the SCIs of this SPA. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity.

6.4.5.6 Lambay Island SPA

The only SCIs of this SPA recorded within habitats where the microtunnelling compounds will be constructed were herring gull and lesser black-backed gull. Both are highly mobile species that spend a significant amount of time in flight (Garthe and Hüppop, 2004; Furness and Wade, 2012), and have large foraging ranges (Thaxter *et al.*, 2012).

The other SCIs (cormorant, fulmar, greylag goose, guillemot, kittiwake, puffin, razorbill and shag) were not recorded within habitats where the microtunnelling compounds will be constructed.

The highly localised, temporary and reversible nature of the habitat loss impact pathway could result in a temporary redistribution of a small number of birds, none of which would be lost from the SPA population. It is considered highly likely that the birds in question were unlikely to have originated from this SPA due to the distance between it and the proposed GDD project.

On this basis, it is considered the conservation objectives of this SPA will be unaffected and there is no adverse effect on the integrity of the site.

6.4.5.7 Dalkey Islands SPA

No SCIs of this SPA (Arctic tern, common tern and roseate tern) were recorded within habitats where the microtunnelling compounds will be constructed. Furthermore, this SPA is situated at substantial distance from the proposed GDD project. It is there considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for the single SCI of this SPA. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity.

6.4.5.8 Skerries Islands SPA

The only SCI of this SPA recorded within habitats where the microtunnelling compounds will be constructed was herring gull, which is a highly mobile species that spends a significant amount of time in flight (Garthe and Hüppop, 2004; Furness and Wade, 2012), and have large foraging ranges (Thaxter *et al.*, 2012).

The other SCIs (cormorant, light-bellied brent goose, purple sandpiper, shag and turnstone) were not recorded within habitats where the microtunnelling compounds will be constructed.

The highly localised, temporary and reversible nature of the habitat loss impact pathway could result in a temporary redistribution of a small number of birds, none of which would be lost from the SPA population. It is considered highly likely that the birds in question were unlikely to have originated from this SPA due to the distance between it and the proposed GDD project.

On this basis, it is considered the conservation objectives of this SPA will be unaffected and there is no adverse effect on the integrity of the site.

6.4.5.9 Rockabill SPA

No SCIs of this SPA (Arctic tern, common tern, purple sandpiper and roseate tern) were recorded within habitats where the microtunnelling compounds will be constructed. Furthermore, this SPA is situated at substantial distance from the proposed GDD project. It is there considered that the habitat loss impact pathway of the Proposed Project during construction and operation will not compromise the targets of the conservation objectives for the single SCI of this SPA. The construction and operation of the Proposed Project will therefore not cause an adverse effect on site integrity.

6.5 Assessment of In-Combination Effects with Other Plans and Projects

Article 6(3) of the Habitats Directive requires that in-combination effects with other plans or projects are considered. On this basis, a range of other projects were considered in terms of their potential to have in-combination effects with the Proposed Project. Those projects are identified in Chapter 22 of the EIAR and listed below in Table 6-11:

Table 6-11 Permitted Projects and the potential for Cumulative Effects during Construction.

Project	Potential for cumulative effects on European sites during construction?
Aviation fuel pipeline from Dublin Airport to Dublin Port; pipeline route crosses the	This project is located approximately 3km from the European Sites considered in this NIS.

proposed orbital sewer route approx. 200m west of WwTP compound. Permission granted.	Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur due to the distance of this project away from the European sites.
Belcamp Housing Development redevelopment of Belcamp Hall and construction of further residential development to provide total of 260 dwellings, including associated works. Permission granted.	This project is located approximately 3.5km from the European Sites considered in this NIS. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur due to the distance of this project away from the European sites.
Remediation of 1.5ha of land Clonshagh, Belcamp – excavation and off-site disposal of historically deposited waste and restoration of the area. A temporary site compound will be constructed. Permission was extended to May 2017, however as this permission has lapsed a new planning permission will be sought by IDA Ireland.	This project is located approximately 2.5km from the European Sites considered in this NIS. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur due to the distance of this project away from the European sites.
The Coast Development – Baldoyle, Growth Area 1 - Construction of 550 residential units, a village centre and surface water wetlands. Permission granted.	This project is located approximately 1km from the European Sites considered in this NIS. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a

	result of underwater noise or vibration cannot occur as there is no open pathway from this project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur due to the distance of this project away from the European sites.
Connolly Hospital Development – Paediatric Outpatients and Urgent Care Centre. Permission granted.	This project is located approximately 10km from the European Sites considered in this NIS. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur due to the distance of this project away from the European sites.
Irish Water: Blanchardstown Regional Drainage Scheme (BRDS) for development in the Tolka River Valley Park.	This project is located approximately 3km from the European Sites considered in this NIS. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur due to the distance of this project away from the European sites.
Drumnigh Housing Development- Housing development immediately to the north of the proposed orbital sewer route. Permission granted.	This project is located <1km from the European Sites considered in this NIS. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated

	run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur due to the distance of this project away from the European sites.
Dublin Airport Authority Plc: Construction on airport lands of a runway, 3110m in length and 75m in width. Under construction.	This project is located approximately 4km from the European Sites considered in this NIS. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this element of the project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur due to the distance of this project away from the European sites.
Red Arches Housing Development, The Coast Construction of 205 residential units. Application for modifications granted 2015.	This project is located >500m from the European Sites considered in this NIS. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur due to the distance of this project away from the European sites.
Ringsend WwTP Upgrade Project Extension of Ringsend WwTP, use of AGS technology. Application to be lodged in 2018.	This project is located adjacent to South Dublin Bay and River Tolka Estuary SPA and in proximity to South Dublin Bay SAC. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli cannot occur at this distance. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur due to the distance of this project away from

	the European sites. It is predicted that the operation of this WwTP may have positive impacts on general water quality.
Station Manor Portmarnock Housing Development - Housing development, comprising 684 residential units, north of proposed outfall pipeline; proposed outfall pipeline route crosses distributor road of Phase A of development; sewer to Grange pumping station runs next to/beneath road. Granted and construction commenced in 2017.	This project is located adjacent to Baldoyle Bay SAC and SPA. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli could occur during construction should the construction periods coincide, however the western micro tunnelling compound will be screened to minimise impacts on Baldoyle Bay SPA. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur due to the distance of this project away from the European sites.
Sutton to Malahide Greenway – pedestrian and cycle route along the Fingal Coast. Application to be lodged in 2018.	This project is located adjacent to Baldoyle Bay SAC and SPA. Disturbance or displacement of feature species of European sites as a result of airborne noise, vibration or other visual stimuli could occur during construction should the construction periods coincide, however the western micro tunnelling compound will be screened to minimise impacts on Baldoyle Bay SPA. Due to the linear nature of the cycle way development, any possibility of construction activities coinciding will be short term. Disturbance or displacement of feature species of European sites as a result of underwater noise or vibration cannot occur as there is no open pathway from this project to those marine receptor species of European sites. There is a possibility of release of suspended sediment or contaminated run off during construction into the same catchments traversed by the Proposed Project. Habitat loss cannot occur as this project is located outside of any European sites.

Table 6-11 concludes that the only potential for cumulative impact during construction arises as a result of surface water run-off during construction of the permitted projects. All projects have listed ‘Adherence to measures prescribed in the CEMP and implementation of effective surface water management procedures’ in application documents. Similarly the construction of the GDD will require adherence to measures prescribed in the CEMP and surface water management during construction and maintenance of SUDs during operation.

The operation of the Proposed Project will not result in any potential for cumulative impacts with the above projects due to the distance of the only above ground elements of the project i.e. the WwTP and Pumping Station away from European sites.

Therefore, there are no impacts from the above proposals that would have the potential to give rise to in-combination or cumulative effects on the 18 European Sites assessed as part of this NIS.

6.5.1 Other Water Quality Pressures

The water quality model developed for the project included consideration of flows from WwTPs at Shanganagh, Ringsend, Swords, Malahide, Portrane, Barnageeragh, and the Proposed Project WwTP discharge. The WwTPs were included in the modelling study to assess the potential in-combination effects with the proposed outfall. The extensive modelling undertaken as part of this EIAR predicted that the Proposed Project will have an imperceptible to slight impact on the water quality of the coastal waters off Co. Dublin.

6.5.1.1 Malahide Estuary SAC

The predicted run-off from the proposed RBSF will not have any impacts on the river system that discharges into Malahide Estuary SAC. Hence there is no potential for in-combination impacts of any other plan and project with either the Ringsend WwTP upgrade project or the proposed RBSF.

7. Mitigation Measures for the Protection of Natura 2000 sites

In light of the assessment of implications on European Sites in Section 6 above, the following sections outline the mitigation measures required to ensure that the Proposed Project does not impact on the integrity of the European Sites.

7.1 Baldoyle Bay SPA

Construction Stage

To eliminate the compromise of conservation objectives on light-bellied brent goose, shelduck and golden plover, a 2.4m high hoarding will be used for the duration of the construction works at both microtunnelling compounds (no. 9 & 10). Compound construction cannot proceed without the installation of hoarding around the entire perimeter of each compound and any associated access track. The deployment of this hoarding will mean that works within the microtunnelling compounds will occur out of sight of birds in the Baldoyle Bay SPA, meaning that disturbance impacts on birds are reduced to a very low level (Cutts et al. 2013). Ikuta and Blumstein (2003) found that protective barriers allow birds to behave as they would in an undisturbed environment. To avoid disturbance to wintering birds, the hoarding can only be erected and uninstalled between April and August under supervision by a professional ecologist.

Operational Stage

No mitigation proposed.

7.2 Ireland’s Eye SPA

Due to the potential for adverse impacts on site integrity during the time period that auks are leaving the Ireland’s Eye breeding colony, it will be necessary to put in place a vessel management plan (see Appendix F). This plan will have two key functions. The first is to ensure that the SPA boundary is not unnecessarily approached or crossed by construction vessels working on the marine diffuser and subsea pipeline section at any time during the construction phase. The second is to ensure the protection of rafting auks leaving the Ireland’s Eye colony in July to mid-August. It should be noted that the vessel management plan has been prepared by the project ornithologist.

Operational Stage

No mitigation proposed.

7.3 Baldoyle Bay SAC

Construction Stage

Due to the potential for adverse impacts on the saltmarsh habitat, the following mitigation measures will be implemented to ensure no runoff of pollutants and suspended sediment loads from construction compounds enters the estuary:

- No discharges to estuary under any circumstances.
- Implementation of measures prescribed in the Construction Environmental Management Plan (see pages 26-29, 31-32 in Volume 2 Part B Appendices) and the Surface Water Management Plan (see Volume 2 Part B Appendices) including bunded storage areas and sediment settlement areas.

The control and management of pressures during the micro tunnelling processes is undertaken to prevent air and bentonite breakouts. However, in the unlikely event of a bentonite breakout occurring, which results in a saltmarsh area high up on the foreshore being covered, intervention will be required. Intervention will involve washing the vegetation using a seawater pump and spray. Typically this would be carried out during a high water period where washings can disperse out of the estuary naturally. Sites will only be accessed by foot (without the use of plant). Should bentonite breakout in a saltmarsh area lower down on the shoreline in areas routinely covered by seawater, this will be left to disperse naturally over the tidal cycle.

Operational Stage

The SUDS systems in place at the WWtP and Abbotstown Pumping Station will need to be maintained to ensure proper functioning during the operation of the project.

7.4 Rockabill to Dalkey Island SAC

Construction Stage

The following mitigation methods will be employed in order to prevent impacts arising from the increased in suspended sediments on the Annex 1 reef habitat:

- Dredging discharges from the hopper will be restricted to flooding tides only.
- Monitoring of plume during dredging operations:
- The turbidity will be monitored using a buoy mounted turbidity meter telemetered back to the dredger to monitor potential impacts from dredging activity. As the reef is only prone to sedimentation during slack water periods, a slightly elevated level of TSS up to 40mg/l (the natural standard deviation for the year) above a daily background will be permitted off Ireland's Eye northern coastline. If this level increases above this threshold as a result of dredging activity, then the discharge of material will be temporarily halted to allow the resulting plume to disperse. This is particularly important 30 minutes before and after slack water where increased suspended sediments can settle within the SAC.
- No discharge or waste to sea under any circumstances.
- Implementation of the following mitigation measures prescribed in the CEMP including strict adherence to MARPOL guidelines an auditing of CEMP:
  - All on board waste discharge, from dredgers, pipeline survey vessels, maintenance vessels and marine rigs, will follow the guidelines from Annex V of the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL) for domestic waste discharges to the environment.
  - Solid and chemical waste will be treated on board and recycling will take place wherever practicable. No waste is to be disposed of at sea. Bilge water will be treated in accordance with MARPOL standards. All waste discharges will be monitored and recorded as per vessel procedures.
  - Any hazardous wastes will be in sealed, labelled drums and stored in lockable chemical cabinets. A record will be kept of the type and quantities of waste arising on each vessel.
  - Ballast tanks will be separated from any hydrocarbon storage areas on board the vessels and no potentially contaminated drain systems will be routed to the ballast tanks. De-ballasting shall be undertaken offshore in accordance with International Marine Organisation (IMO) guidelines and away from sensitive environmental areas to prevent introducing marine organisms from outside the project location.
  - Project vessels and rigs will be equipped with oil-water separation systems in accordance with MARPOL requirements.
  - Any spills on deck will be contained and controlled using absorbing materials. This will be collected in dedicated drums to avoid contamination of deck run-off water. Vessels or rigs without a sewage treatment system will have a suitable holding tank; waste water will then be brought back to shore for treatment by a licensed contractor.
  - All chemicals used on board the project vessels or rigs will be handled in compliance with the relevant Safety Instructions, including Control of Substances Hazardous to Health (COSHH) Handling of Hazardous Materials. For each chemical, a Material Safety Data Sheet will be available, as well as an assessment of the hazards associated with the chemical (to personnel, for storage, for emergency response). These will be available at the various places where the chemical is used, and centralised with the Safety Officer on board.

- Chemicals will be stored in compliance with the handling instruction, including separation of incompatible chemicals, provision of adequate firefighting, spill containment and other safety facilities. The only bulk storage on board vessels will be the fuel; all other chemicals will be stored in drums or smaller containers and will be suitably bunded to contain any leaks or spills.

Mitigation will be undertaken during piling and dredging works to ensure no noise impact to marine mammals (including Harbour Porpoises) within the vicinity of the works. This will include marine mammal observers using a high frequency hydrophone system to establish an operational safe zone around the site. This will prevent the commencement of operations in the event that sensitive receptors (pinnipeds and cetaceans) are observed within this perimeter. The following mitigation measures will also be implemented:

- Following appropriate guidelines from the regulatory authorities, the National Parks & Wildlife Service (2014), the following measures are proposed to remove the risk of direct injury to marine mammals in the area of operations: A trained and experienced Marine Mammal Observer (MMO) will be put in place during piling, dredging, pipeline laying. The MMO will scan the surrounding area to ensure no marine mammals are in a pre-determined exclusion zone in the 30-minute period prior to operations. It is proposed that this exclusion zone is 500m for dredging activities, and 1,000m for piling activities. No works will take place should mammals be recorded in the exclusion zone.
- Noise-producing activities will only commence in daylight hours where effective visual monitoring, as performed and determined by the MMO, has been achieved. Where effective visual monitoring is not possible, the sound-producing activities will be postponed until effective visual monitoring is possible. Visual mitigation for marine mammals (in particular harbour porpoise) will only be effective during daylight hours and if the sea state is 2-3 (Beaufort scale) or less.
- For piling activities, where the output peak sound pressure level (in water) exceeds 170dB, a ramp-up procedure must be employed following the pre-start monitoring. Underwater acoustic energy output will commence from a lower energy start-up and thereafter be allowed to gradually build up to the necessary maximum output over a period of 20-40 minutes.
    - Once operations have begun, operations will cease temporarily if a cetacean or seal is observed swimming in the immediate (<50m) area of piling and dredging and work can be resumed once the animal(s) have moved away.
    - Any approach by marine mammals into the immediate (<50 m) works area should be reported to the National Parks and Wildlife Service.
- If there is a break in piling activity for a period greater than 30 minutes then all pre-activity monitoring measures and ramp-up will recommence as for start-up.
- Once normal operations commence (including appropriate ramp-up procedures), there is no requirement to halt or discontinue the activity at night-time, nor if weather or visibility conditions deteriorate, nor if marine mammals occur within a radial distance of the sound source that is 500m for dredging works, and 1000m for piling activities.
- The MMO will keep a record of the monitoring using “MMO form location and effort (coastal works)” available from the National Parks & Wildlife Service (NPWS) and submit to the NPWS on completion of the works, as described in the NPWS guidance (2014).
- In order to reliably quantify the zone of responsiveness associated with the proposed programme of piling activities associated with the interface pit or cable crossing, a vessel deployed hydrophone will be used to confirm the sound source level of the operation. Additionally passive acoustic monitoring will be used to provide additional support to the identification of harbour porpoises or other cetaceans within the survey area. The effective range of the PAM system will be dictated by the frequency with the ultra high frequency used by porpoises likely to be limited to within 500m of the PAM system.

Operational Stage

No mitigation proposed.

The proposed Regional WwTP will require a waste water discharge licence to be granted by the EPA under the Waste Water Discharge (Authorisation) Regulations, 2007 (S.I No. 684 of 2007) prior to commissioning of the treatment plant, to which the discharge will comply.

7.5 Lambay Island SAC

See mitigation measures for marine mammals listed above for Rockabill to Dalkey Island SAC.

7.6 Other European Sites

No further mitigation is required for the following sites other than the implementation of measures prescribed in the CEMP and surface water management plan for construction activities associated with all elements of the projects as listed in Table 4-1:

1. North Dublin Bay SAC;
2. North Bull Island SPA;
3. Malahide Estuary SPA;
4. Malahide Estuary SAC;
5. Howth Head Coast SPA;
6. Howth Head Coast SAC;
7. South Dublin Bay and River Tolka Estuary;
8. Rogerstown Estuary SAC;
9. Rogerstown Estuary SPA;
10. Lambay Island SPA;
11. Dalkey Island SPA;
12. Skerries Islands SPA; and
13. Rockabill SPA.

8. Conclusions

This Natura Impact Statement has considered the potential for Likely Significant Effects arising from the proposed Greater Dublin Drainage Project that would have the potential to adversely affect the integrity of any Natura 2000 site, with regard to their qualifying interests and conservation objectives. The marine outfall pipeline of the proposed development runs under the Baldoyle Bay SAC & SPA in a tunnel and a 1,300m section of the marine outfall pipeline and the marine diffuser are located in the Rockabill to Dalkey Island SAC. The same 1,300m section lies north of Ireland's Eye SPA & SAC and south of Lambay Island SAC.

The potential for direct, indirect and cumulative impacts affecting the above designations has therefore been assessed in this NIS. The appraisal undertaken in this NIS has been informed by project-specific site investigations and specialist reporting with reference to the ecological communities and habitats potentially affected by the proposed development, in order to provide a scientific basis for evaluations.

With the implementation of mitigation measures the project will not result in direct, indirect or cumulative impacts which would have the potential to adversely affect the qualifying interests/special conservation interests of the Natura 2000 sites within the study area with regard to the range, population densities or conservation status of the habitats and species for which these sites are designated (i.e. conservation objectives).

It is therefore concluded, beyond reasonable scientific doubt, that the Proposed Project with the implementation of the prescribed mitigation measures will not give rise to significant impacts, either individually or in combination with other plans and projects, in a manner which adversely affects the integrity of any designated site within the Natura 2000 network.

8.1 Baldoyle Bay SPA

The Baldoyle Bay SPA has two conservation objectives:

1. To maintain the favourable conservation condition of the waterbird SCI species; and
2. To maintain the favourable conservation condition of the wetland habitat at Baldoyle Bay SPA as a resource for the regularly-occurring migratory waterbirds that utilise it.

Conservation objectives could be compromised due to the proposed GDD project through visual disturbance during construction activities at the microtunnelling compounds (Section 6.1.1). Adverse effects on light-bellied brent goose, shelduck and golden plover were identified. It was also identified that no effect on the conservation objectives of any SCIs would occur as a result of airborne noise disturbance (Section 6.1.1).

No adverse effect on site integrity is predicted due to the water quality and habitat deterioration impact pathway during construction and operation of the proposed GDD project (Section 6.2.4.1), which covers several mechanisms. During construction, these are pollution incidents and elevated suspended sediments occurring upstream of the SPA, bentonite release, surface venting and suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume was also considered.

Conservation objectives could be compromised due to the proposed GDD project through habitat loss, none of which occurs within the SPA boundary (Section 6.4.4). Whilst a small number of one SCI species (ringed plover) was recorded in affected areas during the baseline survey programme, these birds will not be lost from the SPA population as a result of construction of the proposed GDD project. There is no adverse effect on site integrity.

Following the implementation of mitigation to reduce the impact of visual disturbance (screening around both microtunnelling compounds and access track; Section 7.1), no residual impact on the Baldoyle Bay SPA is predicted. On this basis it is concluded that the proposed development will not adversely affect the integrity of the above Baldoyle Bay SPA, having regard to the conservation objectives of the site.

8.2 Ireland's Eye SPA

The single conservation objective of the Ireland's Eye SPA is to maintain or restore the favourable conservation condition of the bird species listed as SCIs.

Due to the highly localised airborne noise impacts that are predicted (Section 5.2.1) there are no airborne noise impacts as a result of works in the subsea environment that will result in effects to SCI species inside the Ireland's Eye SPA. Whilst small scale disturbance effects due to airborne noise could occur in the subsea locations outside the SPA this is not considered to compromise the conservation objective of this SPA. With regard to visual disturbance, it is possible that vessels operating in the easternmost 1km of the outfall pipeline corridor and marine diffuser have the potential to cause disturbance to the SCI species of the Ireland's Eye SPA within and outwith its boundary (Section 6.1.2). For two SCIs (guillemot and razorbill) it is considered that the conservation objectives of the Ireland's Eye SPA will potentially be compromised for this species in the time period of mid July to the end of July.

No adverse effect on site integrity is predicted due to the water quality and habitat deterioration impact pathway during construction and operation of the proposed GDD project (Section 6.2.4.2), which covers several mechanisms. During construction, these are pollution incidents and elevated suspended sediments occurring upstream of the SPA, bentonite release, surface venting and suspended sediment arising from dredging or piling plume originating from the outfall pipeline corridor. During operation, the operational plume was also considered.

It was identified that habitat loss outwith the SPA could impact a single SCI (herring gull) during construction (Section 6.4.4), but the level of this impact would not result in a compromising of the conservation objectives for this SPA.

Following the implementation of mitigation to reduce the impact of visual disturbance (vessel management plan; Section 7.2), no residual impact on the Ireland's Eye SPA is predicted. On this basis it is concluded that the proposed development will not adversely affect the integrity of the above Ireland's Eye SPA, having regard to the conservation objectives of the site.

8.3 Baldoyle Bay SAC

The current assessment has determined that there would be no potential for adverse effects on the coastal habitats listed as qualifying interests of this SAC, arising from the Proposed Project.

The conservation objective for the Baldoyle Bay SAC is to maintain the favourable conservation conditions of the qualifying habitats of *Salicornia* and other annuals colonising mud and sand (1310), Atlantic salt meadows (*Glauco-Puccinellietalia maritimae; 1330), Mudflats and sandflats not covered by seawater at low tide (1140) and Mediterranean salt meadows (Juncetalia maritime; 1410).* The proposed construction method of tunnelling carried out below the estuary will avoid any direct impact to this environment, with only a limited potential for small or isolated incidents occurring through unlikely breakout or pollution events. Mitigation is proposed in Section 7.1.3. but no residual impact to the SAC is predicted. The water quality modelling (see Section 5.2.2) show there is no impact from the construction of the marine outfall pipeline on Baldoyle Bay or from the operation of the project. Mitigation is also proposed to manage surface water run-off from construction activities upstream of Baldoyle Bay, but no residual impact to the SAC is predicted.

On this basis it is concluded that the proposed development will not adversely affect the integrity of the above Baldoyle Bay SAC, having regard to the conservation objectives of the site.

8.4 Rockabill to Dalkey Island SAC

The conservation objective for the Rockabill to Dalkey Island SAC is to maintain the favourable conservation conditions for reefs (subtidal and intertidal; 1170) and for the harbour porpoise (Annex II species).

The current target of the reef is to maintain a stable or increasing habitat subject to natural processes. Survey operations revealed that the sublittoral reef is already subject to high levels of natural siltation although this has not affected the naturally high diversity. The reef is to be protected against "activities or operations that permanently remove habitat from the site". Modelling of the expected suspended sediment plume created during the construction following a controlled tidal release of spoil has shown no effect on the reef (see section 5.2.2).

Residual impacts of the proposed works affecting marine mammals will not be significant. Potential direct impacts from the noise from the proposed construction activities on marine mammals will be insignificant once the mitigation measures are implemented. Behavioural responses to noise from dredging and construction are considered to be temporary and limited to the duration of the works, and will be reduced for the duration of the works through mitigation measures (see Section 7.4). There will be no significant impacts of the proposed development on the Conservation Objectives of the Rockabill to Dalkey Island cSAC.

On this basis, the Proposed Project will not adversely affect the integrity of Rockabill to Dalkey Island cSAC, in view of the site's conservation objectives.

8.5 Lambay Island SAC

Although not directly within the development area, the conservation objective for the Annex II species found at the Lambay Island SAC, but may forage within the development area is to maintain the favourable conservation conditions for both grey and harbour seal species (1364 and 1365).

The proposed construction method of surface dredging out to the Marine Diffuser will provide a negligible level of impact in the immediate vicinity of the diffuser location through increased suspended sediments and increased noise. The impact to the two Annex II species or their expected pretty species will be negligible as the introduction to a sediment plume will be short term, localised and not affect the species ability to forage elsewhere within the vicinity of the development.

Residual impacts of the proposed works affecting marine mammals will not be significant. Potential direct impacts from the noise from the proposed construction activities on marine mammals will be insignificant once the mitigation measures included in this assessment are implemented. Behavioural responses to noise from dredging and construction are considered to be temporary and limited to the duration of the works, and will be reduced for the duration of the works through mitigation measures (see Section 7.4). There will be no significant impacts of the proposed development on the Conservation Objectives of the Lambay Island SAC.

On this basis, the Proposed Project will not adversely affect the integrity of Lambay Island cSAC, in view of the site's conservation objectives.

8.6 Other European Sites

The separation distance of the following SACs from the Proposed Project results in none of the discharged sediment from construction or the effluent from operation reaching the SAC boundaries and therefore no impact is expected within this SAC.

1. North Dublin Bay SAC;
2. Malahide Estuary SAC;
3. Howth Head Coast SAC;
4. Rogerstown Estuary SAC;

On this basis it is concluded that the proposed development will not adversely affect the integrity of the above SACs, having regard to the conservation objectives of each site.

Due to the location of the following SPAs at a greater distance from the project elements, no source of airborne noise disturbance will occur at a sound power level of sufficient magnitude to potentially trigger disturbance within the SPA boundaries. Similarly, there are no visual disturbance sources that will exert an effect within these SPA boundaries. Whilst there is potential for connectivity between these SPAs and habitats that are within the zone of impact of the proposed GDD project (through airborne noise, visual disturbance and habitat loss), the possibility of significant numbers of birds from these more distant SPAs being impacted by the proposed GDD project by this impact pathway is considered to be remote. Similarly, the separation distance of the following SPAs from the Proposed Project results in none of the discharged sediment from construction or the effluent from operation reaching the SPA boundaries and therefore no impact is expected within this SAC.

1. North Bull Island SPA;
2. Malahide Estuary SPA;

3. Howth Head Coast SPA;
4. South Dublin Bay and River Tolka Estuary SPA;
5. Rogerstown Estuary SPA;
6. Lambay Island SPA;
7. Dalkey Island SPA;
8. Skerries Islands SPA; and
9. Rockabill SPA.

On this basis it is concluded that the proposed development will not adversely affect the integrity of the above SPAs, having regard to the conservation objectives of each site.

BIBLIOGRAPHY

Berrow, S & J. O'Brien (2013). Harbour Porpoise SAC Survey 2013. Irish Whale and Dolphin Group Report to the National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht. November 2013

Boorman, L.A, 2003. Saltmarsh Review: An overview of coastal saltmarshes, their dynamic and sensitivity characteristics for conservation and management. JNCC report 334.

British Standards Institution (2009). BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Vibration. June 2014

BSL (2013) Macro-invertebrate Assessment along the length of the Corrib Tunnel within the Broadhaven Bay SAC. Report For Shell Exploration and Production Ireland.

BSL (2015a) Phase I Ireland's Eye Reef Survey Field Report for RPS relating to Irish Water Greater Dublin Drainage. June 2015. Produced by Benthic Solutions Limited. Revision 0.

BSL (2015b) Phase II Ireland's Eye Reef Survey Final Report for RPS relating to Irish Water Greater Dublin Drainage. November 2015. Produced by Benthic Solutions Limited. Revision 0.

de Jong, C. A. F., Ainslie, M. A., Dreschler, J., Jansen, E., Heemskerk, E. & Groen, W (2010). Underwater noise of Trailing Suction Hopper Dredgers at Maasvlakte 2: Analysis of source levels and background noise – TNO-DV 2010 C335.DEHLG (2010a) Appropriate Assessment of Plans and Projects in Ireland. Guidance for Planning Authorities. Department of the Environment, Heritage and Local Government, Dublin

DEHLG (2010b) Department of Environment Heritage and Local Government Circular NPWS 1/10 and PSSP 2/10 on Appropriate Assessment under Article 6 of the Habitats Directive – Guidance for Planning Authorities. Department of the Environment, Heritage and Local Government, Dublin.

Dehnhardt G., Mauck B., Hanke W., Bleckmann H. (2001) Hydrodynamic trail-following in 128 Harbour seals (*Phoca vitulina*), Science, vol. 293 (pg. 102-104).

Dickerson, C., K.J. Reine, and D.G. Clarke (2001). Characterization of underwater sounds produced by bucket dredging operations. U.S. Army Corps of Engineers Research and Development Center. DOER Technical Notes Collection ERDC TN-DOER-E14. http://el.erdc.usace.army.mil/elpubs/pdf/doere14.pdf

European Commission (2000a) Communication from the Commission on the Precautionary Principle. Office for Official Publications of the European Communities, Brussels

European Commission (2000b) Managing Natura 2000 Sites: the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC, Office for Official Publications of the European Communities, Brussels

European Commission (2001) Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Articles 6(3) and (4) of the Habitats Directive 92/43/EEC. Office for Official Publications of the European Communities, Brussels

European Commission (2007) Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC – Clarification of the concepts of: alternative solutions, imperative reasons of overriding public interest, compensatory measures, overall coherence, opinion of the commission. Office for Official Publications of the European Communities, Brussels

European Commission (2009) Estuaries and Coastal Zones within the Context of the Birds and Habitats Directives - Technical Supporting Document on their Dual Roles as Natura 2000 Sites and as Waterways and Locations for Ports. Office for Official Publications of the European Communities, Brussels

European Commission (2011). Guidance document on the implementation of the birds and habitats directive in estuaries and coastal zones with particular attention to port development and dredging. Office for Official Publications of the European Communities, Brussels

European Commission (2013) Interpretation Manual of European Union Habitats. Version EUR 28. Office for Official Publications of the European Communities, Brussels.

Mc Corry, M & T. Ryle (2009) Saltmarsh Monitoring Project 2007-2008. Contract reference D/C/227. A Report for Research Branch, National Parks and Wildlife Service

Nedwell, J. R., Parvin, S. J., Brooker, A. G. & Lambert, D. R (2008). Modelling and measurement of underwater noise associated with the proposed Port of Southampton capital dredge and redevelopment of berths 201/202 and assessment of the disturbance to salmon. 05 December 2008. Subacoustech Report No. 805R0444. Subacoustech.

Newby T. C. , Hart F. M. , Arnold R. A. (1970). Weight and blindness of harbor seals, Journal of Mammalogy , vol. 51 pg.*152*

McConnell B. J. , Fedak M. A., Lovell P., Hammond P. S.. (1999) Movements and foraging areas of grey seals in the North Sea, Journal of Applied Ecology, vol. 36 (pg. 573 – 590)

Natura 2000 sites: The provisions of Article 6 of the ‘‘Habitats’’ Directive 92/43/EEC’ (MN2000).

NPWS (2012a) Marine Natura Impact Statements in Irish Special Areas of Conservation: A working document, April 2012. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin

NPWS (2012b) Conservation Objectives: Baldoyle Bay SAC 000199. Version 1. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin

NPWS (2012c) Baldoyle Bay SAC Conservation objectives supporting document – Marine habitats. Version 1 September 2012. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin

NPWS (2012d) Baldoyle Bay SAC Conservation objectives supporting document – Coastal habitats. Version 1 November 2012. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin

NPWS (2012e) Baldoyle Bay SPA Conservation objectives supporting document. Version 1 December 2012. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin

NPWS (2013a) The Status of EU Protected Habitats and Species in Ireland. Habitat Assessments Volume 2. Version 1.0. Unpublished Report, National Parks & Wildlife Services. Department of Arts, Heritage and the Gaeltacht, Dublin

NPWS (2013b) Conservation Objectives: Baldoyle Bay SPA 004016. Version 1. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin

NPWS (2013c) Rockabill to Dalkey Island SAC Conservation objectives supporting document - Marine Habitats and Species. Version 1, April 2013. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin

NPWS (2013d) Conservation Objectives: Rockabill to Dalkey Island SAC 003000. Version 1. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin

NPWS (2013e) Conservation Objectives: Lambay Island SAC 003000. Version 1. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, DublinNPWS (2015) Conservation objectives for Ireland's Eye SPA [004117]. Generic Version 4.0. Department of Arts, Heritage and the Gaeltacht, Dublin

Reine, K. J., D. G. Clarke, and C. Dickerson (2012). Characterization of underwater sounds produced by a backhoe dredge excavating rock and gravel. DOER Technical Notes Collection ERDC TN-DOER-E36, U.S. Army Engineer Research and Development Centre, Vicksburg, Mississippi, USA

Robinson, S. P., Theobald, P. D., Hayman, G., Wang, L. S., Lepper, P. A., Humphrey, V. & Mumford, S (2011). Measurement of underwater noise arising from marine aggregate dredging operations – MEPF report 09/P108. Marine Aggregate Levy Sustainability Fund.

Robinson, S.P., P.D. Theobald, P.A. Lepper, G. Hayman, V.F. Humphrey, L.S. Wang, and S. Mumford (2012). Measurement of underwater noise arising from marine aggregate operations. In: Popper, A.N. and A.D. Hawkins, eds. The effects of noise on aquatic life. New York: Springer Science + Business Media, LLC. Pp. 465-469.

Southall, Brandon L. & Ann E. Bowles, William T. Ellison, James J. Finneran, Roger L. Gentry, Charles R. Greene Jr., David Kastak, Darlene R. Ketten, James H. Miller, Paul E. Nachtigall, W. John Richardson, Jeanette A. Thomas, & Peter L. Tyack (2007) Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations Aquatic Mammals, Volume 33, Number 4, 2007 ISSN 0167-5427

Appendix A Ornithology Survey Report

Greater Dublin Drainage

Appendix A

Estuarine, Coastal and Marine Ornithology Technical Report

May 2018

Project Number: SEC7909

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This report has been prepared within the RPS Planning and Development Quality Management System to British Standard EN ISO 9001 : 2008

REPORT TEMPLATE

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CONTENTS

1. INTRODUCTION

1.1 Purpose of this Document

This document outlines the protocols for surveys and presents the ornithology data collected for the Greater Dublin Drainage (GDD) Project on estuarine, coastal and marine ornithology. It should be read in conjunction with the relevant Environmental Impact Assessment Report (EIAR) chapter (Chapter 10: Marine Ornithology).

The following surveys are covered by this document:

- Coastal and Marine VP (Velvet Strand; VP1);
- Coastal and Marine VP (Ireland's Eye; VP2); and
- Estuarine bird surveys (Baldoyle Bay).

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Data collected between December 2014 and March 2018 is included.

2. ESTUARINE BIRD SURVEYS

2.1 Survey Methodology

2.1.1 Introduction

Estuarine walkover surveys were carried out based on the standard Wetland Bird Survey methods (Gilbert *et al*., 1998; BTO 2016a and 2016b), using a more refined methodology involving the recording of precise locations of birds as well as their behaviour. Surveys aimed to count, map and record behaviour of wildfowl and waders using the estuarine habitat, in addition to other species of bird present.

2.1.2 Survey Location

The survey area is shown in Figure 10.1 of the EIAR chapter. The survey area covered the route of the pipeline to the outfall where it crosses intertidal/ estuarine habitat, and extended up to 1km from this route across the Baldoyle Bay SPA and surrounding habitats. The size of the survey area was approximately 4.95km².

2.1.3 Target Species

The key species groups were wildfowl, waders and seabirds. However, during the surveys all birds were recorded. Priority was given to recording birds on the ground or on water within the survey area. Records of notable flying birds were made, for example raptors or flocks of waterfowl and waders.

2.1.4 Survey Timing and Effort

In each month, two estuarine survey counts were completed. Each survey was of six hours duration. If the survey area was covered before the allotted time has elapsed (which was possible at high tide), the remaining time was used to undertake repeat counts of any wader or wildfowl hotspots.

Timings of counts throughout the survey period were made so that the whole tidal cycle was equally covered. Counts were made during full daylight.

2.1.5 Field Recording

Species were recorded using standard BTO codes and the behaviour codes specified on the survey map. Information on the age and sex of target species was also desirable. Notable observations that occurred outside the study area but within sight of the surveyors inside the study area were recorded.

2.2 Results

2.2.1 Survey Effort

Survey effort during the estuarine walkover surveys is presented in Appendix 1 (Table A10.1).

2.2.2 Peak Counts

Peak counts from estuarine walkover surveys are presented in Appendix 2 (Tables A10.2 to A10.4).

2.2.3 Figures

The distribution of 53 species encountered during the estuarine walkover surveys is presented in Figures TA10.1 to TA10.53. A figure was produced for species that were named on citations of the Baldoyle Bay, Ireland’s Eye or Howth Head Coast SPA, or if more than ten records of the species were made during the surveys.

3. COASTAL AND MARINE VANTAGE POINT (VP) SURVEYS

3.1 Survey Methodology

3.1.1 Introduction

VP surveys were carried out based on those undertaken for the MeyGen Tidal Energy Project in the Pentland Firth (RPS, 2013). They were carried out from December 2014, with six hours of survey carried out monthly per VP to March 2018.

Survey protocol was designed to count birds on the water (primary focus) and in flight (through snapshot recording).

3.1.2 Survey Locations

One location on the mainland and one location on Ireland's Eye were used. The mainland coastal VP was positioned as in previous surveys at the proposed landfall location at Portmarnock (IO250423, Lat. 53.41631, Long. -6.11966, mean viewing angle 70°). The Ireland's Eye VP was positioned at IO287415 (Lat. 53.40792, Long. -6.06387, mean viewing angle 0°).

The mainland coastal VP covered the area of the marine outfall out to sea using a 2km viewing arc; and the Ireland's Eye VP covered the remaining pipeline route using a 2km viewing arc. In this way, a buffer around the marine outfall pipeline footprint and working area was achieved.

3.1.3 Target Species

Key species/ species groups are as listed below. These are primarily seabirds which utilise the marine environment for breeding, foraging or roosting. All species listed were covered, but species marked in bold were considered priority.

- Seaducks
- Divers
- Grebes
- **Fulmar** and other tubenoses (petrels, shearwaters)
- Gannet
- **Cormorant**
- **Shag**
- Skuas
- **Lesser black-backed gull**
- **Herring gull**
- Other large gulls
- **Kittiwake**
- Other small gulls (e.g. black-headed gull, common gull)
- **Roseate tern**
- **Common tern**
- **Arctic tern**
- **Auks**

3.1.4 Survey Timings

From each VP, six hours of survey were undertaken each month, timed to give coverage over a range of tide states, whilst ensuring a spread between neap and spring tides. Surveys commenced and ended no earlier than half an hour before sunrise and or no later than half an hour after sunset. Each VP survey was three hours long, and a minimum of 30 minutes taken as a break between surveys.

3.1.5 Field Recording

The 2km 180° viewing arc was divided into 6 (30°) sections labelled A-F. Each section was subdivided into 500m distance bands (numbered sequentially 1 to 4 away from observer). Each section was identified using land features, rangefinders, and by measuring the compass bearing from the observer.

A full binocular/telescope (dependent on distance band) scan of the whole area was made every 10 minutes, the surveyor working sequentially through the grid and distance bands and recording all birds observed on the water. Only birds on the sea surface, or birds in flight but using the sea (e.g. plunge diving or surface feeding, or clearly observing the sea surface in preparation to do so, or even, if not feeding, regularly dropping to the sea surface) were recorded during this scan; flying birds were ignored. The location of each record was determined using bearings, angles of declination or with reference to static easily identifiable objects in the sea. Standardised protocols for dealing with recording of behaviours and associations were used.

At the end of each full scan, birds in flight were counted in each sector. To reduce/ eliminate double counting this should be as near an instantaneous count as possible.

Throughout a day's observations, environmental conditions were recorded at hourly intervals using standard recording forms.

The following behaviour codes were used to describe birds on the water:

- SU: Surface feeding;
- PL: Plunge feeding;
- DP: Dip feeding;
- FE: Feeding (other);
- SC: Scavenging;
- SF: Scavenging at fishing vessel;
- KL: Kleptoparasitising;
- CN: Carrying nest material;
- CF: Carrying food;
- PR: Preening or bathing;
- ED: Escape diving from vessel;
- EF: Escape flight from vessel;
- RO: Roosting on water;
- LO: Loafing.

3.2 Results

3.2.1 Survey Effort

Survey effort during the Coastal and Marine VP surveys is presented in Appendix 3.

3.2.2 VP Peak Counts

Peak counts from Coastal and Marine VP surveys are presented in Appendix 4. Presented are tables which show the species recorded during both the breeding (April to August) and passage/winter (September to March) seasons, the total number of times they were recorded during surveys (split by in flight or on sea), and the peak count of birds that were recorded during a single scan (split by in flight or on sea, and combined). Species have been split into tables based on SPA citation (i.e. Ireland’s Eye/Howth Head Coast SPA, Baldoyle Bay SPA, and non-cited species).

4. REFERENCES

- BTO (2016a). WeBS Core Counts Method. Available at: http://www.bto.org/volunteer-surveys/webs/taking-part/core-counts-methods.

- BTO (2016b). WeBS Low Tide Counts Method. Available at: http://www.bto.org/volunteer-surveys/webs/taking-part/low-tide-counts.

- Gilbert G., Gibbons D.W. & Evans, J. (1998) Bird Monitoring Methods: A Manual of Techniques for Key UK Species. RSPB, Sandy.

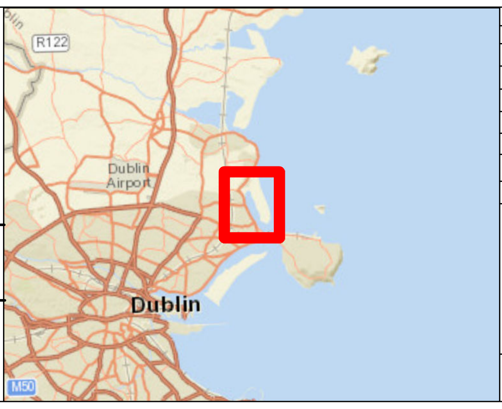
- RPS (2013). MeyGen Tidal Energy Project Inner Sound, Pentland Firth Ornithological Technical Report.

FIGURES

Legend

🟥	Proposed Project Boundary
🟩	Proposed Outfall Pipeline Route (Marine Section)
▨	Baldoyle Bay SPA
▨	RPS estuarine survey area
●	Bar-tailed Godwit

Greater Dublin Drainage



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Drawing Title
Figure A10.1 Bar-tailed Godwit Records in Baldoyle Bay (Dec 2014 to March 2018)

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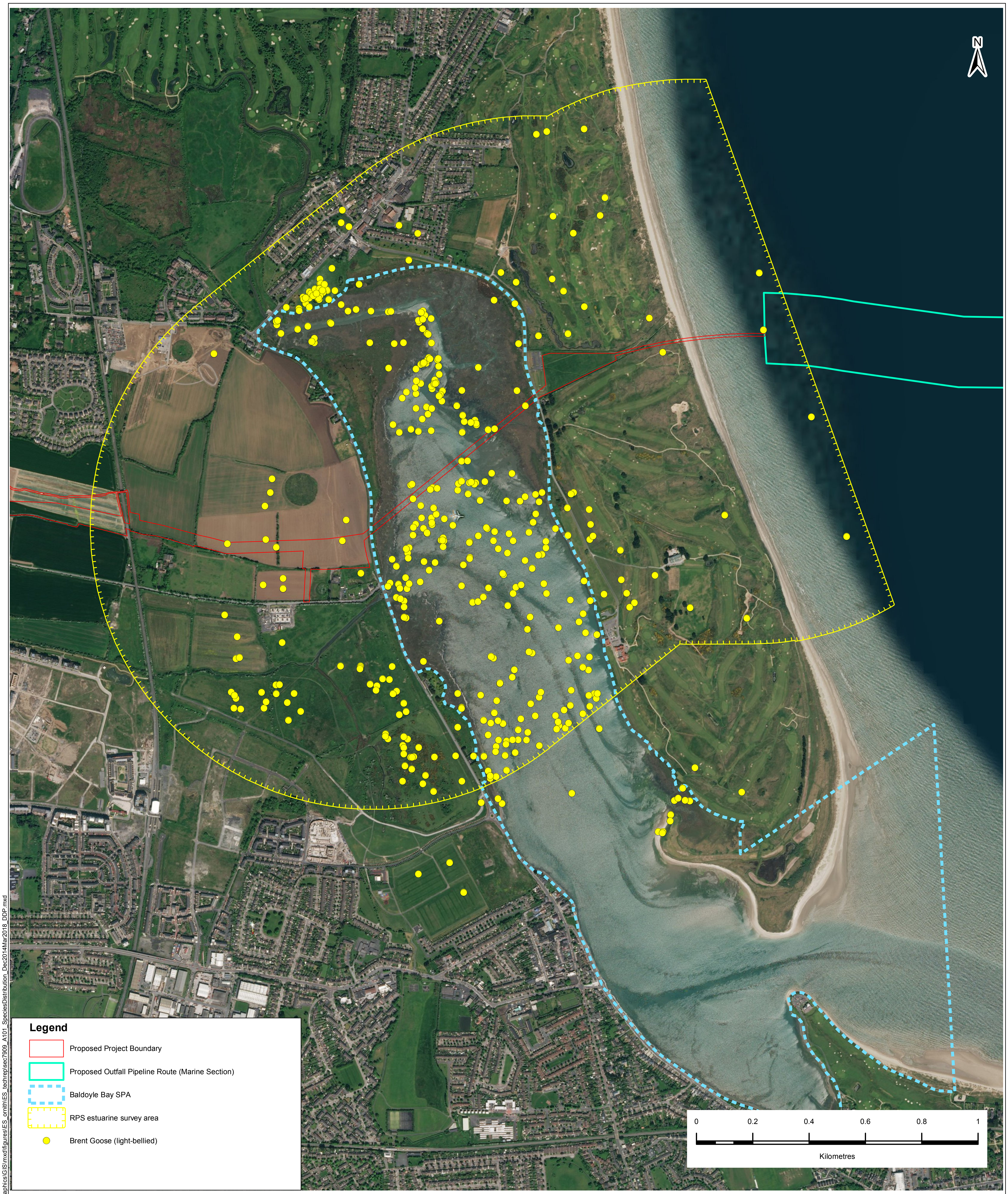

Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▨ Baldoyle Bay SPA
- ▨ RPS estuarine survey area
- ● Brent Goose (light-bellied)

Greater Dublin Drainage

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Figure A10.2 Brent Goose (LB) Records in Baldoyle Bay (Dec 2014 to March 2018)

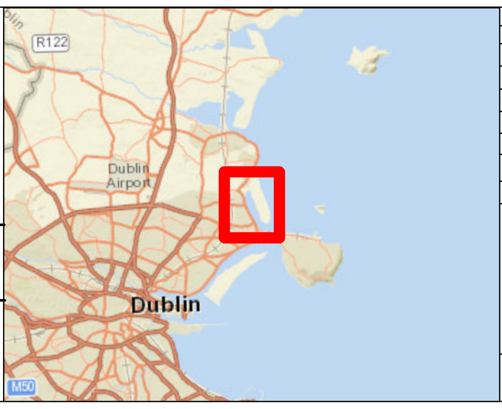

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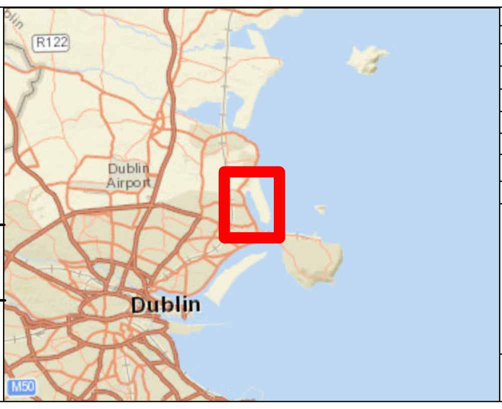
Figure A10.3 Golden Plover Records in Baldoyle Bay (Dec 2014 to March 2018)



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Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▭ Baldoyle Bay SPA
- ▭ RPS estuarine survey area
- ● Grey Plover

Greater Dublin Drainage

Project
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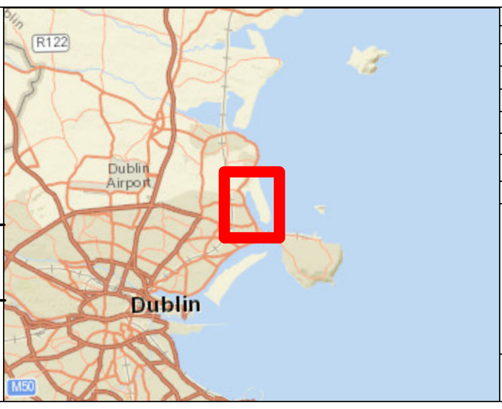
Drawing Title
Figure A10.4 Grey Plover Records in Baldoyle Bay (Dec 2014 to March 2018)



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Project
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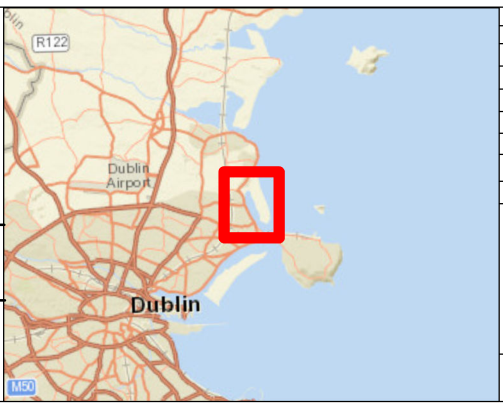
Drawing Title
Figure A10.5 Ringed Plover Records in Baldoyle Bay (Dec 2014 to March 2018)



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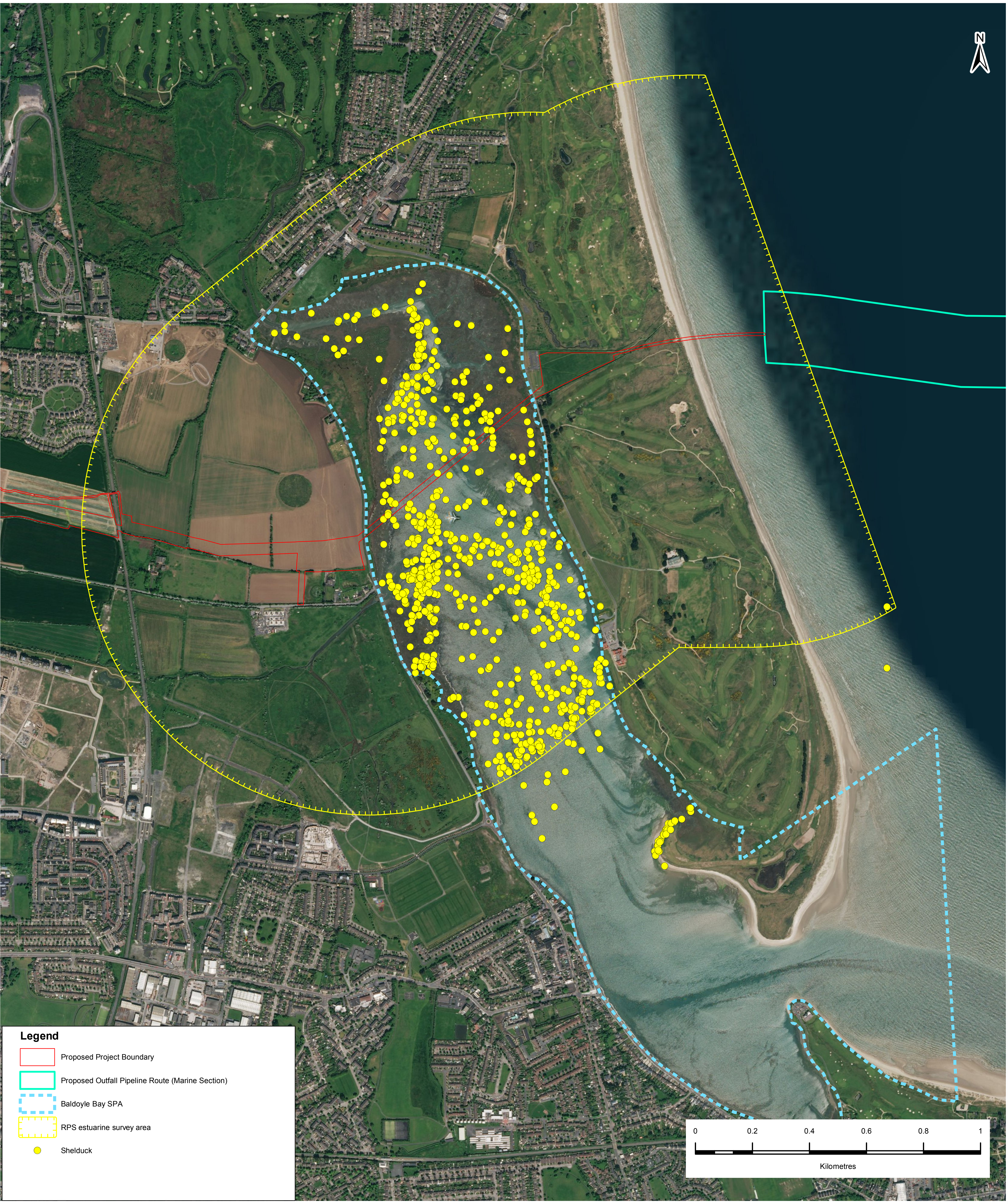

Greater Dublin Drainage

Project
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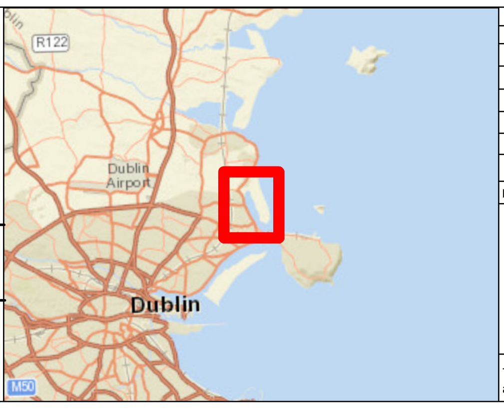
Drawing Title
Figure A10.6 Shelduck Records in Baldoyle Bay (Dec 2014 to March 2018)



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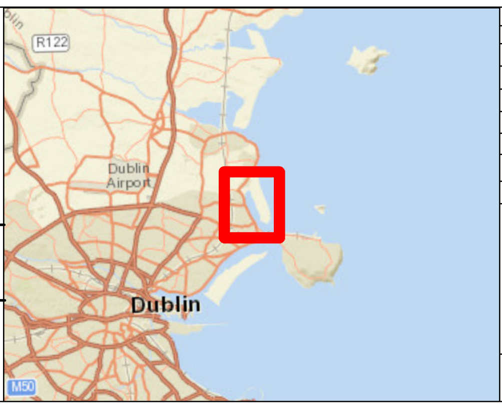
Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▨ Baldoyle Bay SPA
- ▨ RPS estuarine survey area
- ● Black-tailed Godwit
- ● Bluethroat

Greater Dublin Drainage



Project
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Drawing Title
Figure A10.7 Black-tailed Godwit Records in Baldoyle Bay (Dec 2014 to March 2018)

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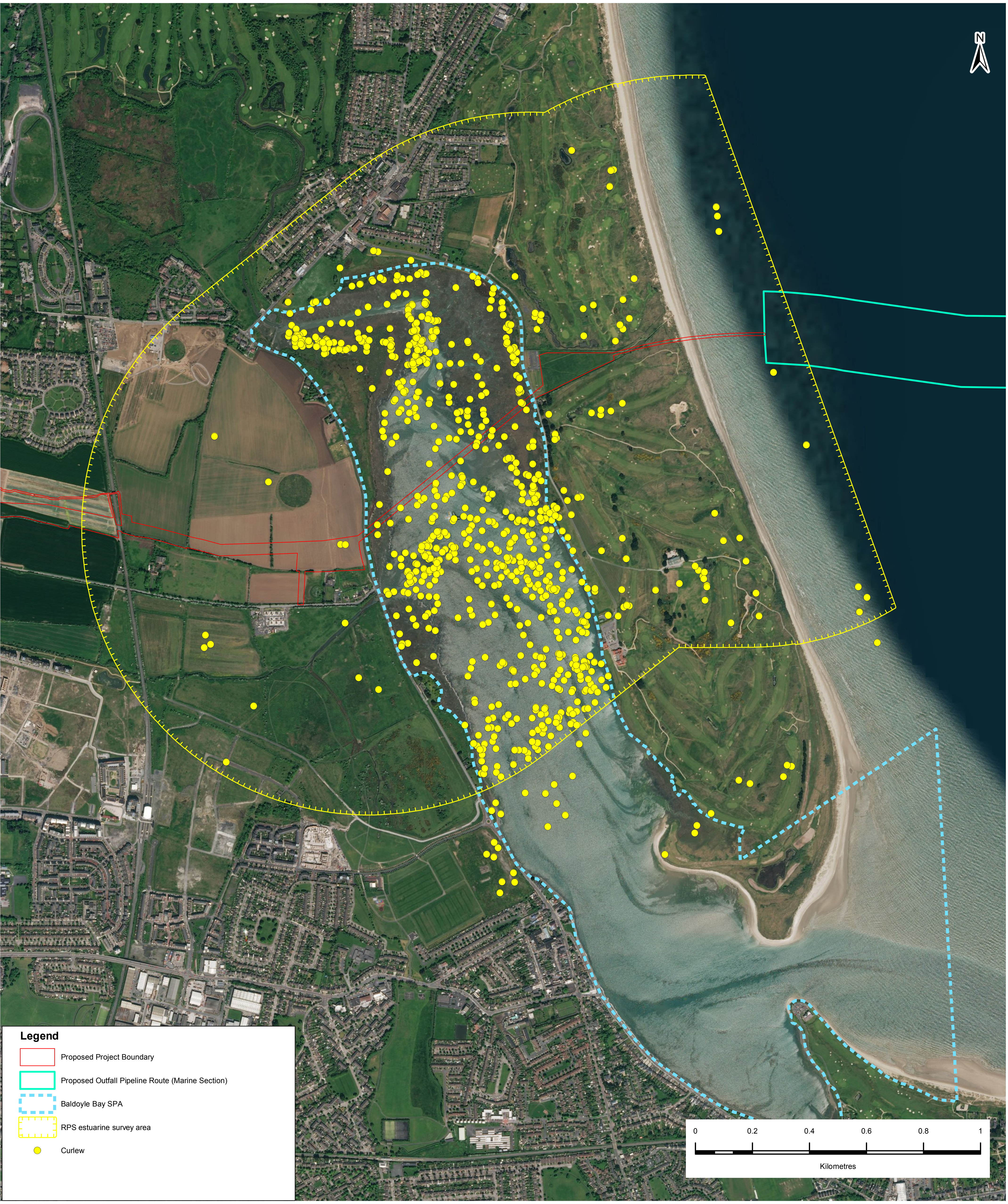

Project

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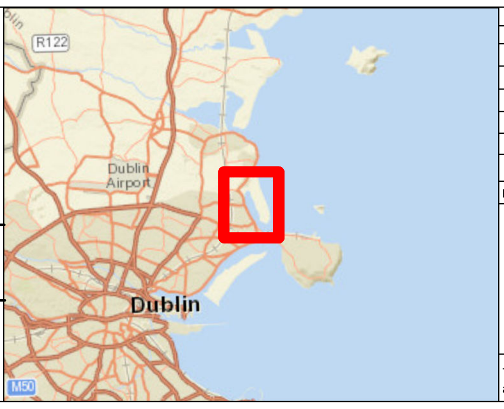
Drawing Title

Figure A10.8 Curlew Records in Baldoyle Bay (Dec 2014 to March 2018)



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
1	21/05/18	Additional survey data	CH	RI	KAG	RI
1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

Drawing Status	Final
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A108

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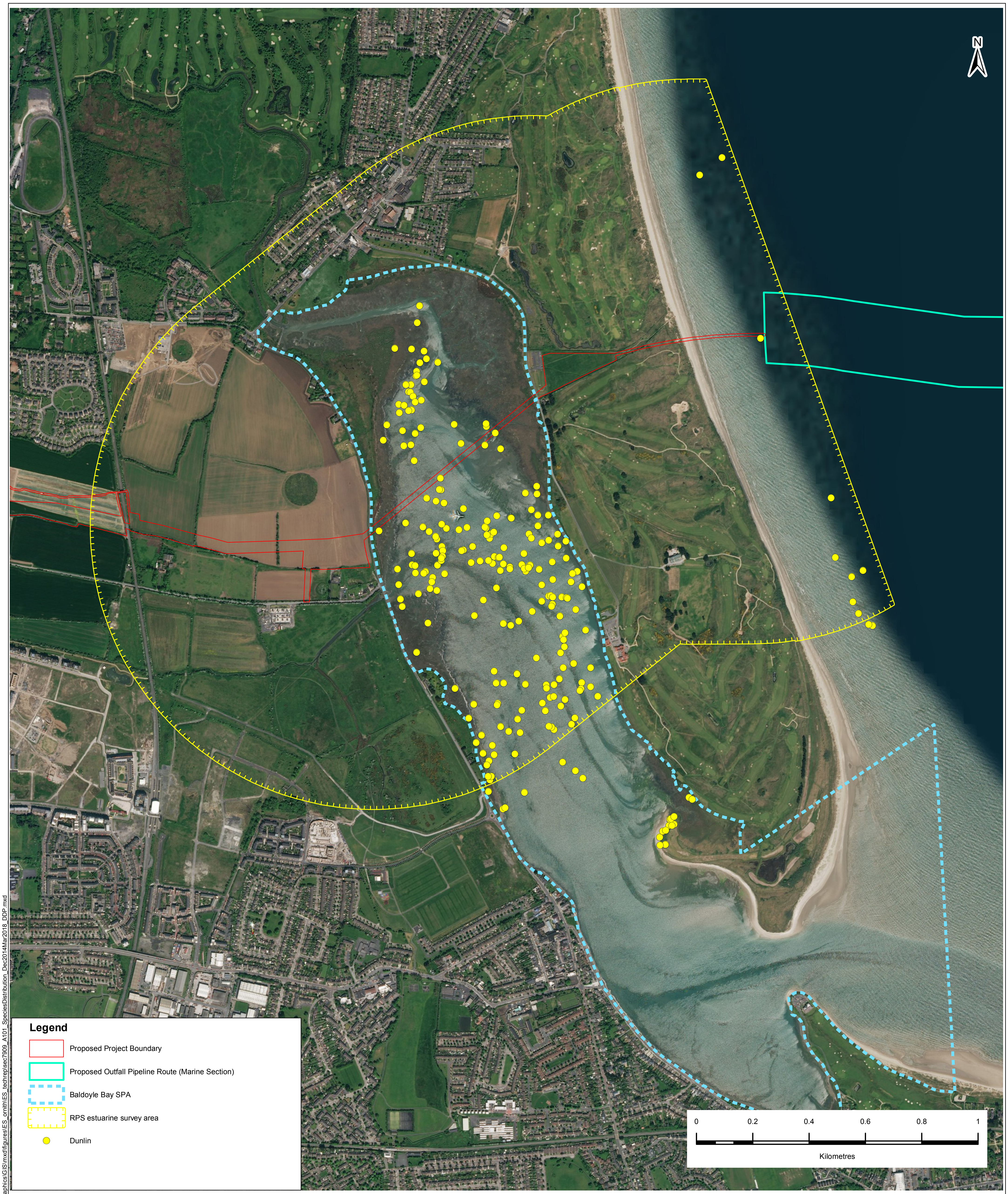

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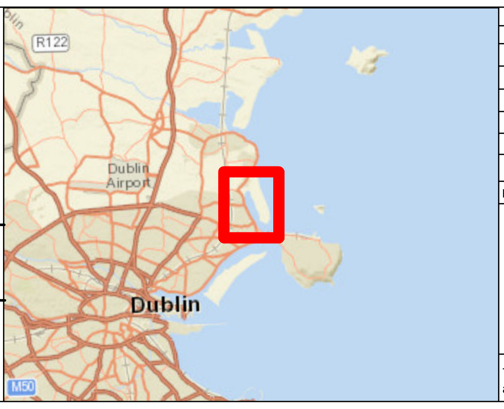
Project
Greater Dublin Drainage Project

Drawing Title
Figure A10.9 Dunlin Records in Baldoyle Bay (Dec 2014 to March 2018)



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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Status	Final
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A109

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Project
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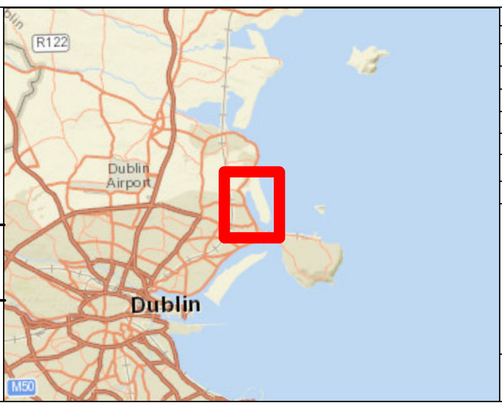
Drawing Title
Figure A10.10 Great Crested Grebe Records in Baldoyle Bay (Dec 2014 to March 2018)



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
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Drawing Status	Final
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1010

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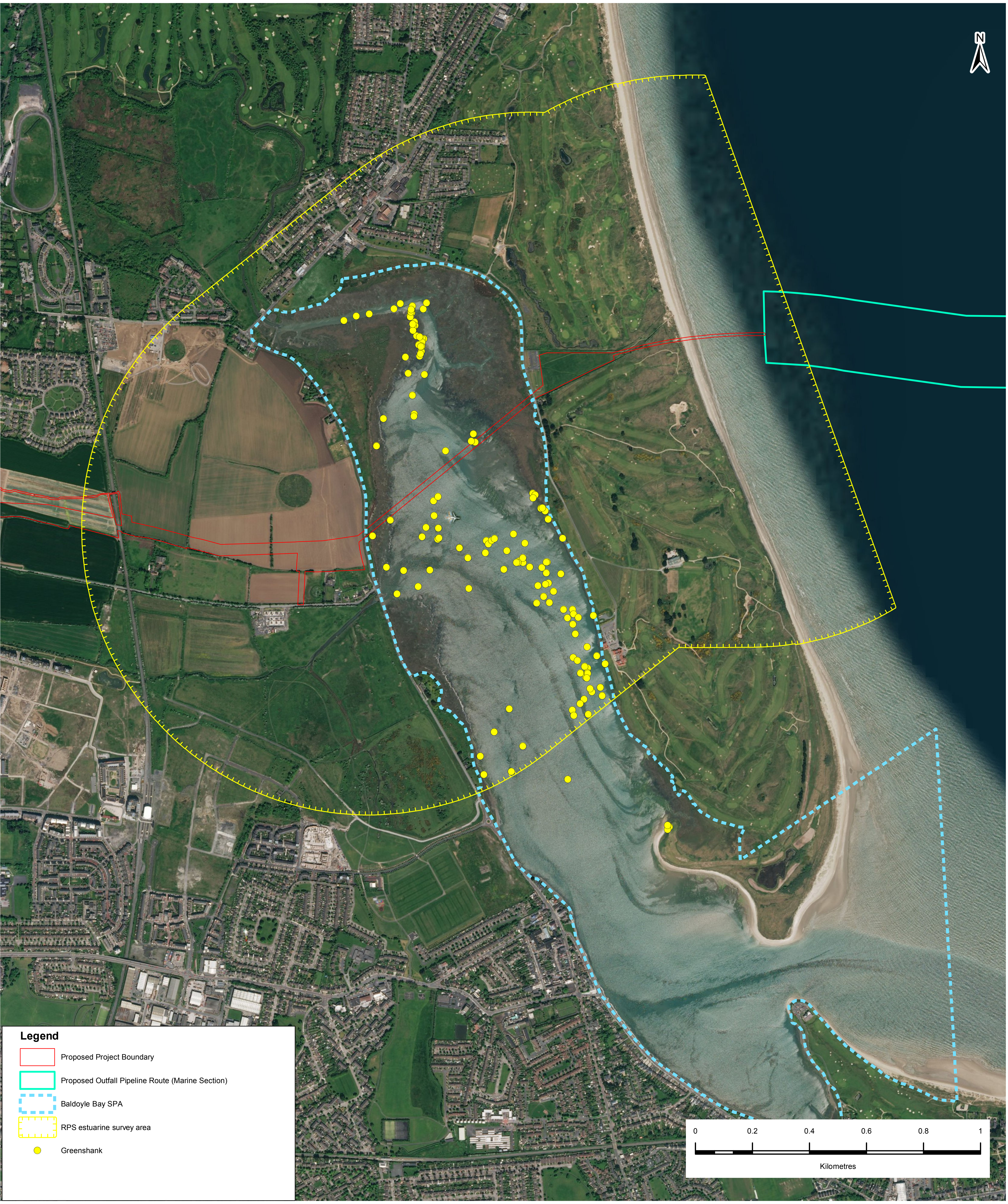

Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▨ Baldoyle Bay SPA
- ▨ RPS estuarine survey area
- ● Greenshank

Project
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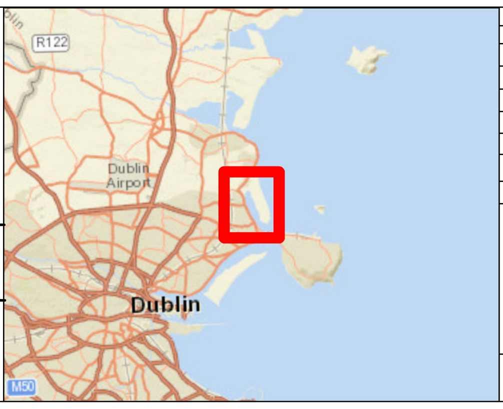
Drawing Title
Figure A10.11 Greenshank Records in Baldoyle Bay (Dec 2014 to March 2018)



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0	17/10/17	Draft	CH	RI	KAG	RI

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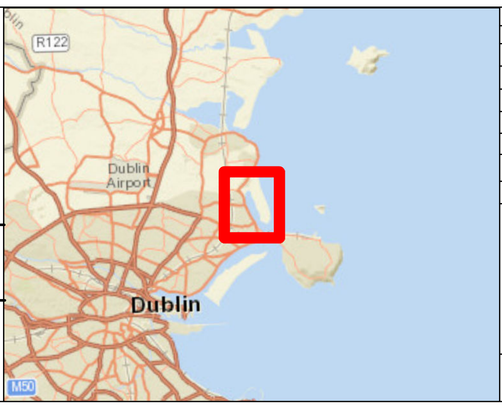
Drawing Status	**Final**
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1011

Legend

🟥	Proposed Project Boundary
🟩	Proposed Outfall Pipeline Route (Marine Section)
▨	Baldoyle Bay SPA
▨	RPS estuarine survey area
●	Grey Heron

Greater Dublin Drainage



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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
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Drawing Title
Figure A10.12 Grey Heron Records in Baldoyle Bay
(Dec 2014 to March 2018)

Drawing Status **Final**
Scale @ A3 1:12,500
Job No. SEC7909
Drawing No. 32102902-EIAR-A1012

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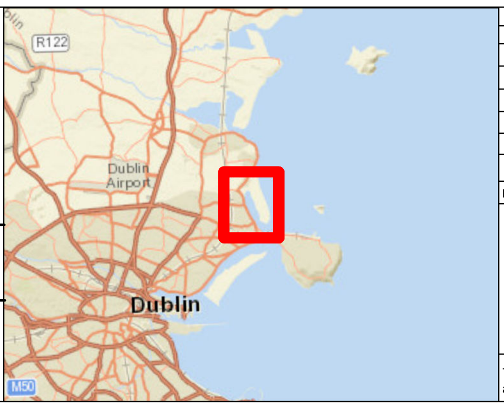
Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▭ Baldoyle Bay SPA
- ▭ RPS estuarine survey area
- ● Knot

Greater Dublin Drainage



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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Title
Figure A10.13 Knot Records in Baldoyle Bay (Dec 2014 to March 2018)

Drawing Status	Final
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1013

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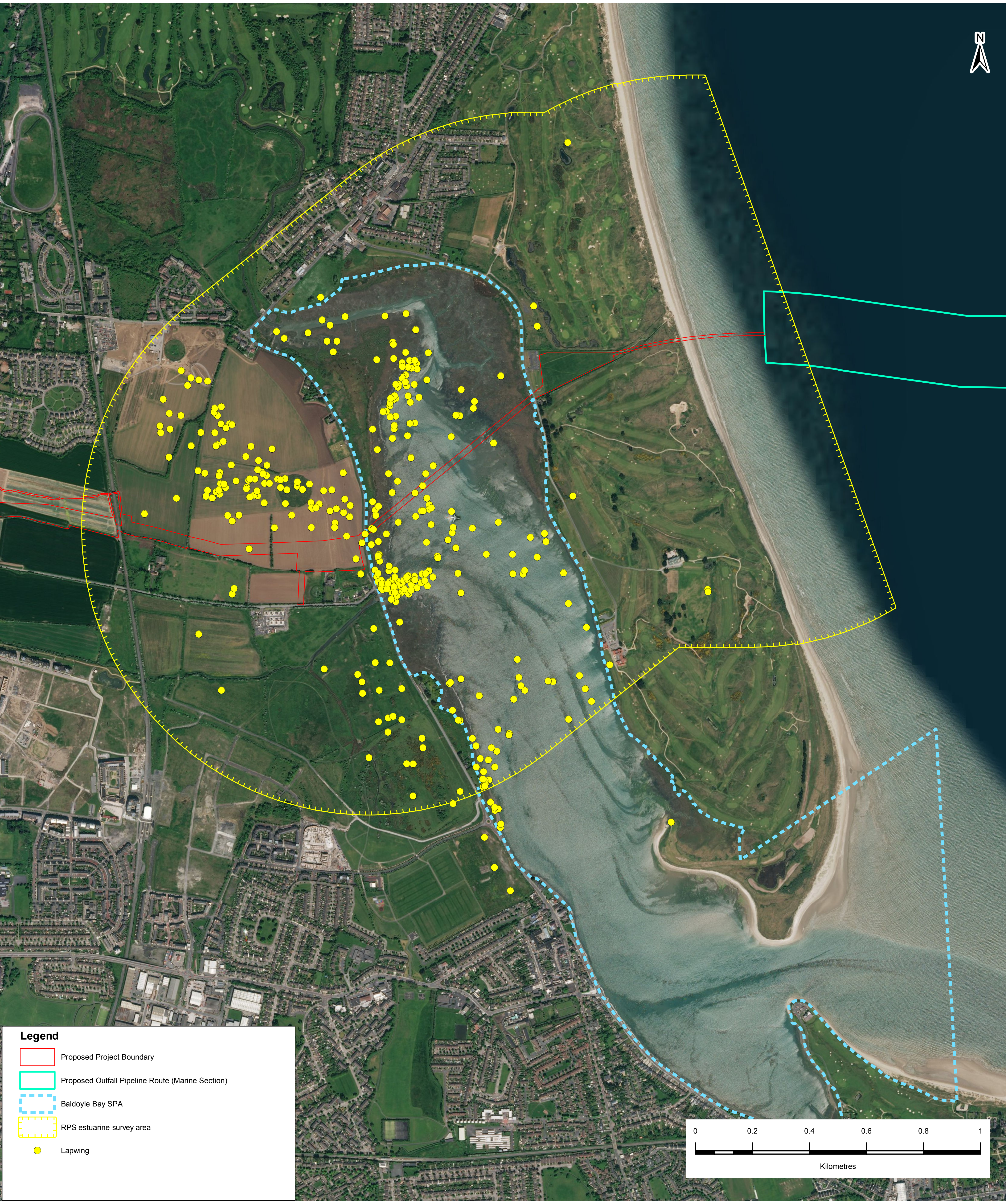
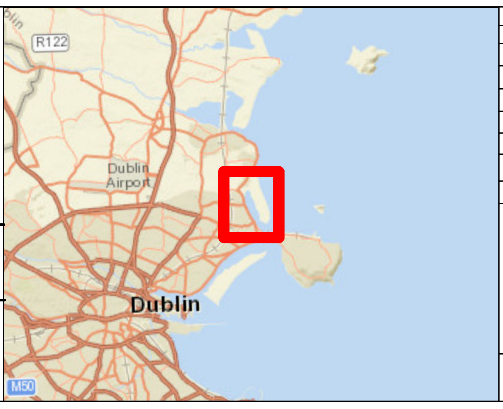


Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▭ Baldoyle Bay SPA
- ▭ RPS estuarine survey area
- ● Lapwing

Greater Dublin Drainage



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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Title
Figure A10.14 Lapwing Records in Baldoyle Bay (Dec 2014 to March 2018)

Drawing Status	Final
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1014

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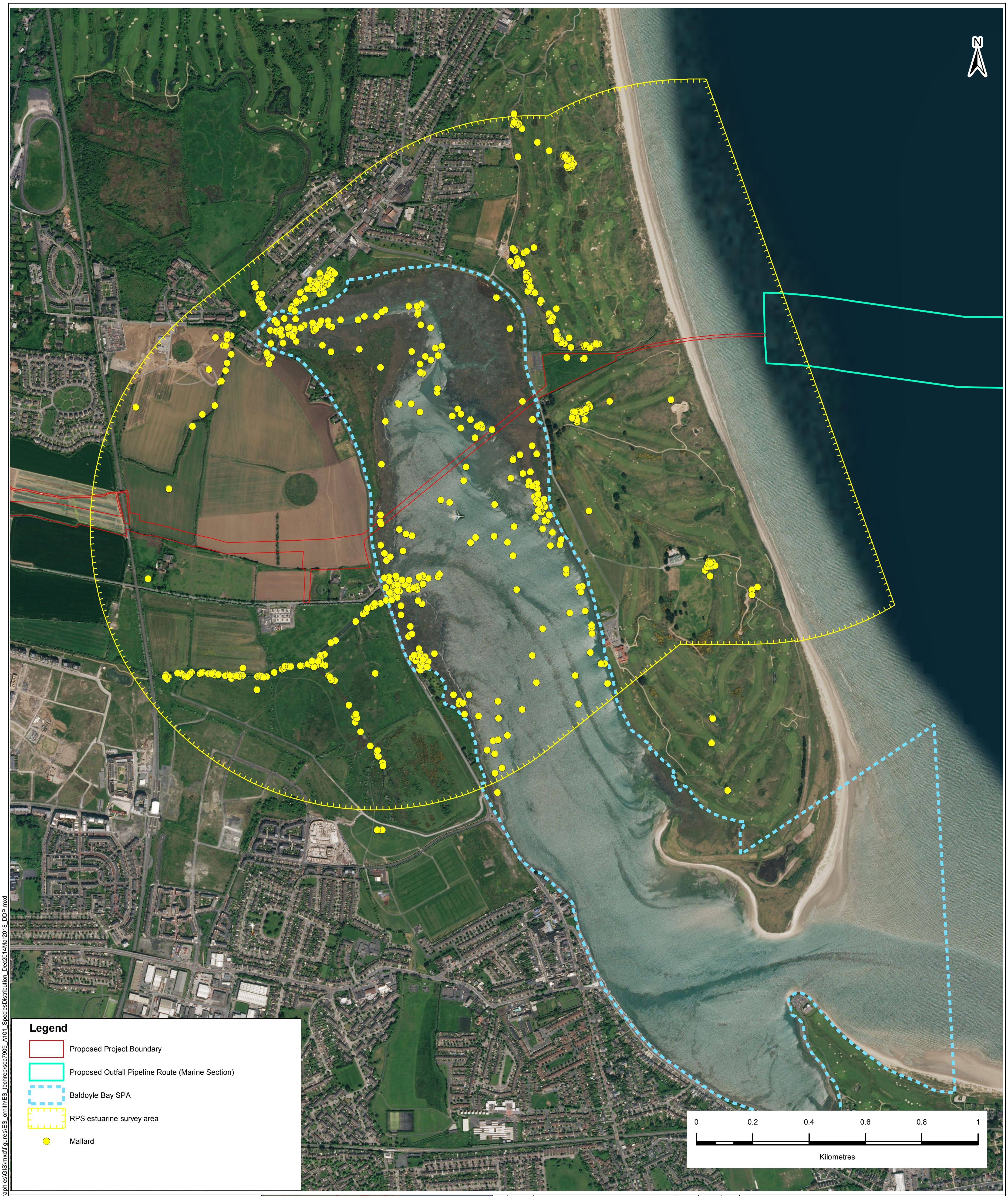
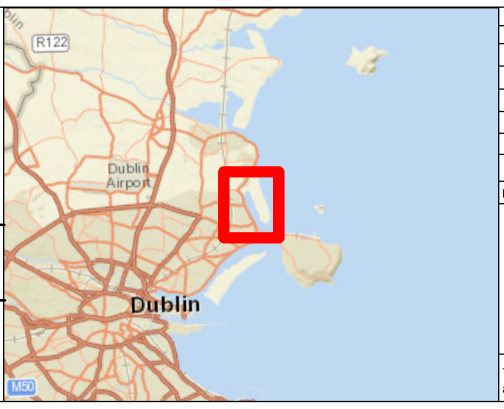


Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▨ Baldoyle Bay SPA
- ▨ RPS estuarine survey area
- ● Mallard



Project

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Drawing Title

Figure A10.15 Mallard Records in Baldoyle Bay (Dec 2014 to March 2018)

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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

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Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1015

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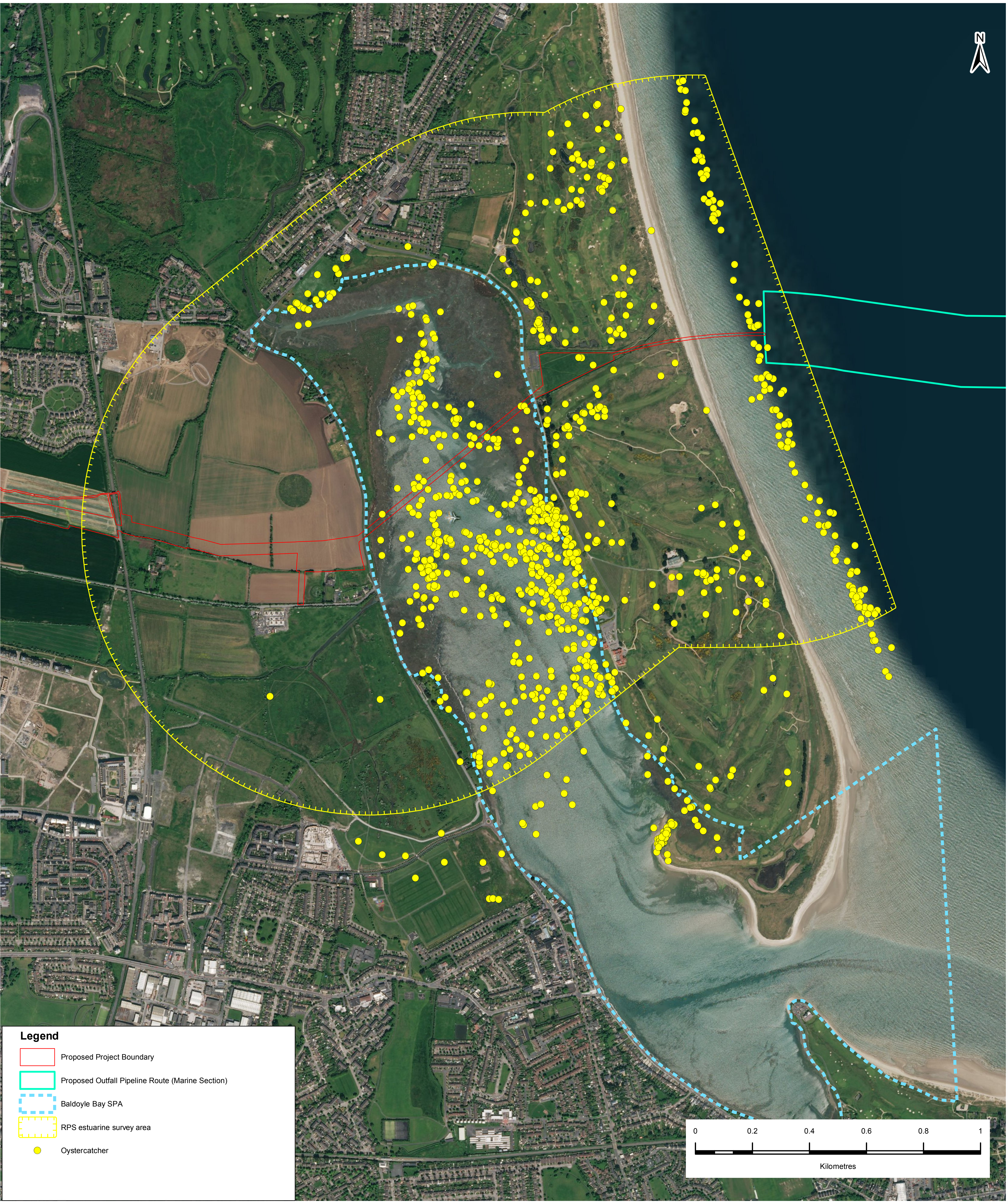

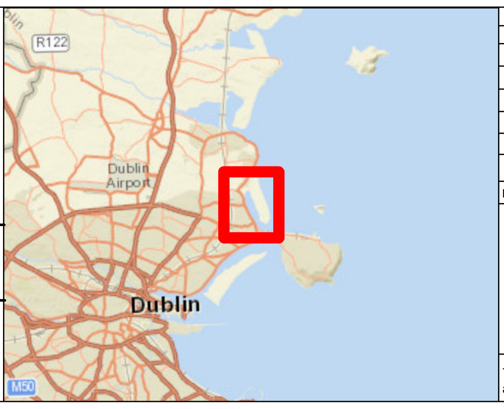

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0	17/10/17	Draft	CH	RI	KAG	RI

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Drawing Title
Figure A10.16 Oystercatcher Records in Baldoyle Bay (Dec 2014 to March 2018)

Drawing Status **Final**
Scale @ A3 1:12,500
Job No. SEC7909
Drawing No. 32102902-EIAR-A1016

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Project
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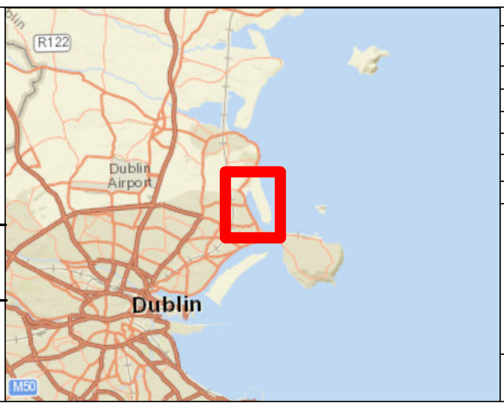
Drawing Title
Figure A10.17 Pintail Records in Baldoyle Bay (Dec 2014 to March 2018)



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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

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Scale @ A3	1:12,500
Job No.	SEC7909
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Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▨ Baldoyle Bay SPA
- ▨ RPS estuarine survey area
- ● Red-breasted Merganser

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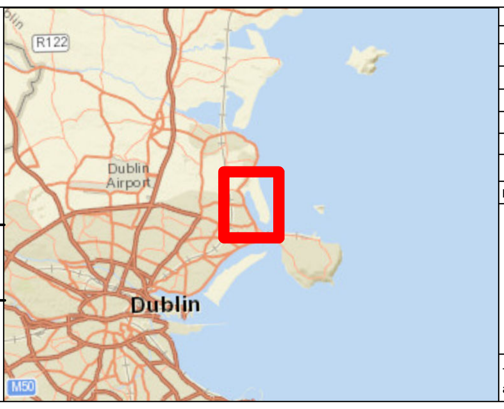
Drawing Title
Figure A10.18 Red-breasted Merganser Records in Baldoyle Bay (Dec 2014 to March 2018)



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Drawing Status	**Final**
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1018

Legend

🟥	Proposed Project Boundary
🟩	Proposed Outfall Pipeline Route (Marine Section)
▨	Baldoyle Bay SPA
▨	RPS estuarine survey area
●	Redshank

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Project
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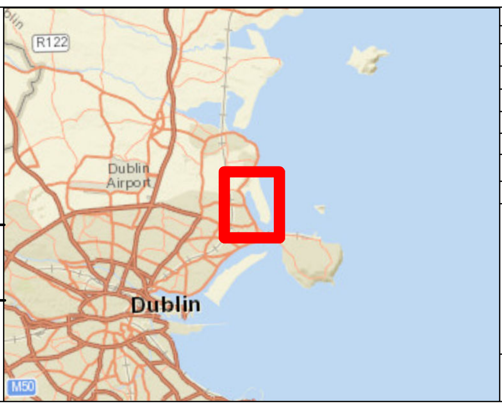
Drawing Title
Figure A10.19 Redshank Records in Baldoyle Bay
(Dec 2014 to March 2018)



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Drawing Status	Final
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1019

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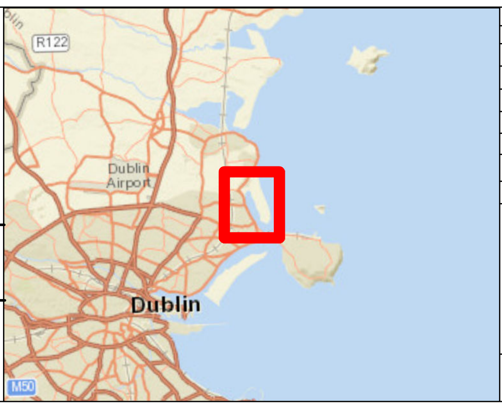
Drawing Title
Figure A10.20 Sanderling Records in Baldoyle Bay
(Dec 2014 to March 2018)



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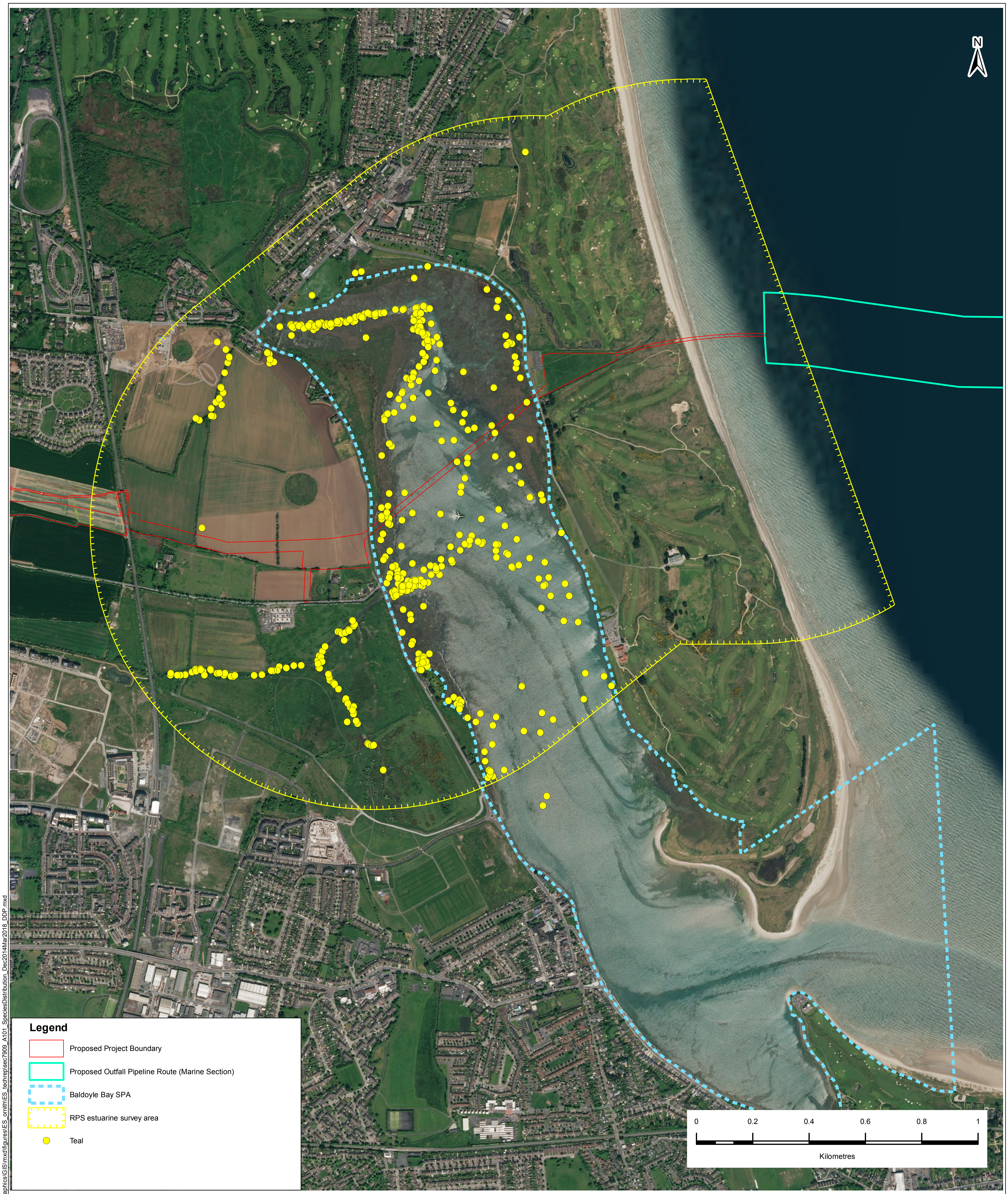

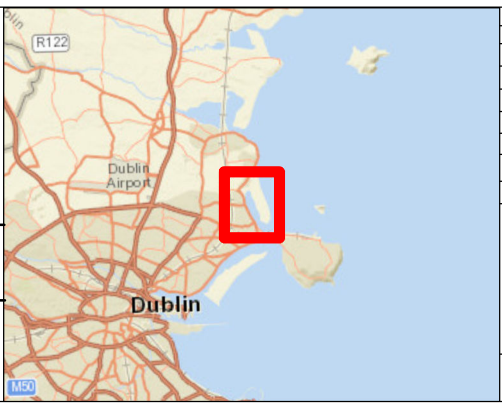

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Drawing Title
Figure A10.21 Teal Records in Baldoyle Bay (Dec 2014 to March 2018)

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0	17/10/17	Draft	CH	RI	KAG	RI

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Job No.: SEC7909
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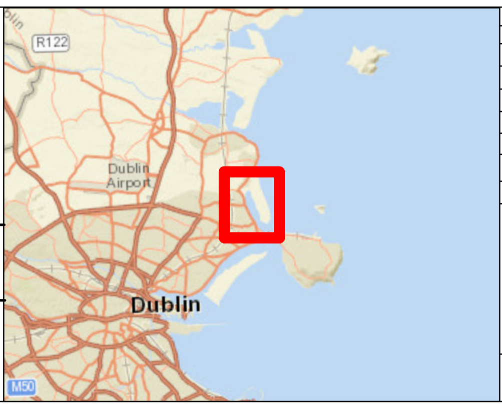

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Project
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Drawing Title
Figure A10.22 Turnstone Records in Baldoyle Bay
(Dec 2014 to March 2018)

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Job No.	SEC7909
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Project
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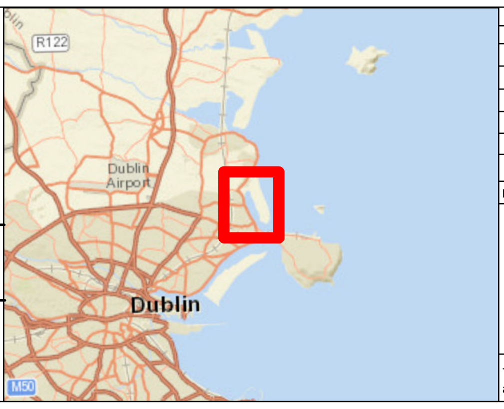
Drawing Title
Figure A10.23 Black Guillemot Records in Baldoyle Bay (Dec 2014 to March 2018)



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0	17/10/17	Draft	CH	RI	KAG	RI

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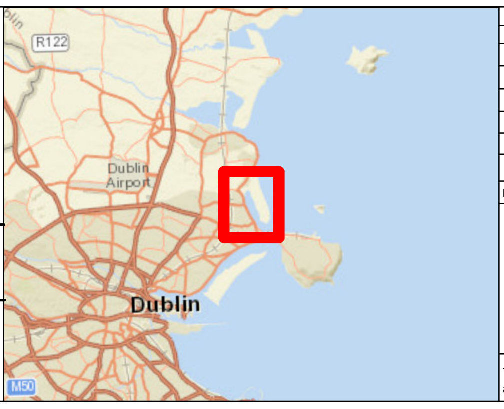
Drawing Title
Figure A10.24 Guillemot Records in Baldoyle Bay
(Dec 2014 to March 2018)



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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

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Job No. SEC7909
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Project
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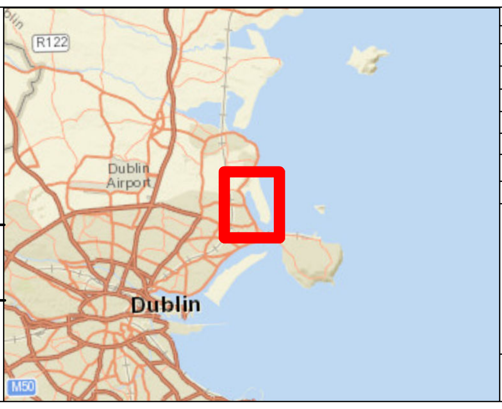
Drawing Title
Figure A10.25 Razorbill Records in Baldoyle Bay (Dec 2014 to March 2018)



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0	17/10/17	Draft	CH	RI	KAG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Status	Final
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1025

Legend

🟥 Proposed Project Boundary

🟩 Proposed Outfall Pipeline Route (Marine Section)

▨ Baldoyle Bay SPA

🟨 RPS estuarine survey area

● Great Northern Diver

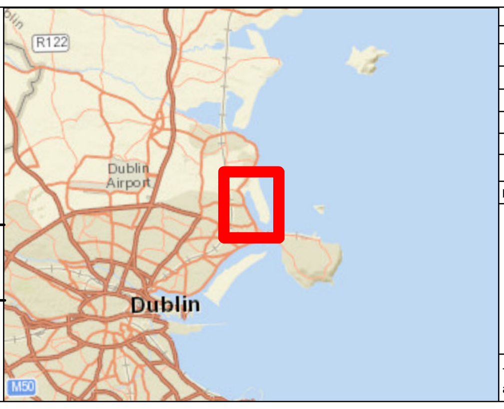
Greater Dublin Drainage

Project

Greater Dublin Drainage Project

Drawing Title

Figure A10.26 Great Northern Diver Records in Baldoyle Bay (Dec 2014 to March 2018)



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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Job No. SEC7909
Drawing No. 32102902-EIAR-A1026

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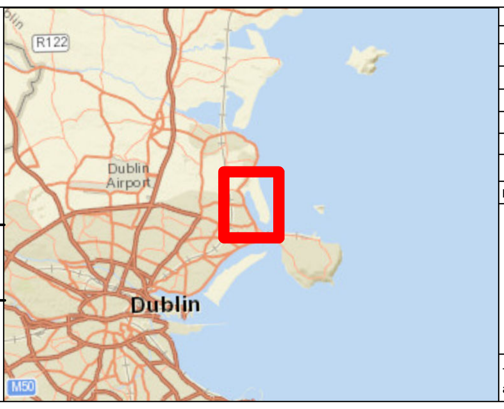
Greater Dublin Drainage

Project
Greater Dublin Drainage Project

Drawing Title
Figure A10.27 Red-throated Diver Records in Baldoyle Bay (Dec 2014 to March 2018)



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
1	21/05/18	Additional survey data	CH	RI	KAG	RI
1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

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Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1027

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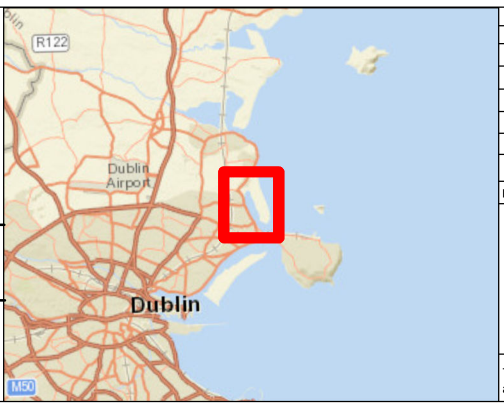
Legend

🟥	Proposed Project Boundary
🟩	Proposed Outfall Pipeline Route (Marine Section)
▨	Baldoyle Bay SPA
▨	RPS estuarine survey area
●	Mute Swan



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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Title
Figure A10.28 Mute Swan Records in Baldoyle Bay
(Dec 2014 to March 2018)

Drawing Status: Final
Scale @ A3: 1:12,500
Job No.: SEC7909
Drawing No.: 32102902-EIAR-A1028

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Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▨ Baldoyle Bay SPA
- ▨ RPS estuarine survey area
- ● Common Scoter

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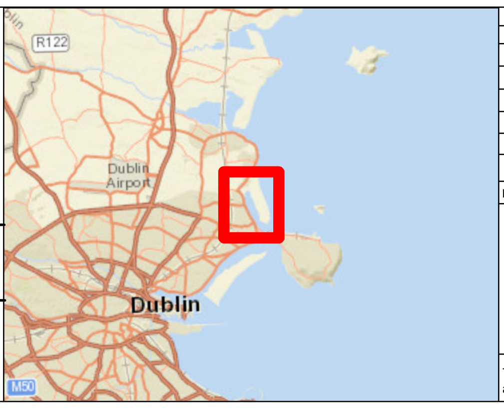
Project
Greater Dublin Drainage Project

Drawing Title
Figure A10.29 Common Scoter Records in Baldoyle Bay (Dec 2014 to March 2018)



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Job No.	SEC7909
Drawing No.	32102902-EIAR-A1029

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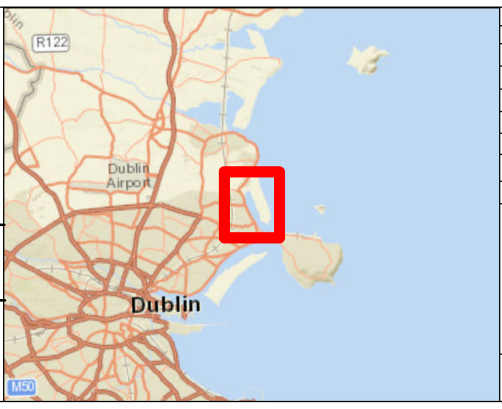
Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▨ Baldoyle Bay SPA
- 🟨 RPS estuarine survey area
- ● Coot



Project

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Drawing Title

Figure A10.30 Coot Records in Baldoyle Bay (Dec 2014 to March 2018)

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0	17/10/17	Draft	CH	RI	KAG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

Drawing Status	Final
Scale @ A3	1:12,500
Job No.	SEC7909
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Project

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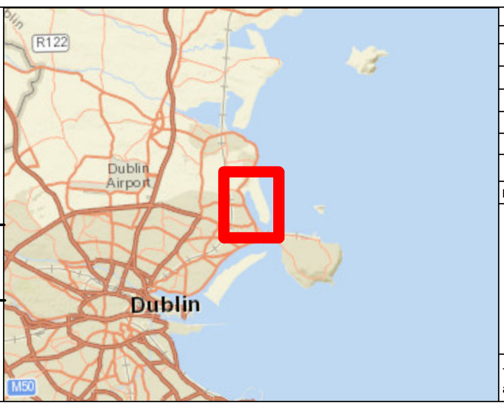
Drawing Title

Figure A10.31 Little Grebe Records in Baldoyle Bay (Dec 2014 to March 2018)



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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1031

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Legend

🟥	Proposed Project Boundary
🟩	Proposed Outfall Pipeline Route (Marine Section)
▭	Baldoyle Bay SPA
▭	RPS estuarine survey area
●	Moorhen

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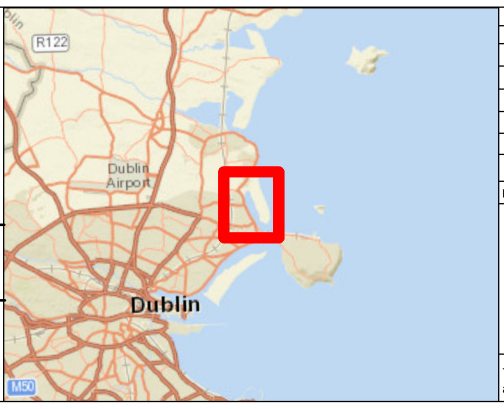
Drawing Title
Figure A10.32 Moorhen Records in Baldoyle Bay (Dec 2014 to March 2018)



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0	17/10/17	Draft	CH	RI	KAG	RI

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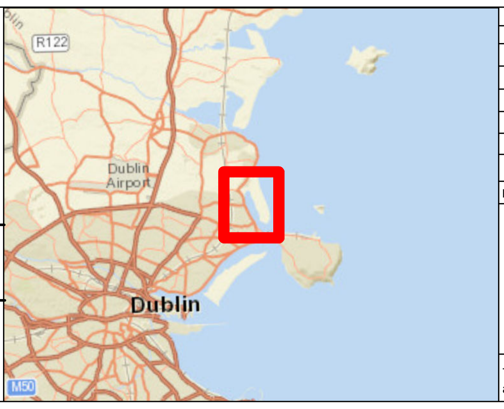
Drawing Title

Figure A10.33 Wigeon Records in Baldoyle Bay (Dec 2014 to March 2018)



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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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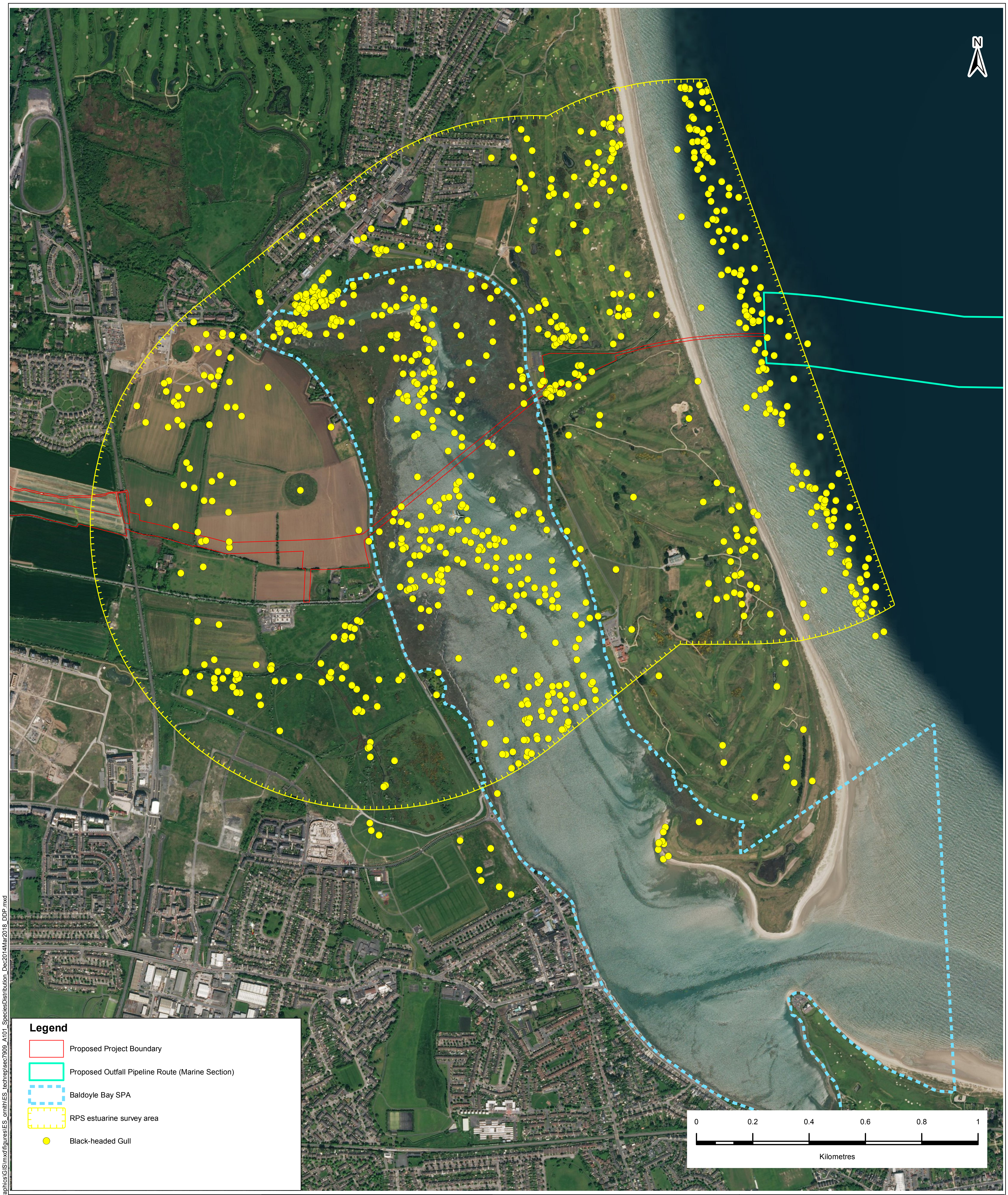

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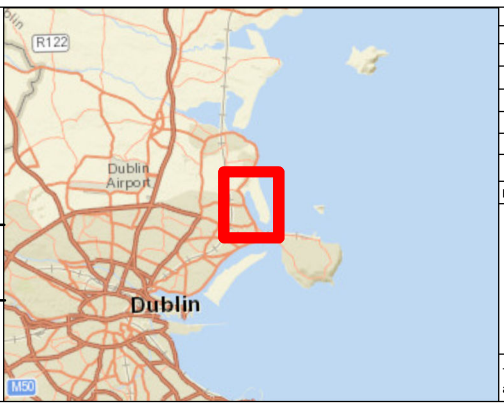

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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Title
Figure A10.34 Black-headed Gull Records in Baldoyle Bay (Dec 2014 to March 2018)

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Scale @ A3	1:12,500
Job No.	SEC7909
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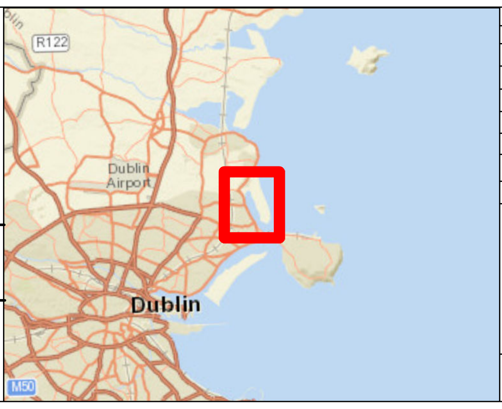
Drawing Title

Figure A10.35 Common Gull Records in Baldoyle Bay (Dec 2014 to March 2018)



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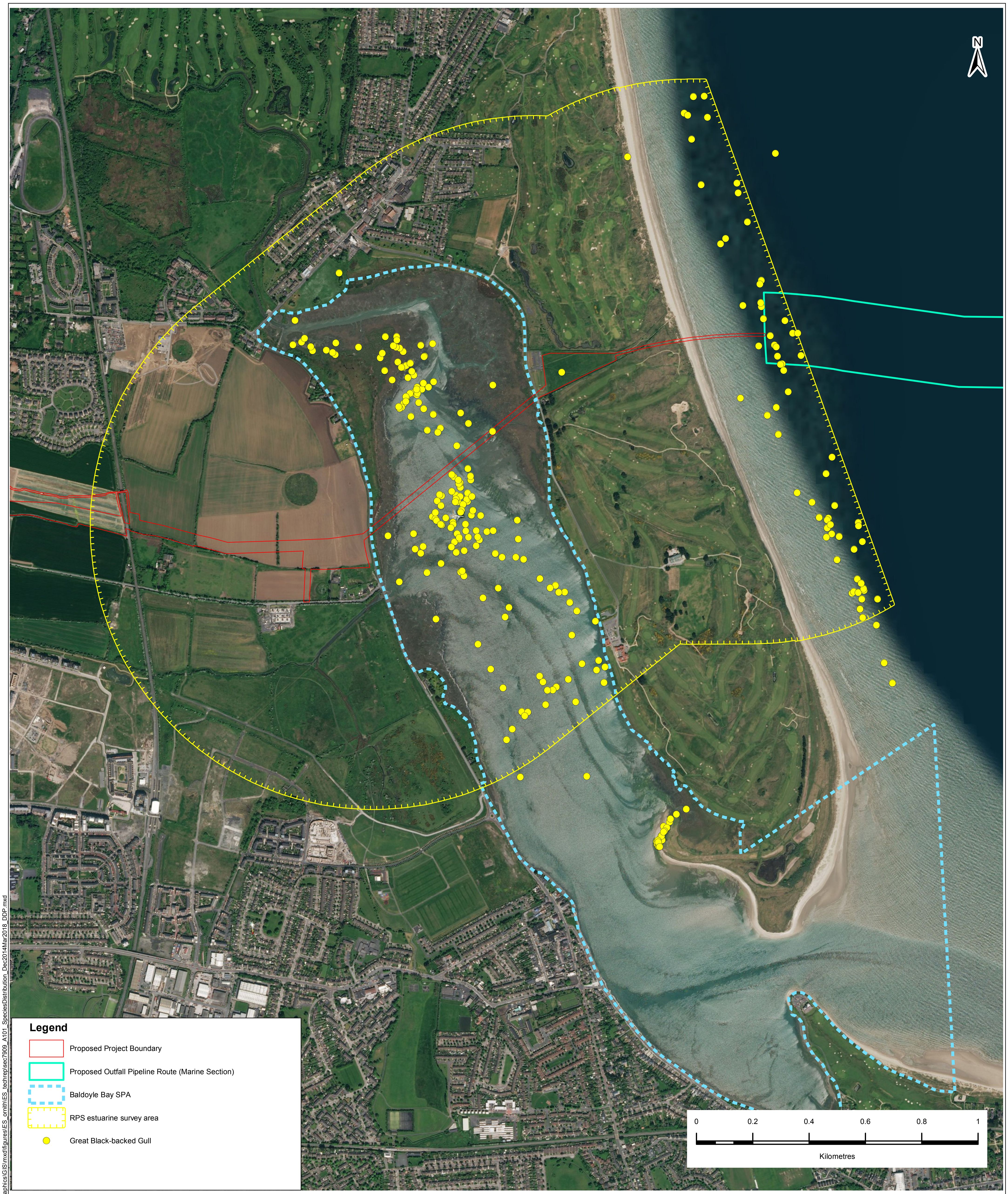

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Project
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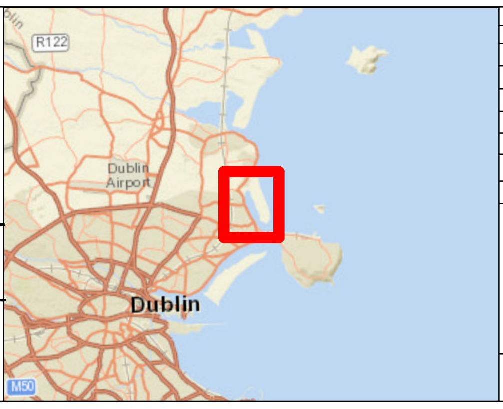
Drawing Title
Figure A10.36 Great Black-backed Gull Records in Baldoyle Bay (Dec 2014 to March 2018)



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Scale @ A3: 1:12,500
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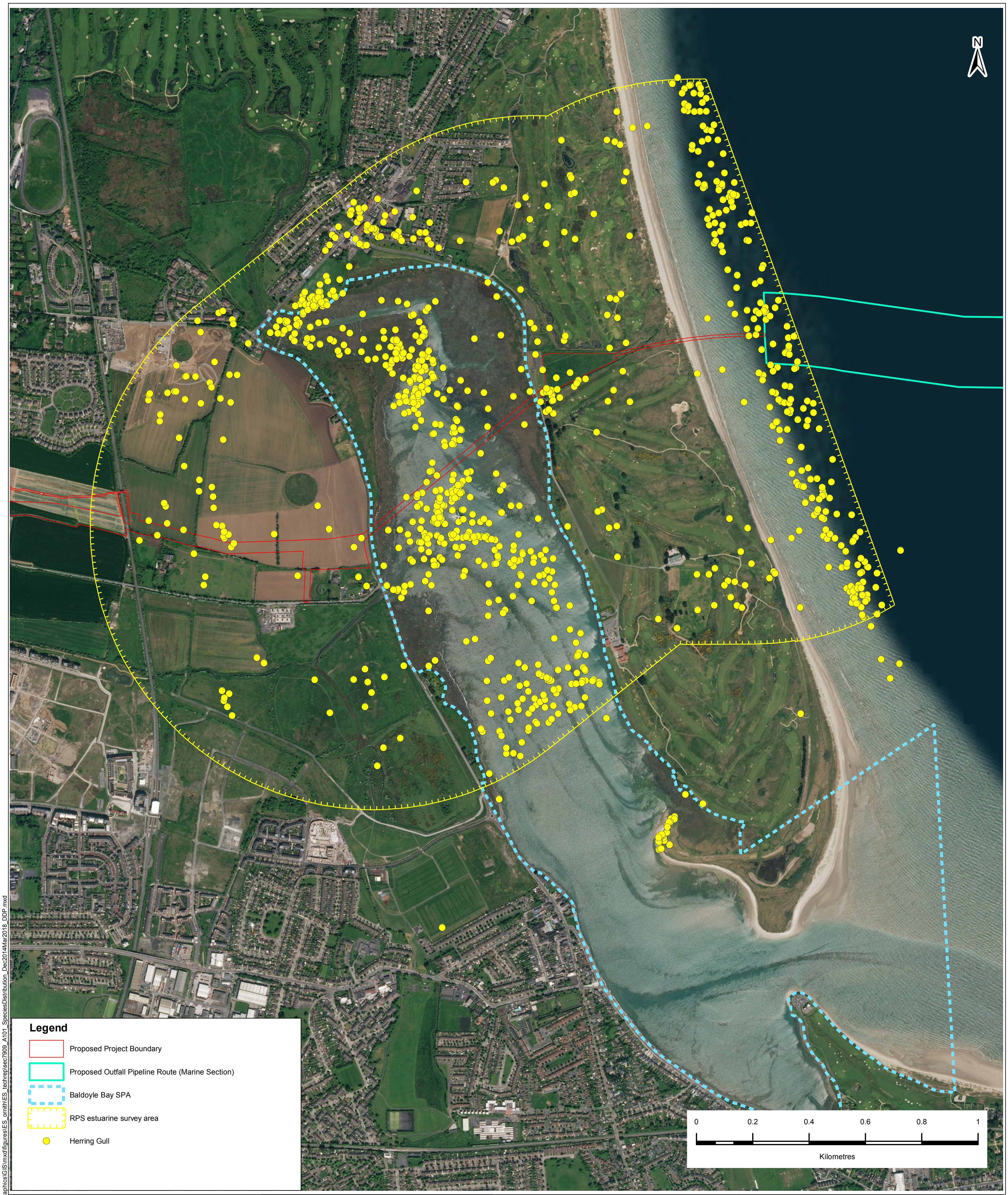
Drawing No.: 32102902-EIAR-A1036



Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▭ Baldoyle Bay SPA
- ▭ RPS estuarine survey area
- ● Herring Gull

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Project
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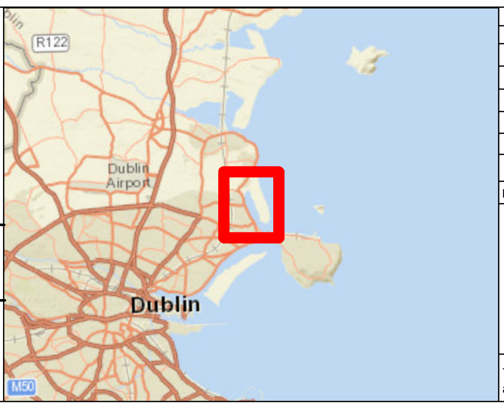
Drawing Title
Figure A10.37 Herring Gull Records in Baldoyle Bay (Dec 2014 to March 2018)



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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Status	**Final**
Scale @ A3	1:12,500
Job No.	SEC7909
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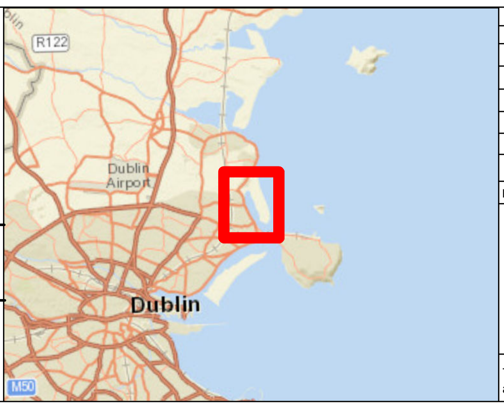

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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Title
Figure A10.38 Kittiwake Records in Baldoyle Bay (Dec 2014 to March 2018)

Drawing Status Final
Scale @ A3 1:12,500
Job No. SEC7909
Drawing No. 32102902-EIAR-A1038

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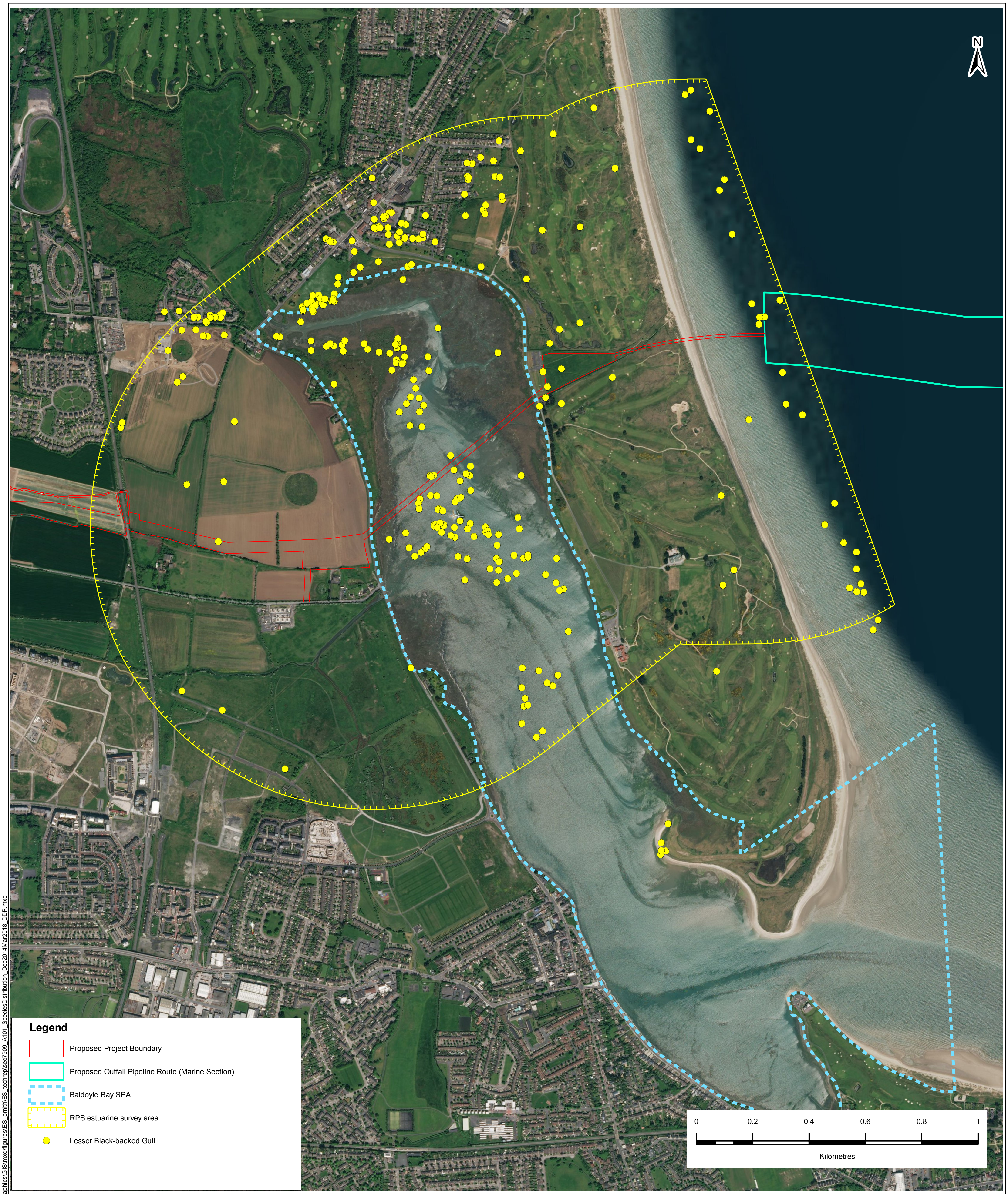

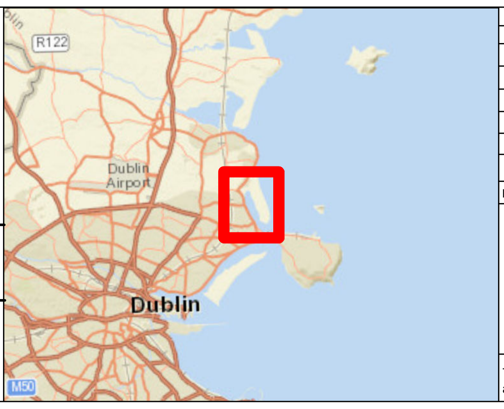

Project
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Drawing Title
Figure A10.39 Lesser Black-backed Gull Records in Baldoyle Bay (Dec 2014 to March 2018)

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Project
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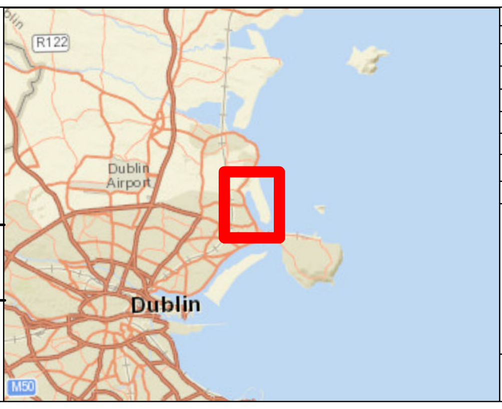
Drawing Title
Figure A10.40 Little Egret Records in Baldoyle Bay (Dec 2014 to March 2018)



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
1	21/05/18	Additional survey data	CH	RI	KAG	RI
1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

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Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1040

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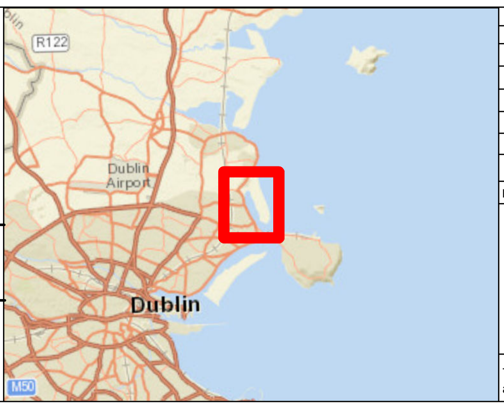
Project

Greater Dublin Drainage Project

Drawing Title

Figure A10.41 Buzzard Records in Baldoyle Bay (Dec 2014 to March 2018)



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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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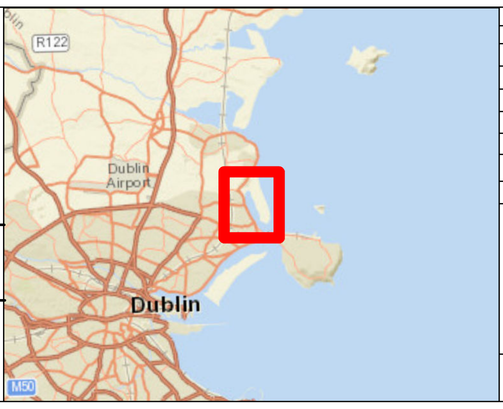
Drawing Status	Final
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1041

Legend

- 🟥 Proposed Project Boundary
- 🟩 Proposed Outfall Pipeline Route (Marine Section)
- ▨ Baldoyle Bay SPA
- ▨ RPS estuarine survey area
- ● Peregrine

Greater Dublin Drainage



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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Title
Figure A10.42 Peregrine Records in Baldoyle Bay
(Dec 2014 to March 2018)

Drawing Status Final
Scale @ A3 1:12,500
Job No. SEC7909
Drawing No. 32102902-EIAR-A1042

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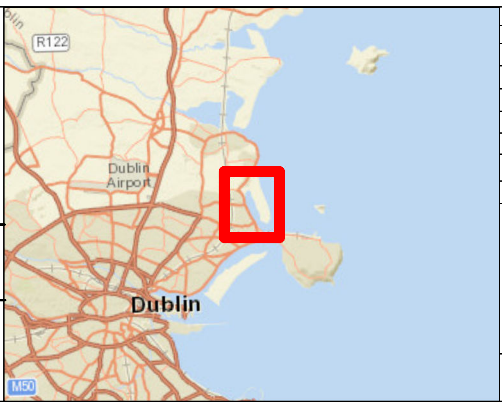
Project
Greater Dublin Drainage Project

Drawing Title
Figure A10.43 Cormorant Records in Baldoyle Bay (Dec 2014 to March 2018)



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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Status	**Final**
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1043

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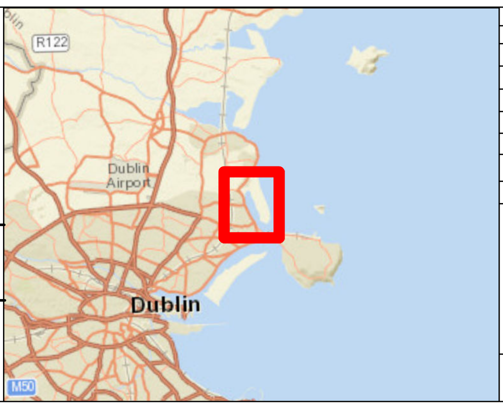

Project
Greater Dublin Drainage Project

Drawing Title
Figure A10.44 Shag Records in Baldoyle Bay (Dec 2014 to March 2018)

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

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Scale @ A3 1:12,500
Job No. SEC7909
Drawing No. 32102902-EIAR-A1044

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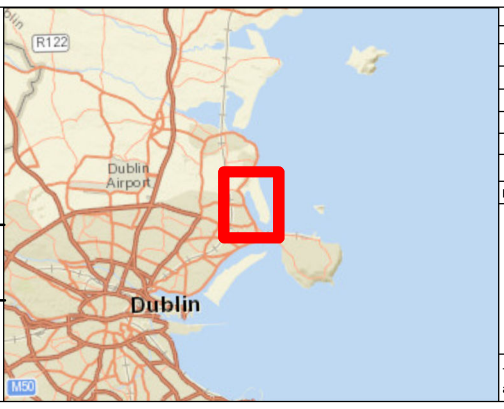
Greater Dublin Drainage

Project
Greater Dublin Drainage Project

Drawing Title
Figure A10.45 Common Tern Records in Baldoyle Bay (Dec 2014 to March 2018)



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

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Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1045

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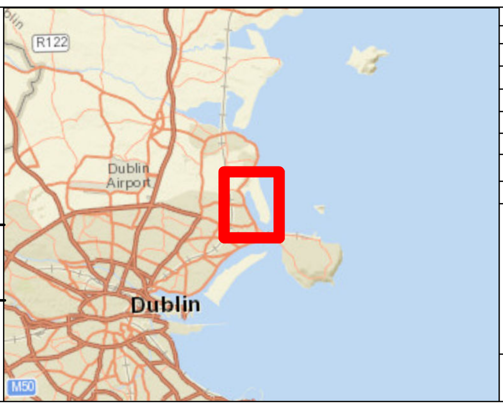
Legend

🟥	Proposed Project Boundary
🟩	Proposed Outfall Pipeline Route (Marine Section)
▨	Baldoyle Bay SPA
▨	RPS estuarine survey area
●	Sandwich Tern

Greater Dublin Drainage



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

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Drawing Title
Figure A10.46 Sandwich Tern Records in Baldoyle Bay (Dec 2014 to March 2018)

Drawing Status: Final
Scale @ A3: 1:12,500
Job No.: SEC7909
Drawing No.: 32102902-EIAR-A1046

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Project
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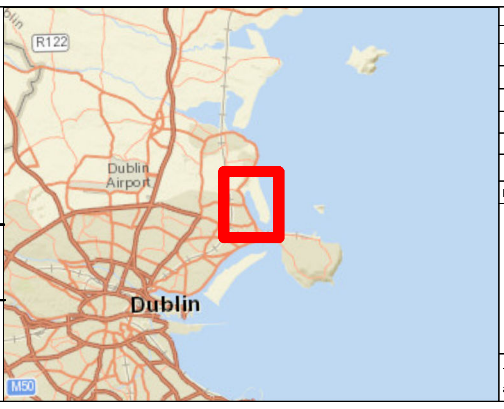
Drawing Title
Figure A10.47 Common Sandpiper Records in Baldoyle Bay (Dec 2014 to March 2018)



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

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Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1047

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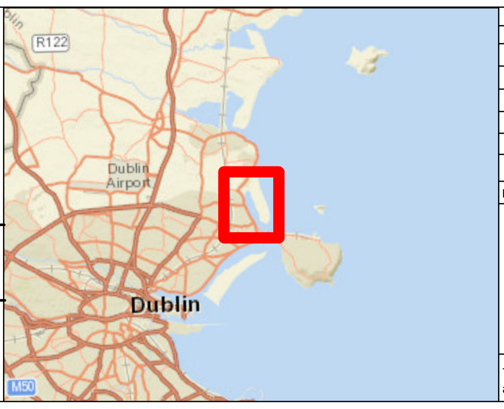
Greater Dublin Drainage

Project
Greater Dublin Drainage Project

Drawing Title
Figure A10.48 Common Snipe Records in Baldoyle Bay (Dec 2014 to March 2018)



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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

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Scale @ A3 1:12,500
Job No. SEC7909
Drawing No. 32102902-EIAR-A1048

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Project
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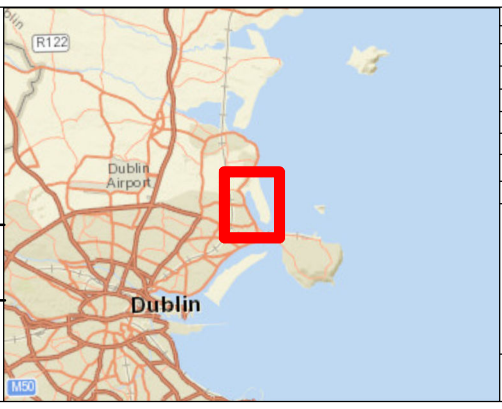
Drawing Title
Figure A10.49 Whimbrel Records in Baldoyle Bay (Dec 2014 to March 2018)



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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Scale @ A3: 1:12,500
Job No.: SEC7909
Drawing No.: 32102902-EIAR-A1049

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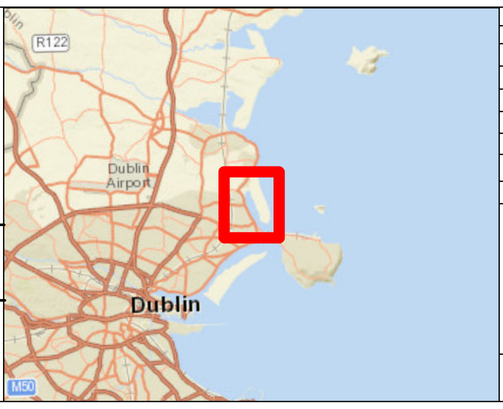
Greater Dublin Drainage

Project

Greater Dublin Drainage Project

Drawing Title

Figure A10.50 Kestrel Records in Baldoyle Bay (Dec 2014 to March 2018)



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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Scale @ A3: 1:12,500
Job No.: SEC7909
Drawing No.: 32102902-EIAR-A1050

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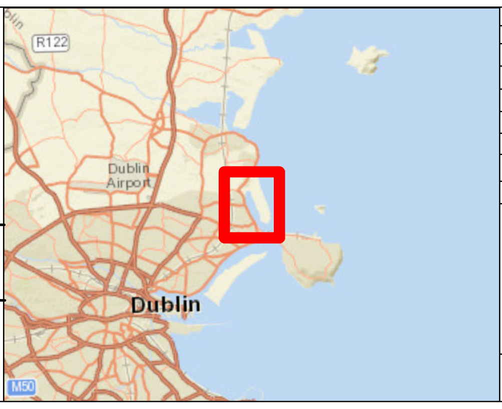
Greater Dublin Drainage

Project
Greater Dublin Drainage Project

Drawing Title
Figure A10.51 Mediterranean Gull Records in Baldoyle Bay (Dec 2014 to March 2018)



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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Status	Final
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1051

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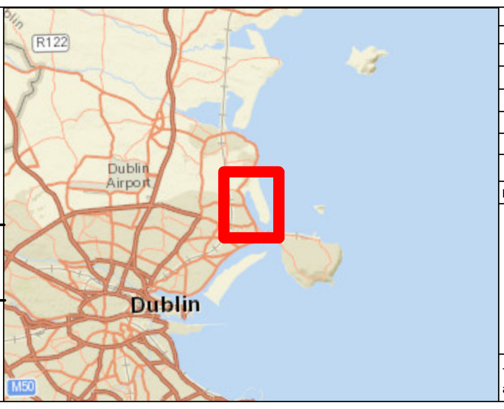
Greater Dublin Drainage

Project
Greater Dublin Drainage Project

Drawing Title
Figure A10.52 Roseate Tern Records in Baldoyle Bay (Dec 2014 to March 2018)



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0	17/10/17	Draft	CH	RI	KAG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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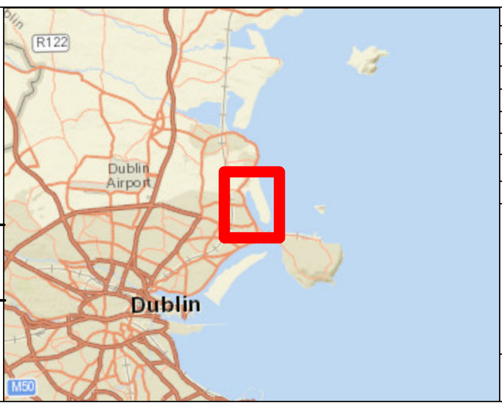
Drawing Status	**Final**
Scale @ A3	1:12,500
Job No.	SEC7909
Drawing No.	32102902-EIAR-A1052

Greater Dublin Drainage

Project
Greater Dublin Drainage Project

Drawing Title
Figure A10.53 Ruff Records in Baldoyle Bay (Dec 2014 to March 2018)



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1	19/03/18	Infrastructure updated	CH	RI	KAG	RI
0	17/10/17	Draft	CH	RI	KAG	RI

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Drawing Status **Final**
Scale @ A3 1:12,500
Job No. SEC7909
Drawing No. 32102902-EIAR-A1053

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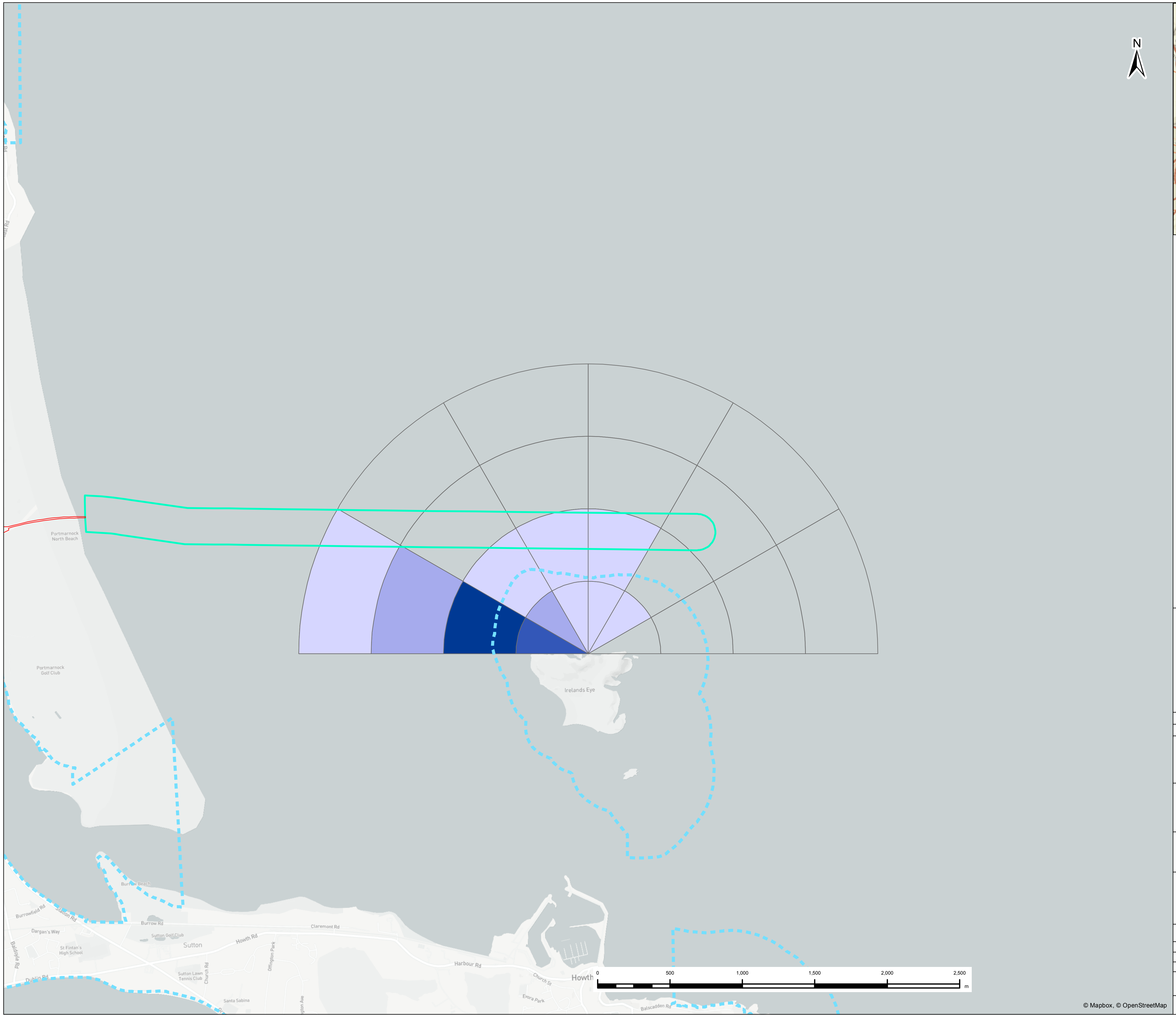

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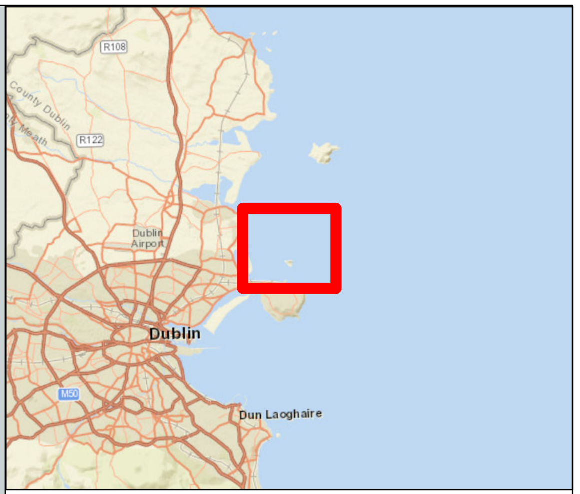

Key

🟥 Proposed Project Boundary

🟩 Proposed Outfall Pipeline Route (Marine Section)

▨ SPA boundaries

Index of abundance

Black guillemot - all behaviours

▨ 1 - 10

▨ 11 - 20

▨ 21 - 30

▨ 31 - 40

▨ 41 - 50

▨ 51 - 60

▨ 61 - 70

1	06/06/2018	Infrastructure updated	CH	RI	KG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

Client

Project

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Drawing Title

Figure A10.54 Distribution of all on sea black guillemot records from Ireland's Eye VP during breeding season (March to October)

Drawing Status

Final

Scale @A3 1:25,000

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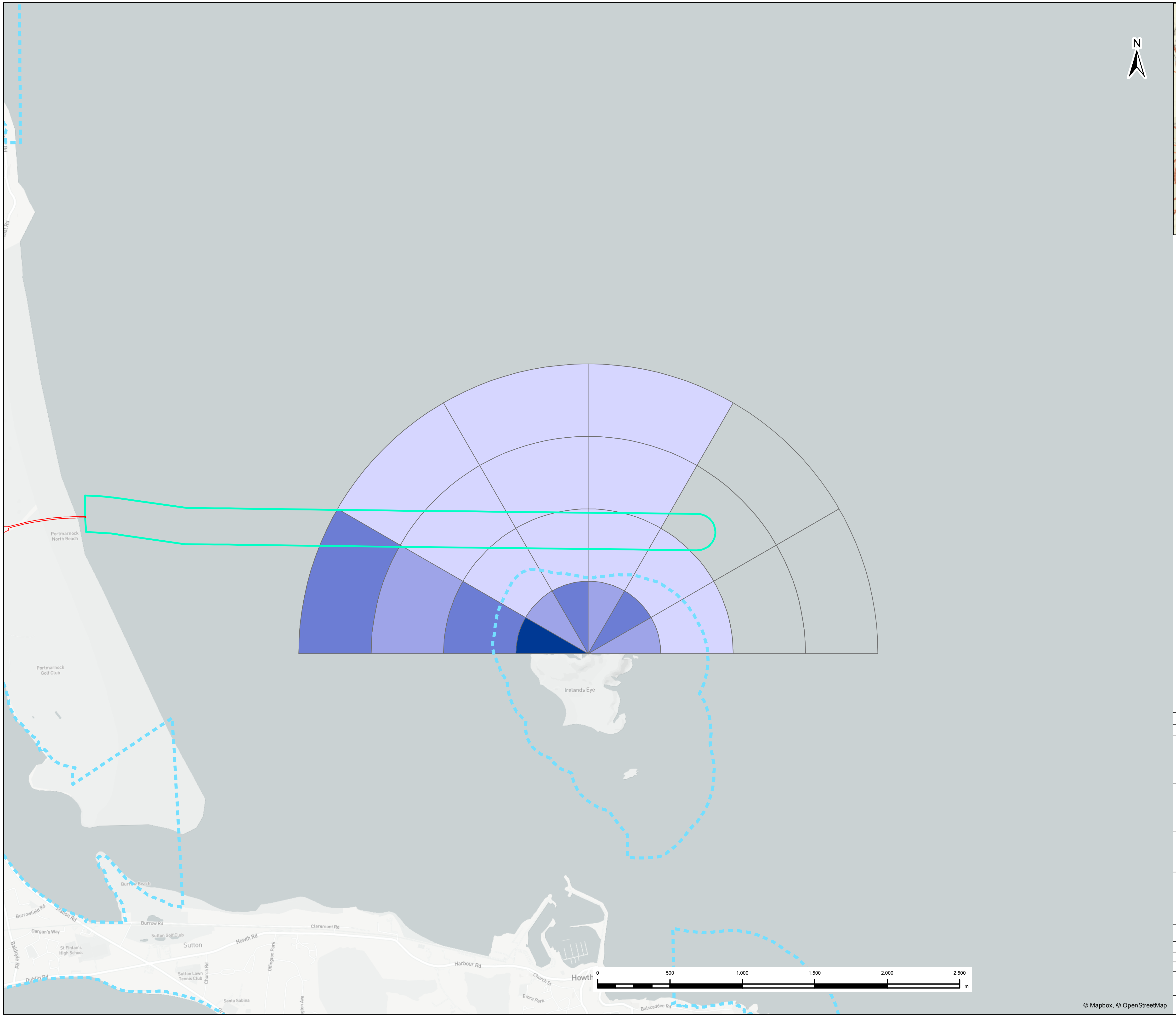

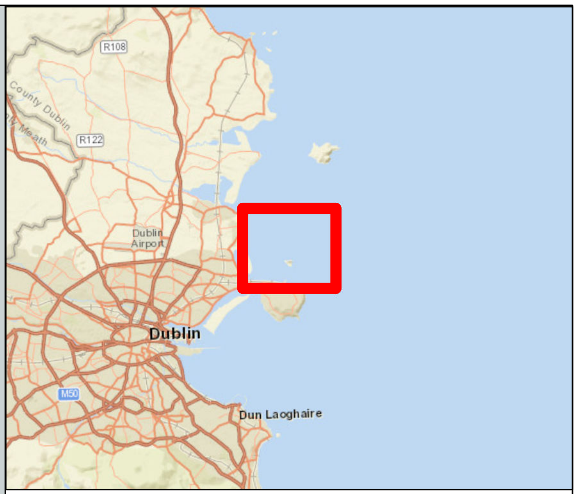

Key

🟥 Proposed Project Boundary

🟩 Proposed Outfall Pipeline Route (Marine Section)

▨ SPA boundaries

Index of abundance

Cormorant - all behaviours

- ▨ 1 - 10
- ▨ 11 - 20
- ▨ 21 - 30
- ▨ 31 - 40
- ▨ 41 - 50
- ▨ 51 - 60

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1	06/06/2018	Infrastructure updated	CH	RI	KG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Project

Greater Dublin Drainage Project

Drawing Title

Figure A10.55 Distribution of all on sea cormorant records from Ireland's Eye VP during breeding season (March to October)

Drawing Status **Final**

Scale @A3 1:25,000

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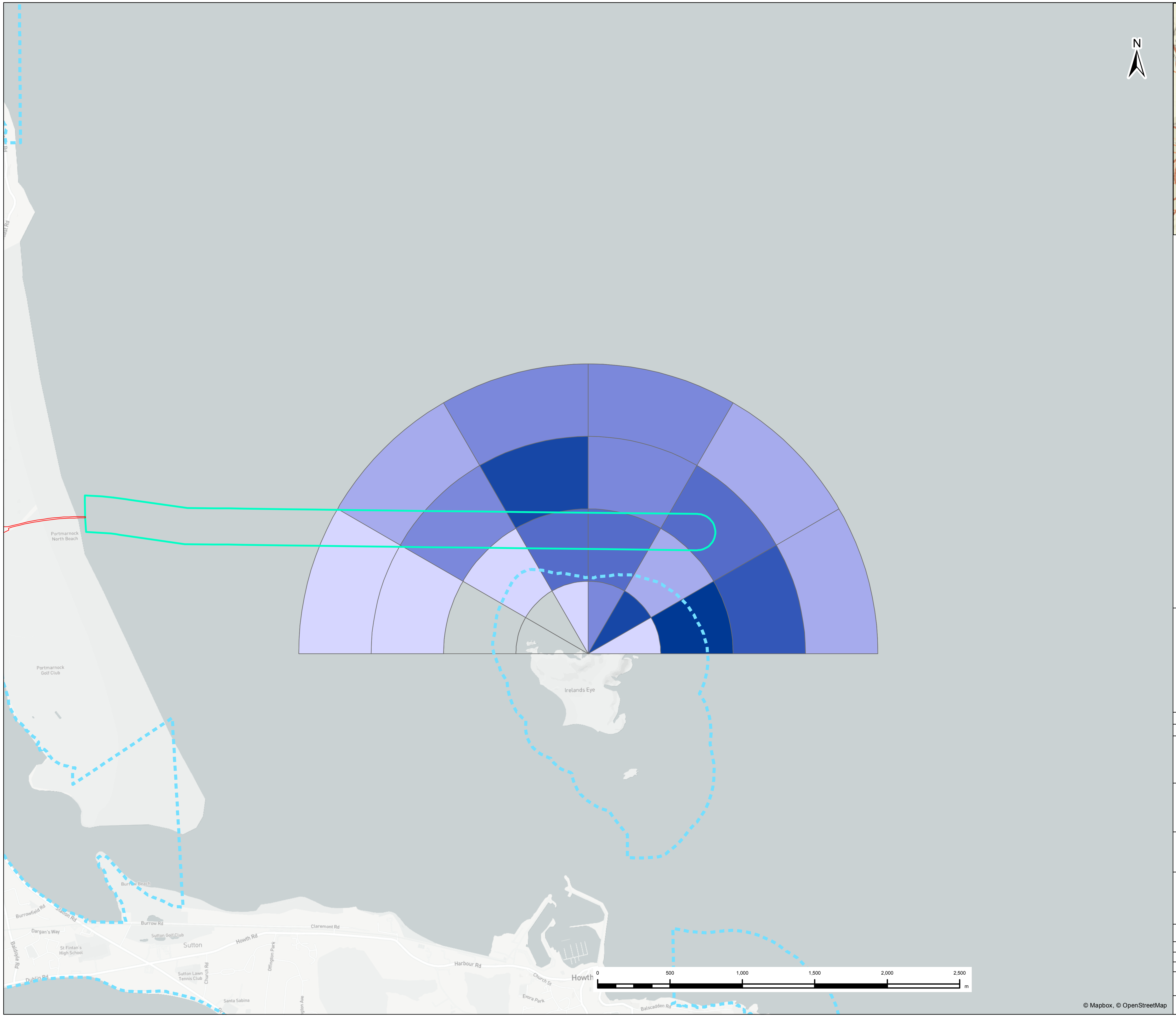
Drawing No. 32102902-EIAR-A1055



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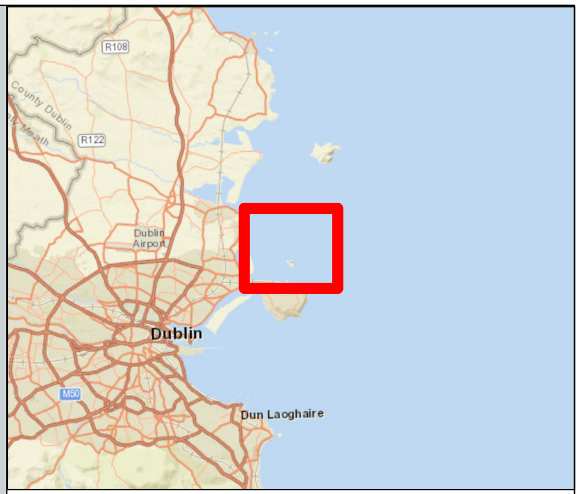


Key

🟥 Proposed Project Boundary

🟩 Proposed Outfall Pipeline Route (Marine Section)

▨ SPA boundaries

Index of abundance

Fulmar - all behaviours

- ▨ 1 - 5
- ▨ 6 - 10
- ▨ 11 - 15
- ▨ 16 - 20
- ▨ 21 - 25
- ▨ 26 - 30
- ▨ 31 - 35

2	06/06/2018	Additional survey data included	CH	RI	KG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

Client

Project

Greater Dublin Drainage Project

Drawing Title

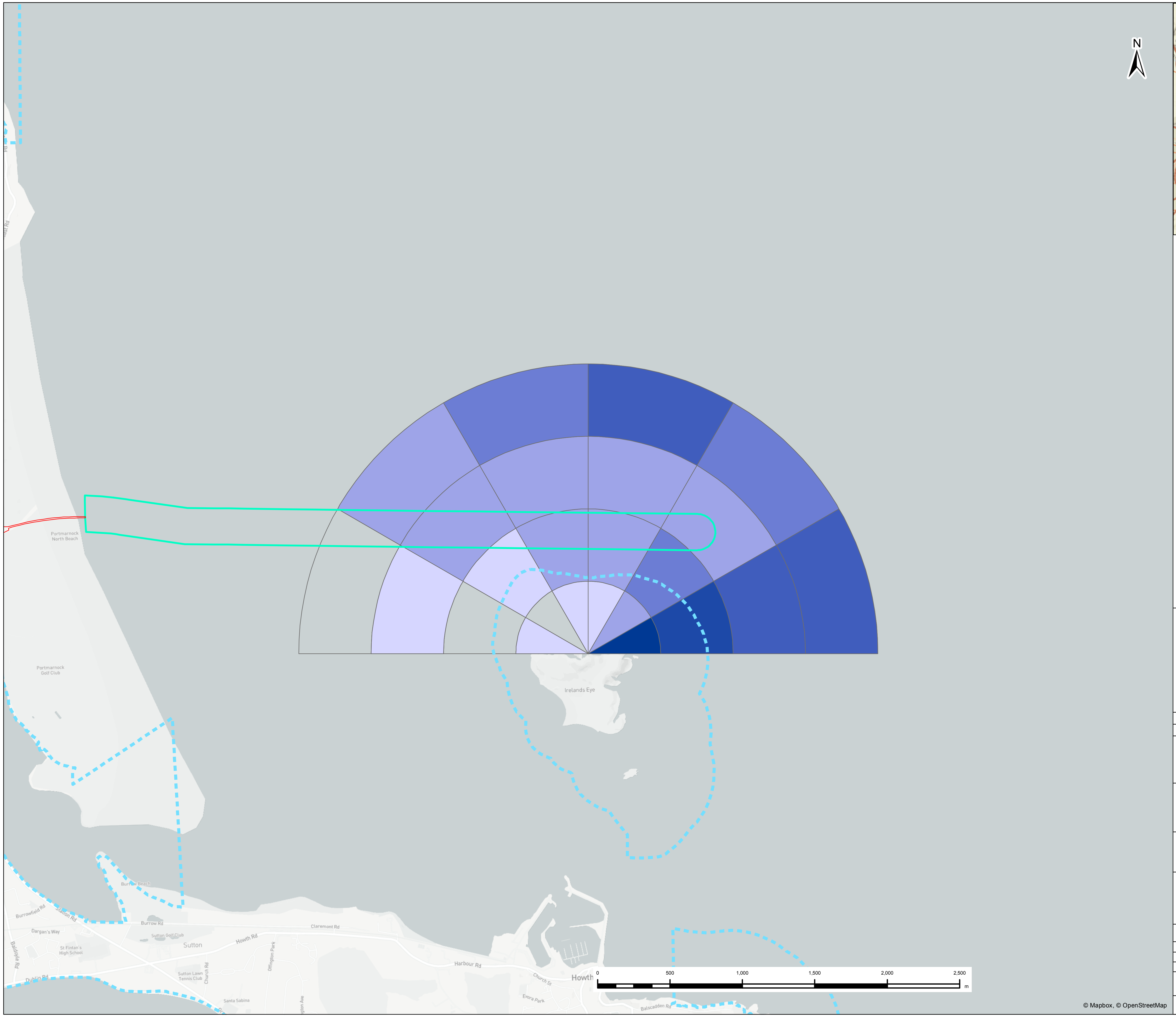
Figure A10.56 Distribution of all on sea fulmar records from Ireland's Eye VP during breeding season (March to October)

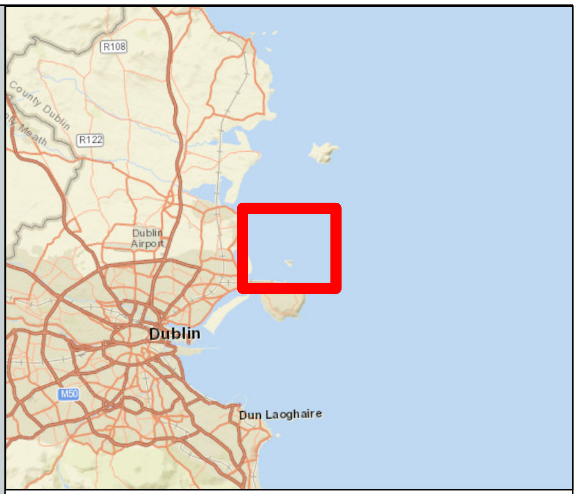
Drawing Status **Final**

Scale @A3 1:25,000

Filepath W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Graphics\GIS\mxd\figures\ES_ornith\ES_techrep\sec7909_A1056_F_onWaterMarToOct_VP2.mxd

Drawing No. 32102902-EIAR-A1056





Key

▭	Proposed Project Boundary
▭	Proposed Outfall Pipeline Route (Marine Section)
┅	SPA boundaries

Index of abundance

Gannet - all behaviours

■	3 - 25
■	26 - 50
■	51 - 75
■	76 - 100
■	101 - 125
■	126 - 150

Greater Dublin Drainage

1	06/06/2018	Infrastructure updated	CH	RI	KG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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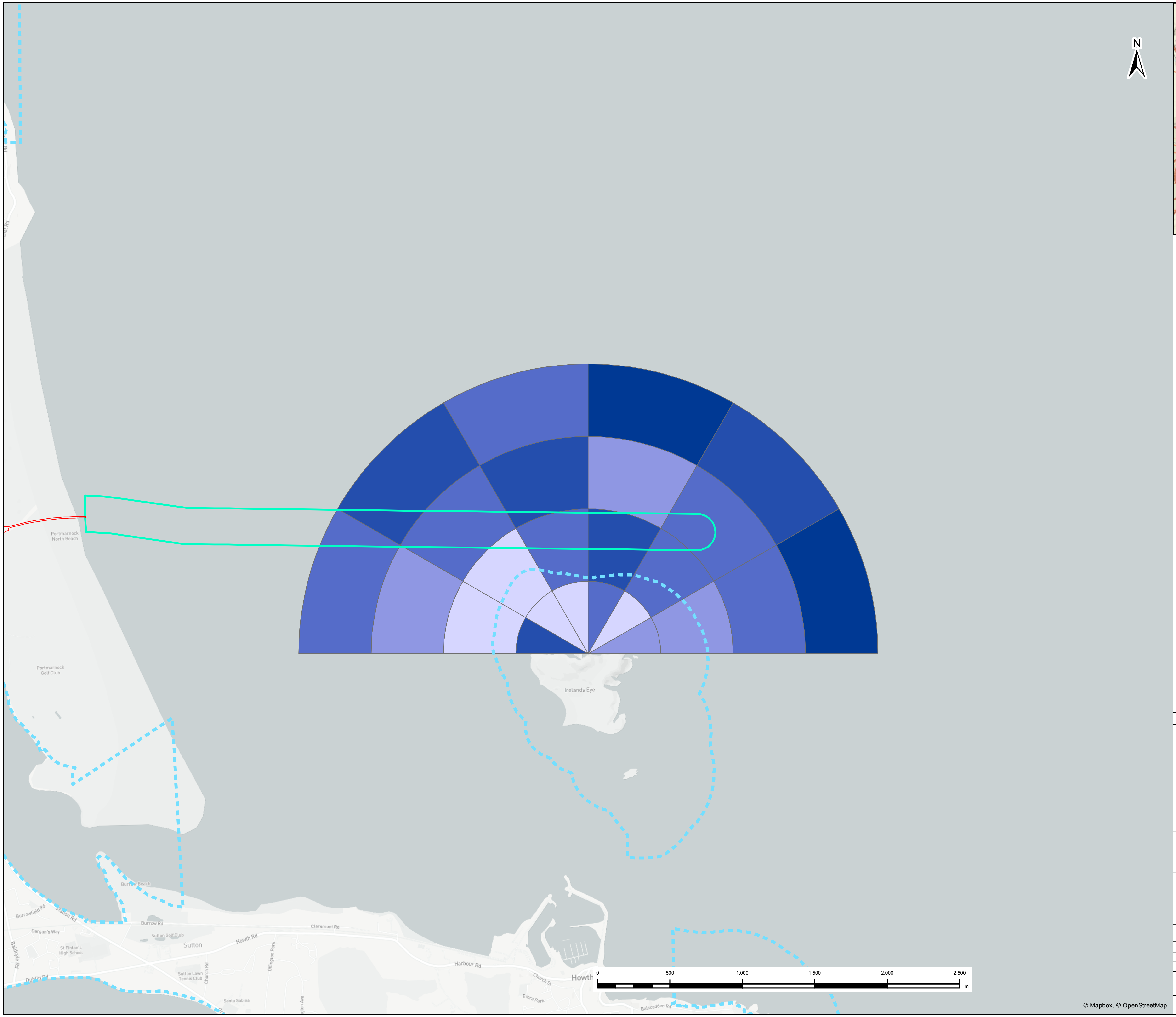
Drawing Title
Figure A10.57 Distribution of all on sea gannet records from Ireland's Eye VP during breeding season (March to October)

Drawing Status **Final**

Scale @A3 1:25,000

Filepath W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Graphics\GIS\mxd\figures\ES_ornith\ES_techrep\sec7909_A1057_GX_onWaterMarToOct_VP2.mxd

Drawing No. 32102902-EIAR-A1057



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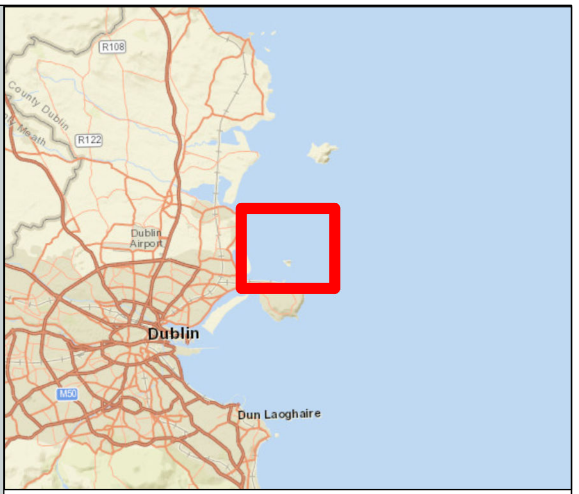

Key

- □ Proposed Project Boundary
- □ Proposed Outfall Pipeline Route (Marine Section)
- ⬚ SPA boundaries

Index of abundance

Great black-backed gull - all behaviours

- ▨ 1 - 10
- ▨ 11 - 20
- ▨ 21 - 30
- ▨ 31 - 40
- ▨ 41 - 50

Greater Dublin Drainage

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
1	06/06/2018	Infrastructure updated	CH	RI	KG	RI

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Drawing Title

Figure A10.58 Distribution of all on sea great black-backed gull records from Ireland's Eye VP during breeding season (March to October)

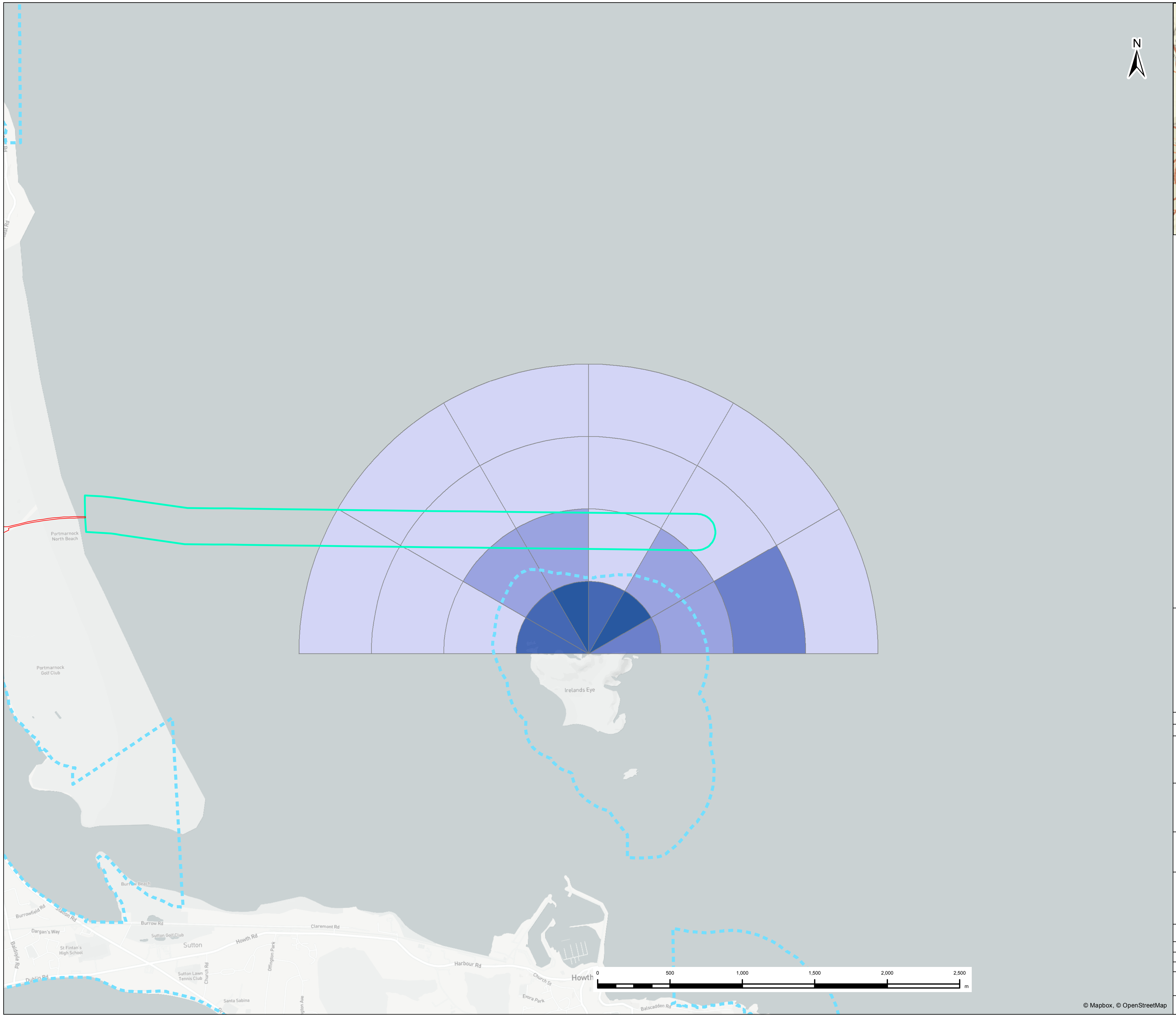
Drawing Status

Final

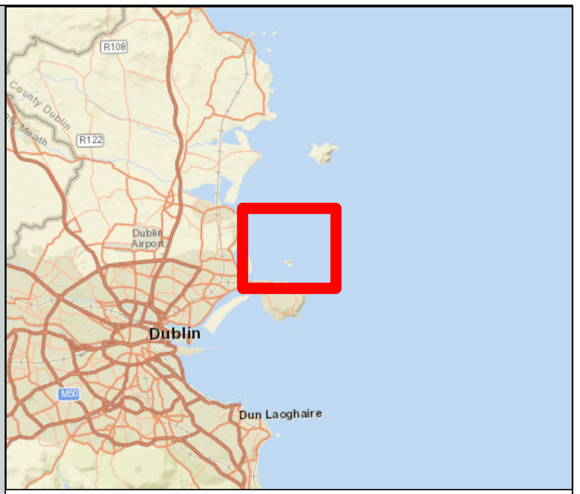
Scale @A3 1:25,000

Filepath

Drawing No. 32102902-EIAR-A1058



© Mapbox, © OpenStreetMap



Key

- ▭ Proposed Project Boundary
- ▭ Proposed Outfall Pipeline Route (Marine Section)
- ┅ SPA boundaries

Index of abundance

Guillemot - all behaviours

- ■ 32 - 200
- ■ 201 - 400
- ■ 401 - 600
- ■ 601 - 800
- ■ 801 - 1000

Greater Dublin Drainage

2	06/06/2018	Additional survey data included	CH	RI	KG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Title
Figure A10.59 Distribution of all on sea guillemot records from Ireland's Eye VP during breeding season (March to October)

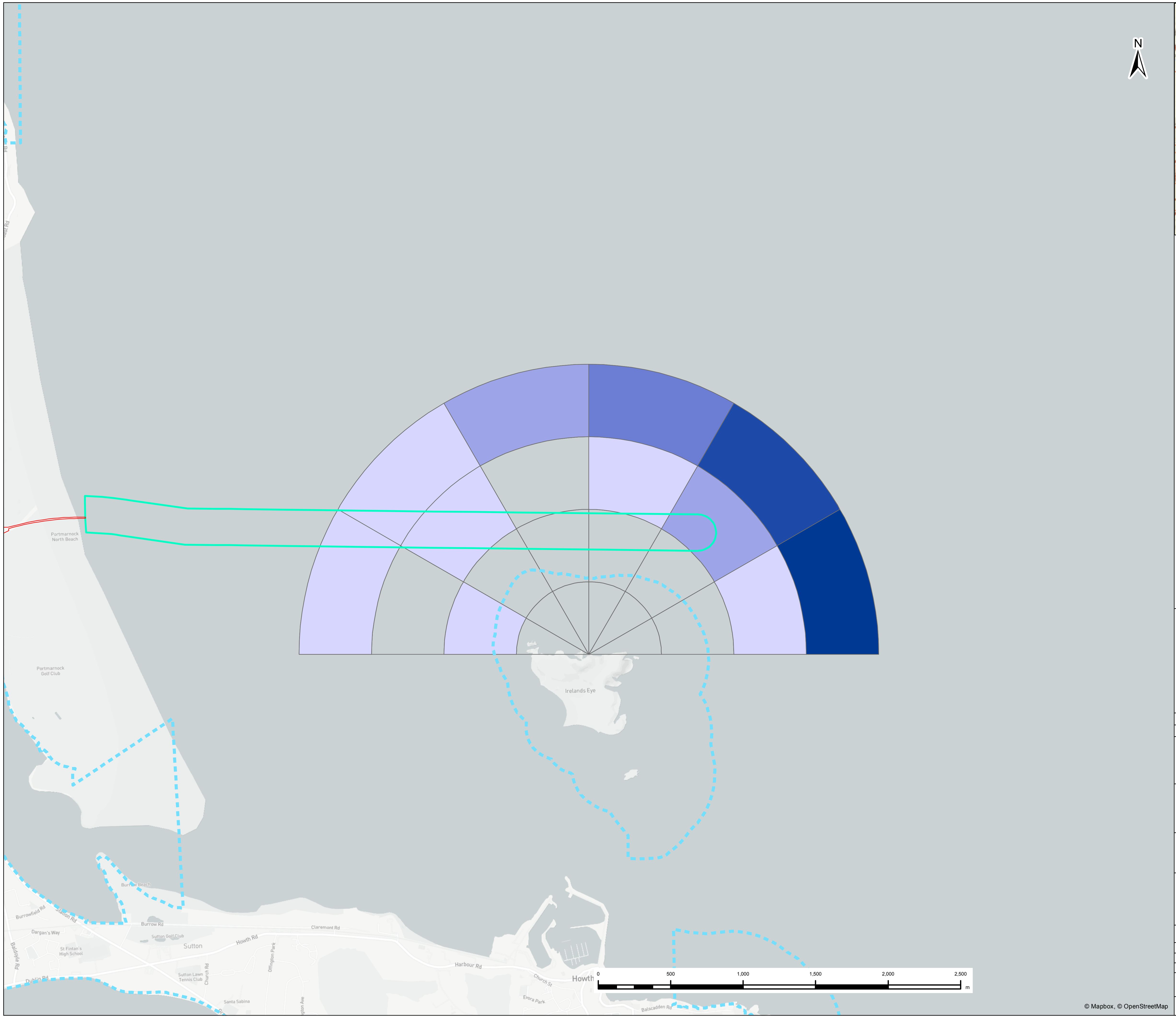
Drawing Status
Final

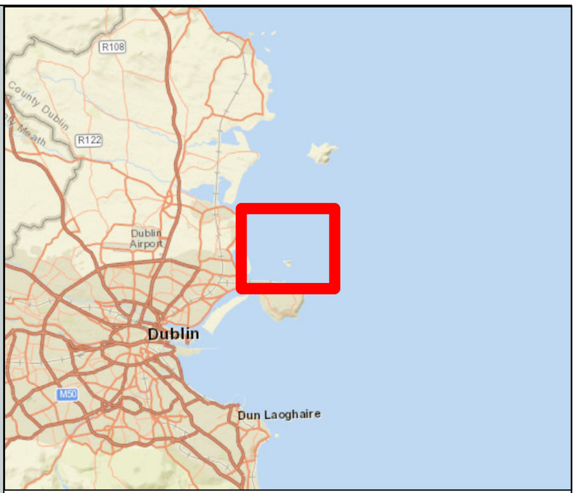
Scale @A3 1:25,000

Filepath W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Graphics\GIS\mxd\figures\ES_ornith\ES_techrep\sec7909_A1059_GU_onWaterMarToOct_VP2.mxd

Drawing No. 32102902-EIAR-A1059

This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.





Key

🟥 Proposed Project Boundary

🟩 Proposed Outfall Pipeline Route (Marine Section)

▨ SPA boundaries

Index of abundance

Guillemot or razorbill - all behaviours

▨	3 - 75
▨	76 - 150
▨	151 - 225
▨	226 - 300
▨	301 - 375
▨	376 - 450

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
2	06/06/2018	Additional survey data included	CH	RI	KG	RI

Client

Project

Greater Dublin Drainage Project

Drawing Title

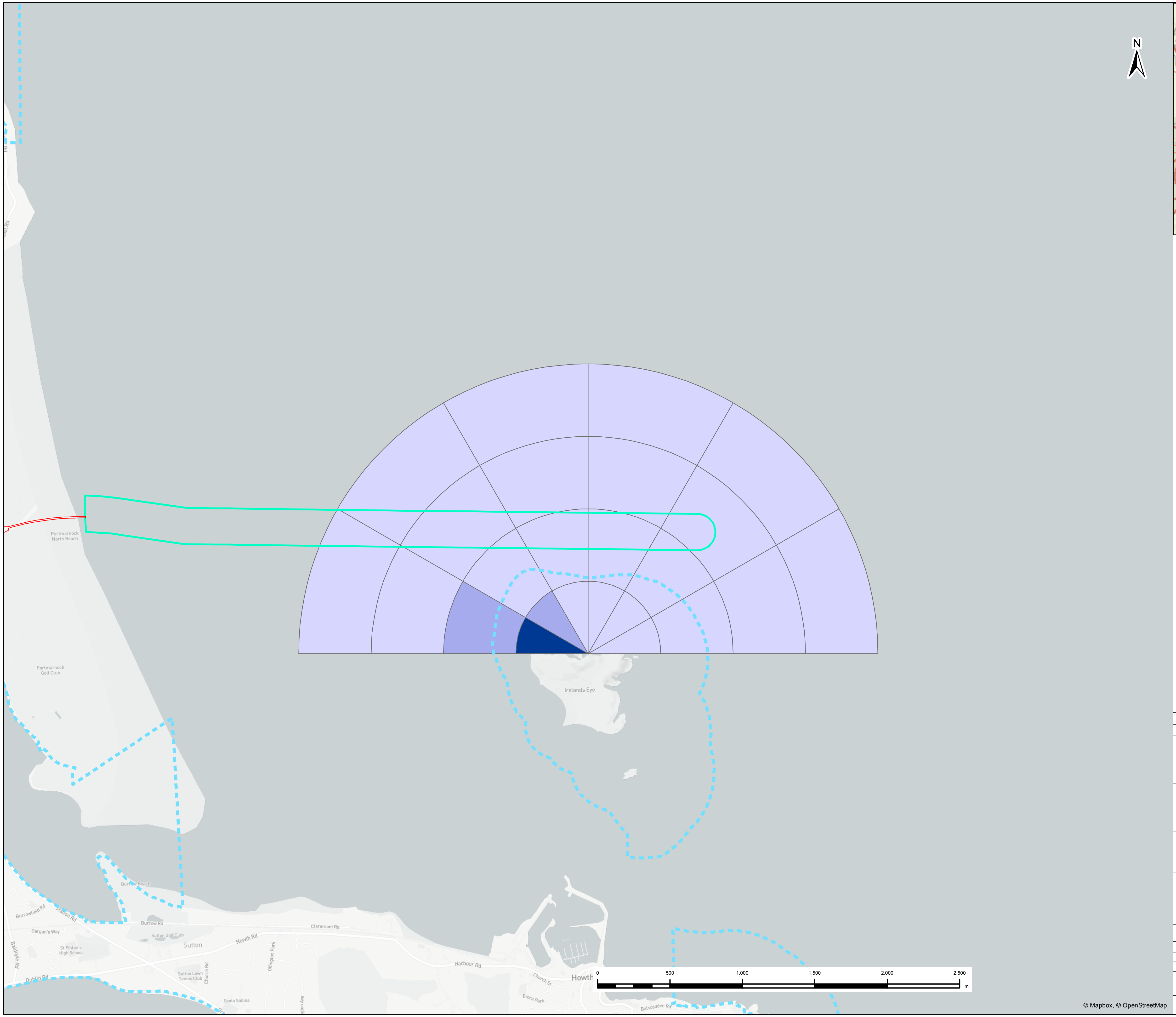
Figure A10.60 Distribution of all on sea guillemot or razorbill records from Ireland's Eye VP during breeding season (March to October)

Drawing Status **Final**

Scale @A3 1:25,000

Filepath W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Graphics\GIS\mxd\figures\ES_ornith\ES_techrep\sec7909_A1060_GRA_onWaterMarToOct_VP2.mxd

Drawing No. 32102902-EIAR-A1060



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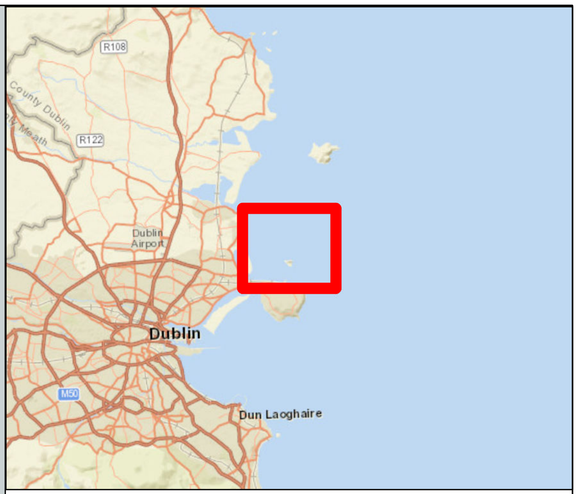

Key

🟥	Proposed Project Boundary
🟩	Proposed Outfall Pipeline Route (Marine Section)
▭	SPA boundaries

Index of abundance

Herring gull - all behaviours

▨	7 - 150
▨	151 - 300
▨	301 - 450
▨	451 - 600
▨	601 - 750
▨	751 - 900
▨	901 - 1050

Greater Dublin Drainage

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
2	06/06/2018	Additional survey data included	CH	RI	KG	RI

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Drawing Title

Figure A10.61 Distribution of all on sea herring gull records from Ireland's Eye VP during breeding season (March to October)

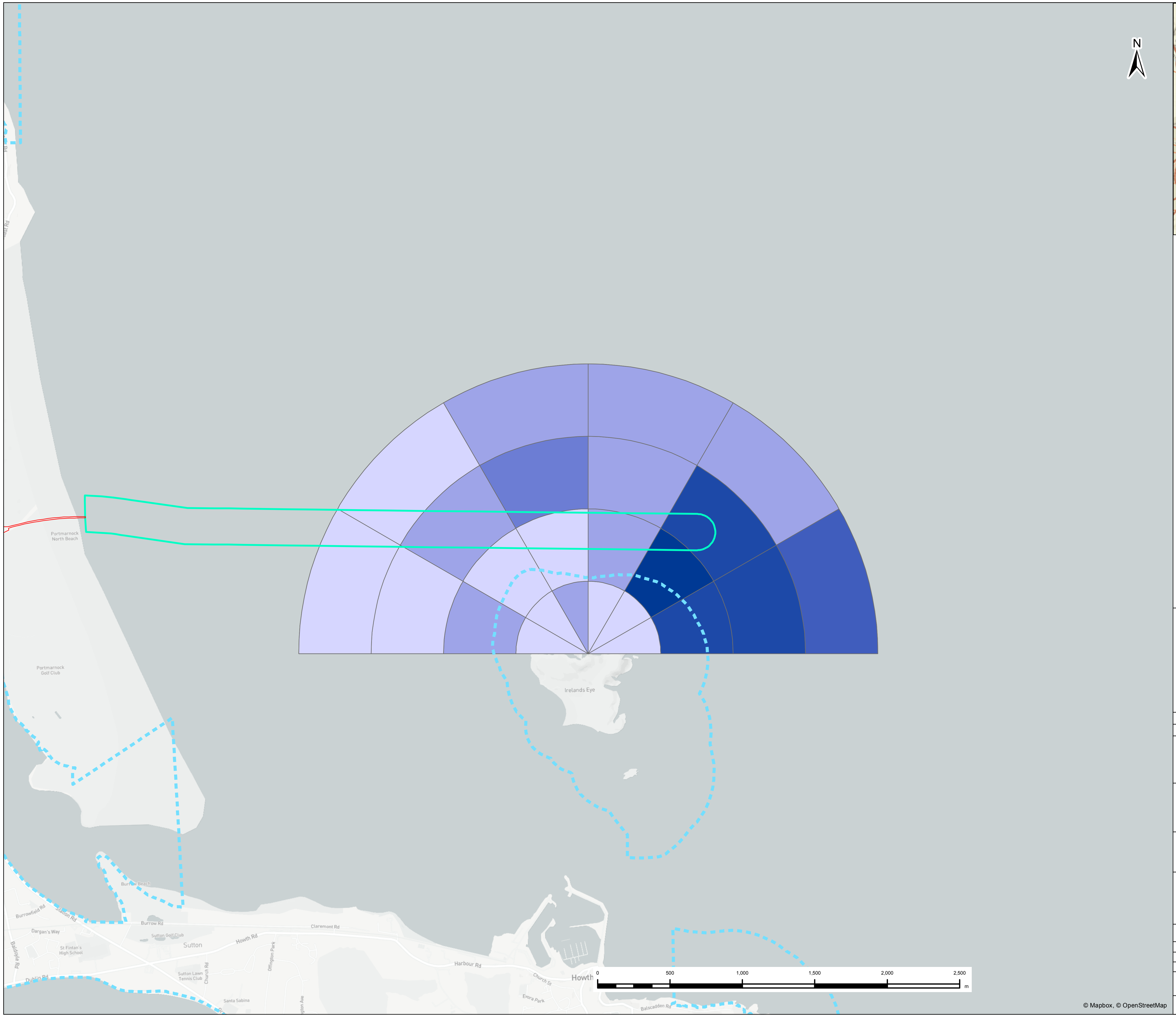
Drawing Status

Final

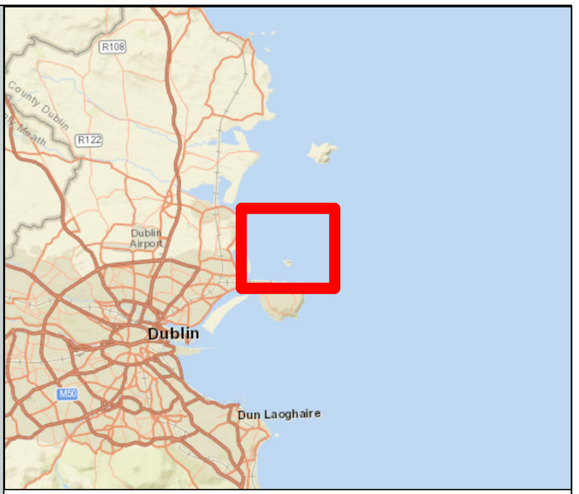
Scale @A3 1:25,000

Filepath W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Graphics\GIS\mxd\figures\ES_ornith\ES_techrep\sec7909_A1061_HG_onWaterMarToOct_VP2.mxd

Drawing No. 32102902-EIAR-A1061



© Mapbox, © OpenStreetMap



Key

🟥 Proposed Project Boundary

🟩 Proposed Outfall Pipeline Route (Marine Section)

▨ SPA boundaries

Index of abundance

Kittiwake - all behaviours

🟦 9 - 75

🟦 76 - 150

🟦 151 - 225

🟦 226 - 300

🟦 301 - 375

🟦 376 - 450

Greater Dublin Drainage

2	06/06/2018	Additional survey data included	CH	RI	KG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Title

Figure A10.62 Distribution of all on sea kittiwake records from Ireland's Eye VP during breeding season (March to October)

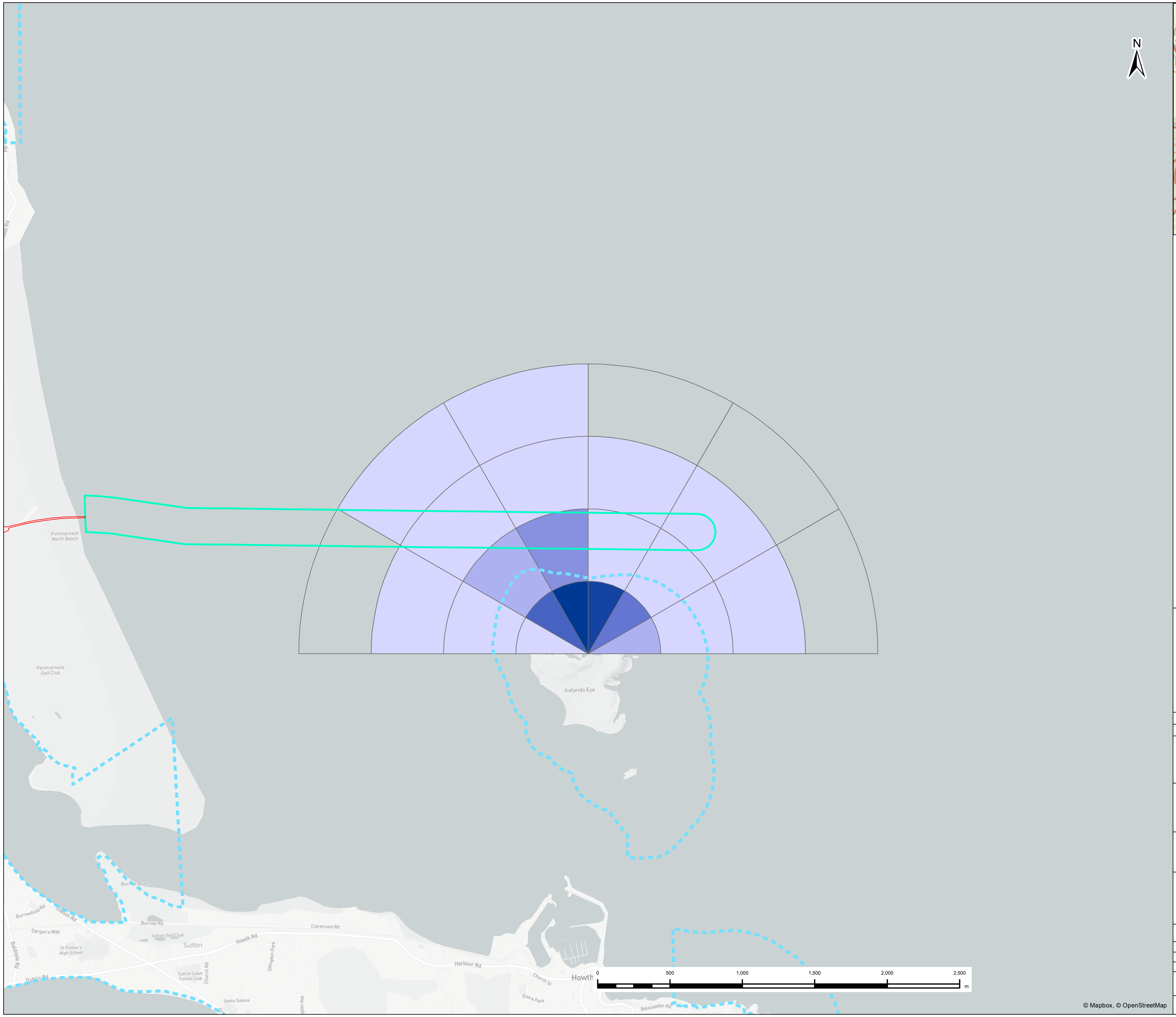
Drawing Status

Final

Scale @A3 1:25,000

Filepath W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Graphics\GIS\mxd\figures\ES_ornith\ES_techrep\sec7909_A1062_KI_onWaterMarToOct_VP2.mxd

Drawing No. 32102902-EIAR-A1062



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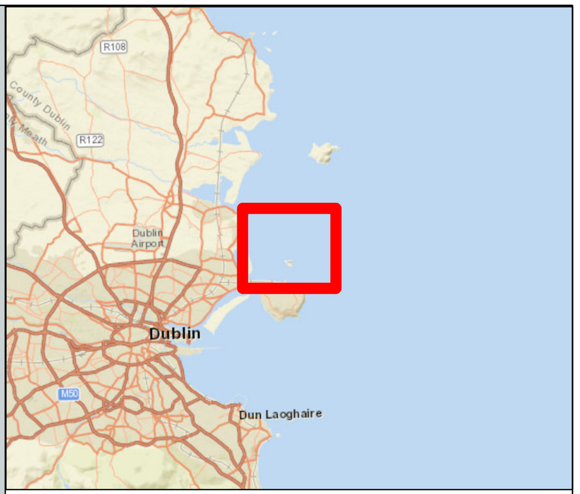

Key

- ▭ Proposed Project Boundary
- ▭ Proposed Outfall Pipeline Route (Marine Section)
- ▭ SPA boundaries

Index of abundance

Puffin - all behaviours

▨	1 - 25
▨	26 - 50
▨	51 - 75
▨	76 - 100
▨	101 - 125
▨	126 - 150
▨	151 - 175
▨	176 - 200

Greater Dublin Drainage

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
2	06/06/2018	Additional survey data included	CH	RI	KG	RI

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Greater Dublin Drainage Project

Drawing Title

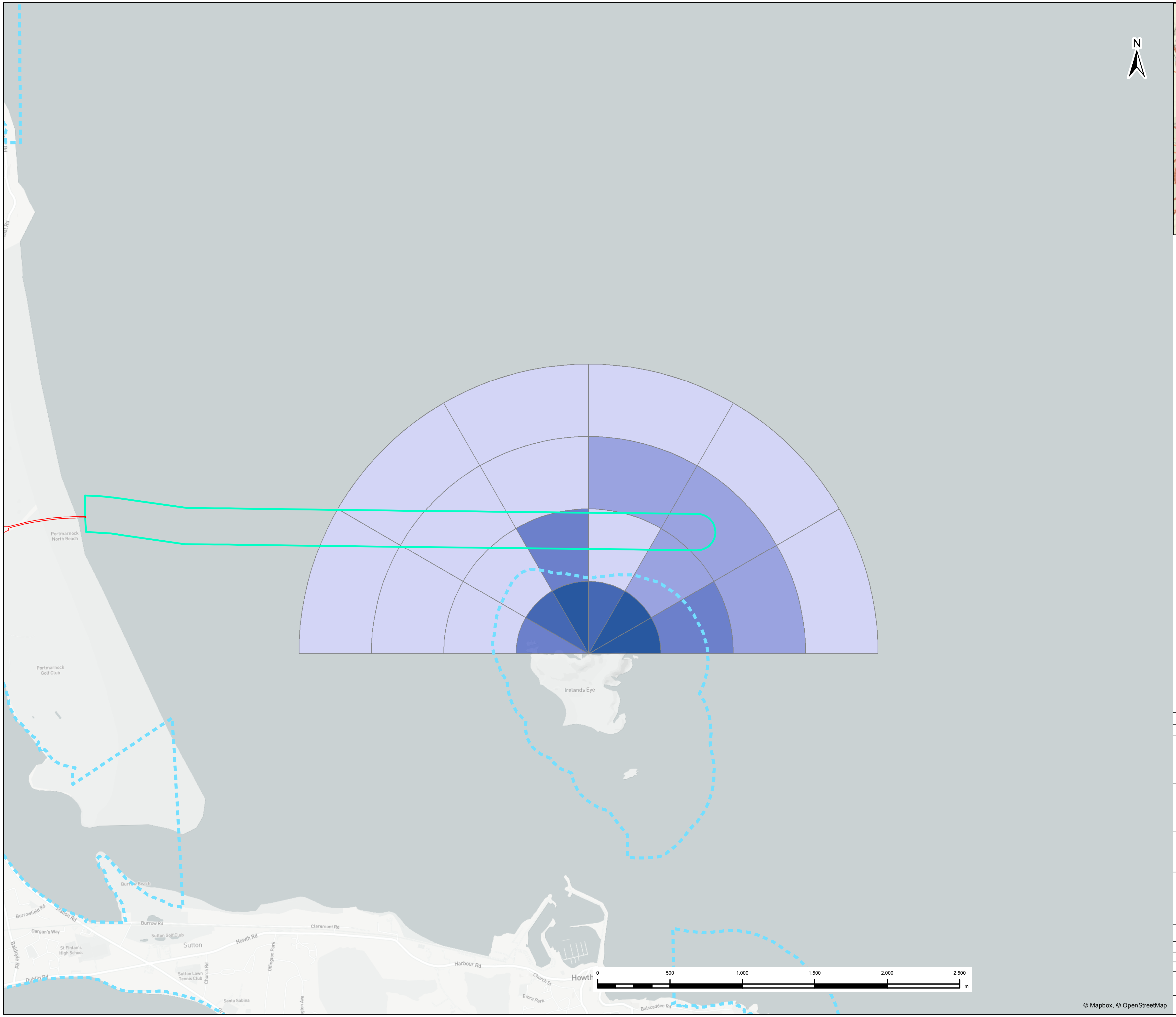
Figure A10.63 Distribution of all on sea puffin records from Ireland's Eye VP during breeding season (March to October)

Drawing Status **Final**

Scale @A3 1:25,000

Filepath W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Graphics\GIS\mxd\figures\ES_ornith\ES_techrep\sec7909_A1063_PU_onWaterMarToOct_VP2.mxd

Drawing No. 32102902-EIAR-A1063



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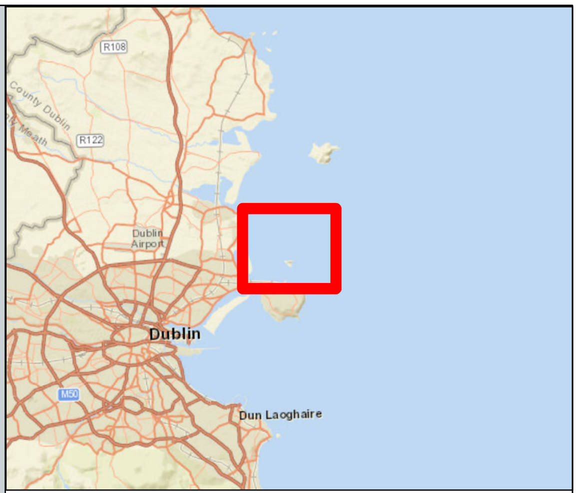

Key

- ▭ Proposed Project
- ▭ Proposed Outfall Pipeline Route (Marine Section)
- ▭ SPA boundaries

Index of abundance

Razorbill - all behaviours

- ■ 31 - 175
- ■ 176 - 350
- ■ 351 - 525
- ■ 526 - 700
- ■ 701 - 875

Greater Dublin Drainage

2	06/06/2018	Additional survey data included	CH	RI	KG	RI
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Drawing Title

Figure A10.64 Distribution of all on sea razorbill records from Ireland's Eye VP during breeding season (March to October)

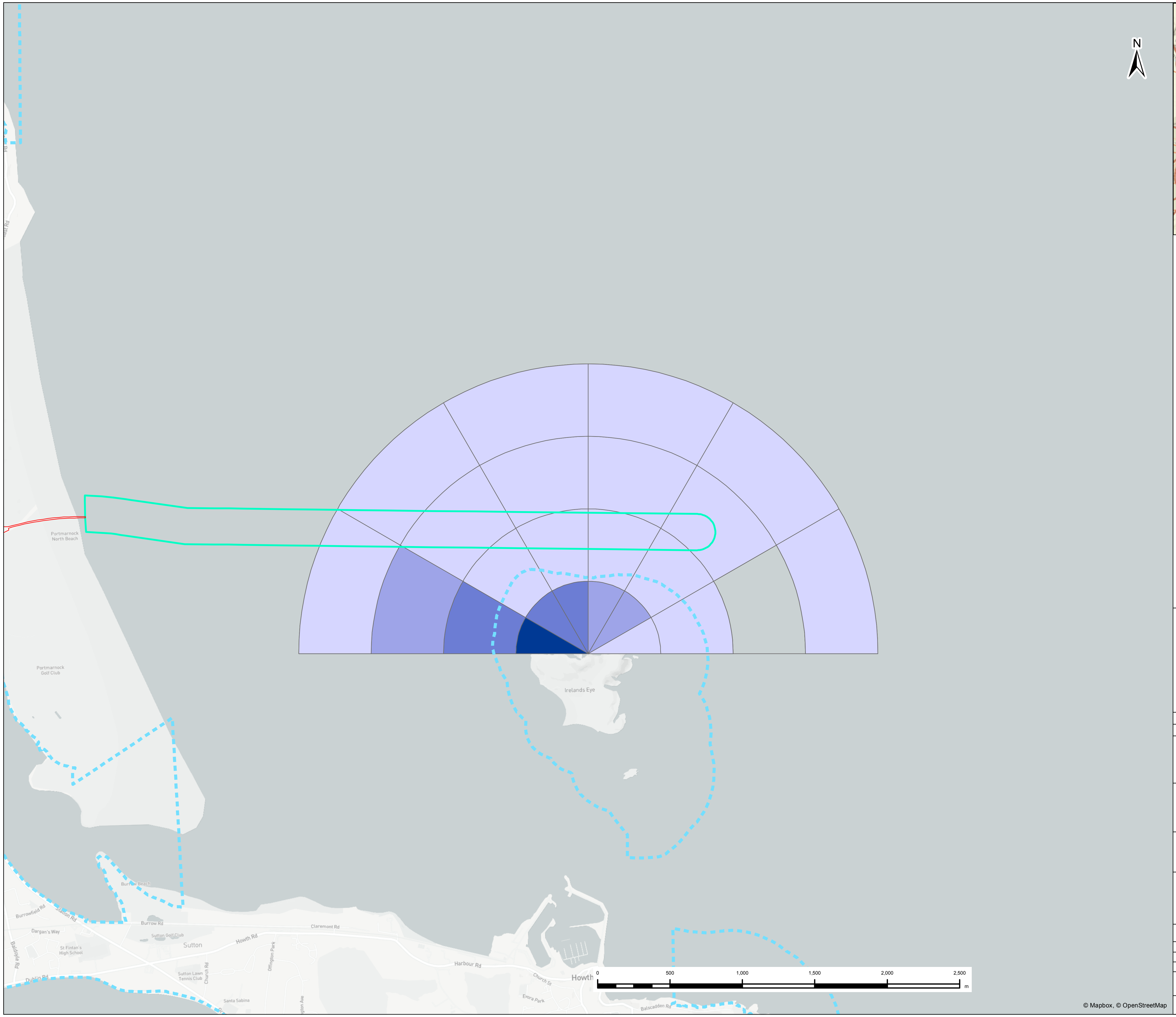
Drawing Status

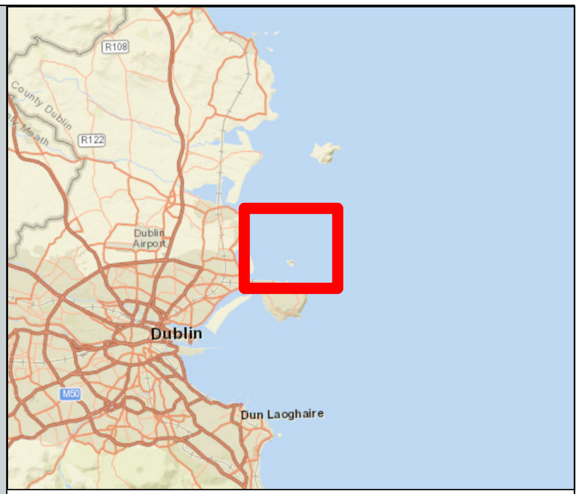
Final

Scale @A3 1:25,000

Filepath W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Graphics\GIS\mxd\figures\ES_ornith\ES_techrep\sec7909_A1064_RA_onWaterMarToOct_VP2.mxd

Drawing No. 32102902-EIAR-A1064





Key

🟥 Proposed Project Boundary

🟩 Proposed Outfall Pipeline Route (Marine Section)

▨ SPA boundaries

Index of abundance

Shag - all behaviours

▨	1 - 50
▨	51 - 100
▨	101 - 150
▨	151 - 200
▨	201 - 250
▨	251 - 300

Greater Dublin Drainage

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
2	06/06/2018	Additional survey data included	CH	RI	KG	RI

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Project
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Drawing Title
Figure A10.65 Distribution of all on sea shag records from Ireland's Eye VP during breeding season (March to October)

Drawing Status
Final

Scale @A3 1:25,000

Filepath W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Graphics\GIS\mxd\figures\ES_ornith\ES_techrep\sec7909_A1065_SA_onWaterMarToOct_VP2.mxd

Drawing No. 32102902-EIAR-A1065

APPENDIX 1 – ESTUARINE BIRD SURVEY EFFORT

Date	Surveyor*	Start Time	Finish Time	Effort	Minimum Tide (m)	Mean Tide (m)	Maximum Tide (m)	Survey Tidal Range (m)	Survey Tidal State**	Area surveyed
16/12/2014	AMcC	11:00	14:10	03:10	1.99	2.11	2.32	0.33	L	Partial
22/12/2014	AMcC	09:40	12:00	02:20	4.44	4.80	4.95	0.51	H	Partial
13/01/2015	AMcC	09:00	12:00	03:00	2.06	2.21	2.49	0.43	L	Partial
13/01/2015	AMcC	12:00	15:00	03:00	2.49	3.20	3.85	1.36	T	Partial
20/01/2015	KM	09:00	11:55	02:55	4.13	4.64	4.85	0.72	H	Full
20/01/2015	KM	11:55	14:50	02:55	2.03	3.44	4.58	2.55	T	Full
20/02/2015	NV	08:30	14:30	06:00	2.85	4.40	5.14	2.29	H	Full
27/02/2015	NV	08:30	14:30	06:00	1.59	2.10	3.27	1.68	T	Full
11/03/2015	NV	08:00	14:00	06:00	1.36	2.62	4.16	2.8	T	Full
19/03/2015	NV	10:00	16:00	06:00	0.47	2.73	4.57	4.1	T	Full
13/04/2015	NV	07:30	13:30	06:00	1.48	2.15	3.58	2.1	T	Full
20/04/2015	NV	07:30	13:30	06:00	1.47	3.74	4.80	3.33	T	Full
18/05/2015	NV	05:15	11:15	06:00	1.07	3.23	4.94	3.87	T	Full
27/05/2015	NV	08:00	14:00	06:00	1.59	2.23	3.52	1.93	T	Full
05/06/2015	NV	06:30	12:30	06:00	1.00	2.66	4.47	3.47	T	Full
30/06/2015	NV	09:15	15:15	06:00	1.42	3.18	4.29	2.87	T	Full
06/07/2015	NV	07:00	13:00	06:00	0.91	2.15	4.10	3.19	T	Full
15/07/2015	NV	09:00	15:00	06:00	1.74	3.51	4.27	2.53	T	Full
03/08/2015	NV	08:00	14:00	06:00	1.26	3.51	4.84	3.58	T	Full
25/08/2015	NV	09:15	15:15	06:00	1.98	2.41	3.40	1.42	T	Full
02/09/2015	NV	07:30	13:30	06:00	0.62	2.76	4.61	3.99	T	Full
22/09/2015	NV	07:30	13:30	06:00	1.84	2.26	3.22	1.38	T	Full
02/10/2015	NV	09:30	15:30	06:00	1.71	3.62	4.51	2.8	T	Full
21/10/2015	NV	08:00	14:00	06:00	2.01	2.39	3.06	1.05	T	Full
08/11/2015	NV	08:00	13:48	05:48	2.20	3.66	4.39	2.19	T	Full
19/11/2015	NV	08:45	14:45	06:00	1.73	2.39	3.65	1.92	T	Full
08/12/2015	NV	09:30	15:30	06:00	1.87	3.17	4.51	2.64	T	Full
14/12/2015	NV	09:30	15:30	06:00	3.05	4.32	4.95	1.9	H	Full
07/01/2016	NV	09:30	15:30	06:00	1.85	3.28	4.61	2.76	T	Full
21/01/2016	NV	09:00	15:00	06:00	1.58	3.21	4.54	2.96	T	Full
15/02/2016	NV	10:00	16:00	06:00	1.11	2.52	4.14	3.03	T	Full
22/02/2016	NV	11:00	17:00	06:00	1.37	3.39	4.60	3.23	T	Full
10/03/2016	NV	10:00	16:00	06:00	1.40	3.77	4.70	3.3	T	Full
16/03/2016	NV	12:00	18:00	06:00	1.47	2.84	3.89	2.42	T	Full
01/04/2016	NV	09:00	15:00	06:00	1.95	2.32	3.09	1.14	T	Full
18/04/2016	NV	08:00	14:00	06:00	1.70	3.40	4.23	2.53	T	Full
06/05/2016	NV	09:00	15:00	06:00	1.31	3.75	4.82	3.51	T	Full
22/05/2016	NV	06:00	12:00	06:00	1.43	3.18	4.49	3.06	T	Full

Date	Surveyor*	Start Time	Finish Time	Effort	Minimum Tide (m)	Mean Tide (m)	Maximum Tide (m)	Survey Tidal Range (m)	Survey Tidal State**	Area surveyed
16/03/2017	NV	07:00	13:00	06:00	1.07	2.62	4.44	3.37	T	Full
28/03/2017	NV	09:20	15:20	06:00	1.91	4.04	4.88	2.97	T	Full
12/04/2017	NV	11:30	17:30	06:00	1.05	3.17	4.60	3.55	T	Full
26/04/2017	NV	05:38	11:38	06:00	1.12	3.37	4.68	3.56	T	Full
17/05/2017	NV	05:20	16:20	11:00	1.60	2.76	4.03	2.43	T	Full
18/05/2017	NV	11:00	17:00	06:00	1.85	3.04	3.92	2.07	T	Full
12/06/2017	NV	05:10	11:10	06:00	1.37	2.15	3.68	2.31	T	Full
28/06/2017	NV	12:30	18:30	06:00	2.17	3.87	4.57	2.4	T	Full
13/07/2017	NV	12:00	18:00	06:00	2.05	3.61	4.27	2.22	T	Full
19/07/2017	NV	08:00	14:00	06:00	1.46	2.51	4.21	2.75	T	Full
01/08/2017	NV	05:50	11:50	06:00	1.84	3.06	4.03	2.19	T	Full
21/08/2017	NV	06:00	12:00	06:00	1.51	3.55	4.62	3.11	T	Full
05/09/2017	NV	09:10	15:10	06:00	1.88	3.69	4.52	2.64	T	Full
12/09/2017	NV	10:30	16:30	06:00	1.76	3.45	4.40	2.64	T	Full
12/10/2017	NV	10:40	16:40	06:00	1.80	3.25	4.36	2.56	T	Full
26/10/2017	NV	13:00	18:00	05:00	3.21	3.85	4.15	0.94	H	Full
06/11/2017	NV	09:00	15:00	06:00	2.80	4.16	4.85	2.05	H	Full
20/11/2017	NV	08:30	14:30	06:00	2.82	4.20	4.81	1.99	H	Full
01/12/2017	NV	08:20	14:20	06:00	1.24	3.07	4.16	2.92	T	Full
11/12/2017	NV	08:15	14:15	06:00	1.82	2.25	3.19	1.37	T	Full
11/01/2018	NV	08:45	14:45	06:00	1.84	2.41	3.61	1.77	T	Full
22/01/2018	NV	08:50	14:50	06:00	1.54	3.22	4.47	2.93	T	Full
01/02/2018	NV	08:20	14:20	06:00	2.82	4.08	4.73	1.91	H	Full
27/02/2018	NV	07:00	13:00	06:00	2.19	3.72	4.36	2.17	T	Full
16/03/2018	NV	07:00	13:00	06:00	2.63	4.04	4.67	2.04	T	Full
28/03/2018	NV	09:20	15:20	06:00	1.01	2.50	4.30	3.29	T	Full

Notes:

* Surveyors: AMcC = Adam McClure, KM = Kevin Mawhinney, NV= Nick Veale.

** Tidal state for each survey is designated as follows. Surveys designated as 'high tide' (H) when survey mean tide >= mid height of the tide AND survey min tide >= highest low tide. Surveys designated as 'low tide'(L) when survey mean tide < the mid height of the tide AND survey max tide < lowest high tide. All other surveys are designate 'through the tide' 'T'

Table A10.1: Estuarine walkover survey effort December 2014 to March 2018

APPENDIX 2 – ESTUARINE BIRD SURVEY DATA

Species	Year	J	F	M	A	M	J	J	A	S	O	N	D	Original SPA Citation*	Five Year Peak Mean**	Two Year Peak Mean***
Bar-tailed godwit	2014	-	-	-	-	-	-	-	-	-	-	-	6	353	134	275
	2015	20	0	33	0	0	1	16	35	30	117	**273**	257			
	2016	57	99	78	13	1	-	-	-	-	-	-	-			
	2017	-	-	36	37	0	11	14	34	88	95	**276**	202			
	2018	81	201	36	**-**	-	-	-	-	-	-	-	-			
Brent goose (LB)	2014	-	-	-	-	-	-	-	-	-	-	-	475	726	874	816
	2015	543	296	364	403	0	0	0	0	8	174	706	803			
	2016	462	**991**	429	323	1	-	-	-	-	-	-	-			
	2017	-	**-**	328	270	0	0	0	0	0	231	524	**641**			
	2018	569	481	328	-	-	-	-	-	-	-	-	-			
Golden plover	2014	-	-	-	-	-	-	-	-	-	-	-	14	1810	914	3061
	2015	**2822**	120	447	87	0	0	0	65	0	870	680	750			
	2016	0	1850	950	0	0	-	-	-	-	-	-	-			
	2017	-	**-**	850	0	0	0	0	550	0	630	1700	1850			
	2018	950	**3300**	850	-	-	-	-	-	-	-	-	-			
Grey plover	2014	-	-	-	-	-	-	-	-	-	-	-	7	200	122	487
	2015	17	3	**669**	0	0	0	0	0	17	31	123	63			
	2016	7	77	**304**	6	0	-	-	-	-	-	-	-			

Species	Year	J	F	M	A	M	J	J	A	S	O	N	D	Original SPA Citation*	Five Year Peak Mean**	Two Year Peak Mean***
	2017	-	-	136	0	0	0	0	0	13	31	113	79			
	2018	24	72	136	-	-	-	-	-	-	-	-	-			
Ringed plover	2014	-	-	-	-	-	-	-	-	-	-	-	0	221	96	204
	2015	0	0	0	12	46	25	47	101	**234**	48	110	138			
	2016	10	159	0	31	73	-	-	-	-	-	-	-			
	2017	-	**-**	7	75	51	42	31	105	33	31	**173**	95			
	2018	25	148	7	**-**	-	-	-	-	-	-	-	-			
Shelduck	2014	-	-	-	-	-	-	-	-	-	-	-	41	147	290	138
	2015	**175**	140	127	158	59	26	79	35	25	54	69	**101**			
	2016	86	65	74	72	47	-	-	-	-	-	-	-			
	2017	-	-	77	85	37	29	55	40	49	45	61	97			
	2018	70	71	87-	-	-	-	-	-	-	-	-	-			

Notes:
- = no survey
*Five year mean peak counts for the period 1995/96 – 1999/00 (I-WeBS) except for light-bellied brent goose (Robinson et al., 2004).
**Five year mean peak for the period 2005/06 – 2009/10 (I-WeBS).
***Two year mean peak based on collected data (underlined and emboldened by species).

Table A10.2: Estuarine walkover peak monthly population estimates for bird species listed as Special Conservation Interests (SCIs) on Baldoyle Bay SPA citation

Species	Year	J	F	M	A	M	J	J	A	S	O	N	D	Original SPA Citation*	Five Year Peak Mean**	Two Year Peak Mean***
Black-tailed godwit	2014	-	-	-	-	-	-	-	-	-	-	-	33	72	204	166
	2015	74	91	**145**	8	30	7	33	6	62	52	78	115			
	2016	61	77	61	29	16	-	-	-	-	-	-	-			
	2017	-	-	116	12	34	6	30	10	47	58	121	92			
	2018	42	100	**187**	-	-	-	-	-	-	-	-	-			
Curlew	2014	-	-	-	-	-	-	-	-	-	-	-	16	61	204	164
	2015	12	28	58	34	36	31	60	58	**238**	93	125	49			
	2016	26	**90**	40	12	12	-	-	-	-	-	-	-			
	2017	-	-	35	12	30	17	31	36	78	37	71	45			
	2018	21	42	31	-	-	-	-	-	-	-	-	-			
Dunlin	2014	-	-	-	-	-	-	-	-	-	-	-	81	879	185	525
	2015	109	393	279	24	166	0	32	98	623	409	472	**618**			
	2016	140	359	244	74	36	-	-	-	-	-	-	-			
	2017	-	-	197	72	99	0	46	148	120	234	335	**431**			
	2018	72	253	199	-	-	-	-	-	-	-	-	-			
Great crested grebe	2014	-	-	-	-	-	-	-	-	-	-	-	0	42	29	44
	2015	0	0	2	3	0	0	0	0	0	12	**55**	17			
	2016	10	37	9	11	1	-	-	-	-	-	-	-			
	2017	-	-	30	18	0	0	0	0	12	14	17	10			
	2018	11	**32**	30	-	-	-	-	-	-	-	-	-			
Greenshank	2014	-	-	-	-	-	-	-	-	-	-	-	1	11	20	20
	2015	1	1	**14**	4	0	1	1	7	5	5	5	9			

Species	Year	J	F	M	A	M	J	J	A	S	O	N	D	Original SPA Citation*	Five Year Peak Mean**	Two Year Peak Mean***
	2016	3	6	9	2	0	-	-	-	-	-	-	-			
	2017	-	-	8	3	0	0	2	3	**25**	6	7	8			
	2018	3	6	8	-	-	-	-	-	-	-	-	-			
Grey heron	2014	-	-	-	-	-	-	-	-	-	-	-	1	16	16	15
	2015	2	1	4	5	5	6	6	11	11	11	16	**17**			
	2016	10	14	5	8	8	-	-	-	-	-	-	-			
	2017	-	-	5	7	8	6	6	8	10	10	**12**	7			
	2018	8	9	8	-	-	-	-	-	-	-	-	-			
Knot	2014	-	-	-	-	-	-	-	-	-	-	-	0	115	111	126
	2015	0	**102**	47	0	0	0	0	0	0	4	0	8			
	2016	6	**150**	56	0	0	-	-	-	-	-	-	-			
	2017	-	-	32	0	0	0	5	0	0	12	12	8			
	2018	0	79	32	-	-	-	-	-	-	-	-	-			
Lapwing	2014	-	-	-	-	-	-	-	-	-	-	-	387	450	365	534
	2015	295	236	12	6	7	9	8	9	15	305	446	336			
	2016	**607**	512	71	26	7	-	-	-	-	-	-	-			
	2017	**-**	-	113	37	6	10	4	23	121	143	231	368			
	2018	424	**461**	256	-	-	-	-	-	-	-	-	-			
Mallard	2014	-	-	-	-	-	-	-	-	-	-	-	114	46	212	185
	2015	**154**	146	116	56	56	45	110	96	**215**	111	103	164			
	2016	99	78	75	85	68	-	-	-	-	-	-	-			
	2017	-	-	108	73	90	68	104	97	100	105	75	110			

Species	Year	J	F	M	A	M	J	J	A	S	O	N	D	Original SPA Citation*	Five Year Peak Mean**	Two Year Peak Mean***
	2018	123	108	108	-	-	-	-	-	-	-	-	-			
Oystercatcher	2014	-	-	-	-	-	-	-	-	-	-	-	49	531	837	739
	2015	120	218	**758**	692	242	369	144	168	**719**	273	361	317			
	2016	197	216	320	257	96	-	-	-	-	-	-	-			
	2017	-	-	181	171	162	95	118	174	217	168	221	305			
	2018	108	163	173	-	-	-	-	-	-	-	-	-			
Pintail	2014	-	-	-	-	-	-	-	-	-	-	-	0	22	26	1
	2015	**2**	0	0	0	0	0	0	0	0	0	0	0			
	2016	0	0	0	0	0	-	-	-	-	-	-	-			
	2017	-	-	0	0	0	0	0	0	0	0	0	0			
	2018	0	0	0	-	-	-	-	-	-	-	-	-			
Red-breasted merganser	2014	-	-	-	-	-	-	-	-	-	-	-	0	14	17	26
	2015	1	1	7	5	0	0	0	10	16	28	**30**	15			
	2016	18	18	12	9	8	-	-	-	-	-	-	-			
	2017	-	-	12	**22**	2	0	0	2	5	8	18	8			
	2018	12	8	12	-	-	-	-	-	-	-	-	-			
Redshank	2014	-	-	-	-	-	-	-	-	-	-	-	23	224	314	294
	2015	40	111	126	110	2	17	22	113	167	257	303	**334**			
	2016	111	146	137	61	7	-	-	-	-	-	-	-			
	2017	-	-	105	54	8	9	67	57	207	87	142	**254**			
	2018	82	100	105	-	-	-	-	-	-	-	-	-			
Sanderling	2014	-	-	-	-	-	-	-	-	-	-	-	0	26	21	50

Species	Year	J	F	M	A	M	J	J	A	S	O	N	D	Original SPA Citation*	Five Year Peak Mean**	Two Year Peak Mean***
	2015	0	14	2	0	0	0	0	0	0	11	18	0			
	2016	0	16	**45**	8	0	-	-	-	-	-	-	-			
	2017	-	-	30	33	0	0	0	0	0	0	**55**	34			
	2018	0	0	30	-	-	-	-	-	-	-	-	-			
Teal	2014	-	-	-	-	-	-	-	-	-	-	-	161	124	238	328
	2015	194	146	192	52	5	11	45	36	198	110	111	248			
	2016	172	**367**	144	46	43	-	-	-	-	-	-	-			
	2017	-	**-**	96	47	8	6	46	46	46	87	133	156			
	2018	111	**288**	96	-	-	-	-	-	-	-	-	-			
Turnstone	2014	-	-	-	-	-	-	-	-	-	-	-	1	43	77	74
	2015	1	2	12	15	0	5	0	11	51	28	40	**74**			
	2016	19	38	62	32	0	-	-	-	-	-	-	-			
	2017	-	-	**74**	30	0	12	8	9	22	30	29	71			
	2018	17	28	74	-	-	-	-	-	-	-	-	-			

Notes:
- = no survey
*Five year mean peak counts for the period 1995/96 – 1999/00 (I-WeBS) with the exception of light-bellied brent goose (Robinson et al., 2004).
**Five year mean peak for the period 2005/06 – 2009/10 (I-WeBS).
***Two year mean peak based on collected data (underlined and emboldened by species).

Table A10.3: Estuarine walkover peak monthly population estimates for other bird species (non-SCI) listed on Baldoyle Bay SPA citation

Species	Category	J	F	M	A	M	J	J	A	S	O	N	D
Black guillemot**	Auks	2	2	2	4	2	2	2	2	2	4	2	2
Guillemot*,****		2	4	0	1	0	2	2	6	1	9	3	20
Razorbill*,****		2	2	0	1	6	1	5	2	2	4	2	2
Great northern diver	Divers	3	3	1	1	0	0	0	0	0	1	6	2
Red-throated diver		3	3	16	7	1	0	0	0	3	16	9	14
Canada goose	Geese and Swans	73	0	0	0	0	0	0	0	0	35	0	0
Mute swan		6	7	13	5	5	13	13	15	10	9	10	12
Pink-footed goose		0	0	1	0	0	0	0	0	0	0	0	0
Black-necked grebe	Grebes, Ducks and Rails	0	0	0	0	0	0	0	0	0	0	14	0
Common scoter		85	70	196	75	73	0	0	43	22	51	233	85
Coot		2	2	0	4	3	1	2	0	1	1	1	0
Eider		0	0	0	3	0	0	0	0	0	3	0	0
Goldeneye		8	0	0	0	0	0	0	0	0	0	0	0
Little grebe		1	1	4	2	1	5	4	4	1	2	2	1
Long-tailed duck		4	3	0	2	0	0	0	0	0	0	0	0
Moorhen		8	8	10	12	7	6	4	4	8	9	6	6
Shoveler		0	0	0	0	0	0	0	2	0	0	2	2
Tufted duck		1	1	0	0	0	0	1	1	1	0	1	0
Wigeon		138	166	67	25	0	4	0	16	16	124	228	257
Black-headed gull	Gulls	112	203	93	110	68	66	80	155	404	332	306	224
Common gull		58	84	26	53	34	10	10	9	28	34	53	54
Great black-backed gull**		6	27	24	26	27	32	28	14	69	27	10	18
Herring gull*		84	181	111	131	154	292	167	114	331	216	190	95

Species	Category	J	F	M	A	M	J	J	A	S	O	N	D
Kittiwake*,***		2	1	6	0	0	0	0	0	0	0	3	0
Lesser black-backed gull		12	3	24	29	26	46	42	25	17	13	23	2
Mediterranean gull		0	2	0	0	0	0	4	3	4	1	2	0
Ring-billed gull		1	0	1	0	0	0	0	0	0	0	1	0
Blue tit	Other	0	1	0	0	0	0	0	0	0	0	0	0
Fulmar		0	0	0	0	0	0	0	0	0	0	0	1
Hooded crow		0	0	0	0	4	0	0	0	0	0	0	0
Kingfisher		0	0	0	0	0	0	0	0	0	0	0	1
Mistle thrush		0	0	1	0	0	0	0	0	0	0	0	0
Little egret		8	7	11	11	12	9	9	9	20	13	13	10
Pheasant		0	0	0	0	1	0	0	0	0	0	0	0
Red-legged partridge		0	1	0	0	0	0	0	0	0	0	0	0
Snow bunting		0	0	0	6	0	0	0	0	0	0	0	0
Song thrush		0	0	1	0	0	0	0	0	0	0	0	0
Stonechat		11	0	0	0	0	0	0	0	0	0	0	0
Wheatear		0	0	0	0	1	0	0	0	0	0	0	0
Buzzard	Raptors	1	2	2	3	3	1	1	1	0	1	1	1
Kestrel		1	1	1	1	1	0	1	2	1	0	0	0
Peregrine**,****		1	2	0	2	1	0	0	1	1	1	0	1
Sparrowhawk		1	0	1	0	0	0	0	0	1	1	1	1
Cormorant*	Shags and Cormorants	17	20	10	28	14	27	24	20	16	42	39	34
Shag**		3	8	6	7	6	5	7	7	10	11	10	2
Arctic tern	Terns	0	0	0	2	3	5	3	0	0	0	0	0

Species	Category	J	F	M	A	M	J	J	A	S	O	N	D
Black tern		0	0	0	0	0	0	0	2	0	0	0	0
Common tern		0	0	0	14	9	12	29	34	0	0	0	0
Roseate tern		0	0	0	0	1	2	4	11	7	0	0	0
Sandwich tern		0	0	4	9	15	5	15	10	42	0	0	0
Avocet	Waders	0	0	0	1	0	0	0	0	0	0	0	0
Common sandpiper		2	1	0	3	1	0	3	2	3	2	1	0
Snipe		7	35	5	6	1	0	0	2	4	5	3	6
Curlew sandpiper		0	0	0	0	0	0	0	0	0	3	6	0
Green sandpiper		0	0	0	0	0	0	1	0	0	0	0	0
Purple sandpiper		0	0	2	0	0	0	0	0	0	0	0	0
Ruff		0	1	0	0	0	0	4	7	8	2	0	0
Little stint		0	0	0	0	0	0	0	1	0	0	0	0
Whimbrel		0	0	62	53	76	3	5	5	4	5	6	0

Notes:
* SCI of Ireland’s Eye SPA.
** Named bird species of Ireland’s Eye SPA.
*** SCI of Howth Head Coast SPA.
**** Named bird species of Howth Head Coast SPA.

Table A10.4: Estuarine walkover peak monthly population estimates for bird species not listed on Baldoyle Bay SPA citation

APPENDIX 3 – MARINE VP SURVEY EFFORT

Date	VP ID	Surveyor*	Start Time	Finish Time	Survey Effort	Minimum Tide (m)	Mean Tide (m)	Maximum Tide (m)	Survey Tidal Range (m)	Survey Tidal State**
19/12/2014	2	AMcC	10:15	13:15	03:00	2.21	3.17	4.00	1.79	T
22/12/2014	1	AMcC	12:25	15:25	03:00	1.90	3.30	4.55	2.65	T
08/01/2015	2	AMcC	09:10	12:25	03:15	2.48	3.59	4.44	1.96	H
12/01/2015	1	AMcC	10:00	13:00	03:00	2.48	3.04	3.69	1.21	H
19/01/2015	1	AMcC	08:45	11:45	03:00	4.12	4.41	4.56	0.44	H
19/01/2015	2	AMcC	12:55	15:55	03:00	1.10	1.89	3.08	1.98	L
18/02/2015	2	KM	08:30	11:30	03:00	3.92	4.51	4.76	0.84	H
18/02/2015	1	KM	13:30	16:30	03:00	0.72	1.56	2.96	2.24	L
25/02/2015	2	KM	08:30	11:30	03:00	1.24	1.41	1.76	0.52	L
25/02/2015	1	KM	13:30	16:30	03:00	2.99	3.74	4.20	1.21	H
05/03/2015	2	NV	09:00	12:00	03:00	3.42	4.11	4.42	1	H
05/03/2015	1	NV	14:00	17:00	03:00	0.95	1.84	3.14	2.19	L
23/03/2015	2	NV	09:00	12:00	03:00	2.04	3.45	4.57	2.53	T
23/03/2015	1	NV	14:00	17:00	03:00	2.01	3.63	4.81	2.8	T
02/04/2015	2	NV	08:30	11:30	03:00	3.65	4.09	4.28	0.63	H
02/04/2015	1	NV	13:30	16:30	03:00	1.10	1.64	2.65	1.55	L
08/04/2015	2	NV	08:00	11:00	03:00	1.15	2.09	3.16	2.01	L
08/04/2015	1	NV	13:00	16:00	03:00	3.23	3.95	4.23	1	H
19/05/2015	1	NV	05:30	08:30	03:00	0.83	1.55	2.73	1.9	L
19/05/2015	2	NV	10:00	13:00	03:00	3.92	4.47	4.70	0.78	H
28/05/2015	2	NV	09:00	12:00	03:00	1.95	2.78	3.59	1.64	L
28/05/2015	1	NV	14:00	17:00	03:00	1.64	2.18	2.88	1.24	L
16/06/2015	2	NV	10:00	13:00	03:00	3.70	4.26	4.48	0.78	H
16/06/2015	1	NV	15:00	18:00	03:00	0.98	1.22	1.82	0.84	L
29/06/2015	2	NV	08:00	11:00	03:00	3.59	3.93	4.09	0.5	H
29/06/2015	1	NV	13:00	16:00	03:00	1.38	1.63	2.24	0.86	L
07/07/2015	1	NV	07:00	10:00	03:00	1.06	1.29	1.83	0.77	L
07/07/2015	2	NV	12:00	15:00	03:00	2.85	3.78	4.46	1.61	H
13/07/2015	1	NV	07:30	10:30	03:00	3.83	4.23	4.40	0.57	H
13/07/2015	2	NV	12:30	15:30	03:00	1.48	1.90	2.77	1.29	L
04/08/2015	2	NV	08:00	11:00	03:00	1.08	2.03	3.21	2.13	L
04/08/2015	1	NV	13:00	16:00	03:00	3.98	4.56	4.79	0.81	H
24/08/2015	2	NV	07:00	10:00	03:00	2.36	3.14	3.83	1.47	H
24/08/2015	1	NV	12:15	15:15	03:00	2.02	2.48	3.09	1.07	L
09/09/2015	1	NV	07:00	10:00	03:00	3.42	3.82	3.99	0.57	H
09/09/2015	2	NV	14:45	17:45	03:00	1.66	2.09	2.77	1.11	L
30/09/2015	1	NV	07:15	10:15	03:00	0.92	2.27	3.61	2.69	L
30/09/2015	2	NV	11:10	14:10	03:00	4.10	4.50	4.70	0.6	H

Date	VP ID	Surveyor*	Start Time	Finish Time	Survey Effort	Minimum Tide (m)	Mean Tide (m)	Maximum Tide (m)	Survey Tidal Range (m)	Survey Tidal State**
01/10/2015	1	NV	08:00	11:00	03:00	1.02	2.32	3.59	2.57	L
01/10/2015	2	NV	13:00	16:00	03:00	4.00	4.44	4.63	0.63	H
22/10/2015	2	NV	11:45	14:45	03:00	2.04	2.33	2.83	0.79	L
22/10/2015	1	NV	15:30	18:30	03:00	3.20	3.77	4.16	0.96	H
05/11/2015	2	NV	08:00	11:00	03:00	2.65	3.28	3.88	1.23	H
06/11/2015	1	NV	12:10	15:10	03:00	2.26	2.41	2.66	0.4	L
23/11/2015	1	NV	07:45	10:45	03:00	3.84	4.29	4.47	0.63	H
23/11/2015	2	NV	11:30	14:30	03:00	1.26	2.01	3.19	1.93	L
03/12/2015	1	NV	09:00	12:00	03:00	2.06	2.19	2.45	0.39	L
04/12/2015	2	NV	10:00	13:00	03:00	2.23	2.33	2.53	0.3	L
09/12/2015	1	NV	10:30	13:30	03:00	2.76	3.79	4.46	1.7	H
10/12/2015	2	NV	09:30	12:30	03:00	3.83	4.31	4.50	0.67	H
15/12/2015	1	NV	09:00	12:00	03:00	2.03	3.17	4.22	2.19	T
16/12/2015	2	NV	09:30	12:30	03:00	1.99	3.02	4.06	2.07	T
06/01/2016	1	NV	09:00	12:00	03:00	3.01	3.77	4.24	1.23	H
08/01/2016	2	NV	10:00	13:00	03:00	3.35	4.28	4.73	1.38	H
19/01/2016	1	NV	09:00	12:00	03:00	1.79	2.68	3.66	1.87	L
23/01/2016	2	NV	10:00	13:00	03:00	3.77	4.39	4.65	0.88	H
06/02/2016	1	NV	13:45	16:45	03:00	1.78	2.05	2.64	0.86	L
10/02/2016	2	NV	12:30	15:30	03:00	2.87	4.22	4.93	2.06	H
17/02/2016	2	NV	11:00	14:00	03:00	1.54	1.71	2.07	0.53	L
18/02/2016	1	NV	10:30	13:30	03:00	1.56	2.30	3.27	1.71	L
08/03/2016	1	NV	09:00	12:00	03:00	4.24	4.68	4.87	0.63	H
15/03/2016	2	NV	14:30	17:30	03:00	3.48	3.95	4.14	0.66	H
18/03/2016	1	NV	12:00	15:00	03:00	1.40	1.56	1.99	0.59	L
21/03/2016	2	NV	14:30	17:30	03:00	1.04	1.26	1.82	0.78	L
04/04/2016	1	NV	08:00	11:00	03:00	3.55	4.19	4.43	0.88	H
04/04/2016	2	NV	13:30	16:30	03:00	1.38	1.55	1.90	0.52	L
12/04/2016	2	NV	12:00	15:00	03:00	3.01	3.93	4.55	1.54	H
17/04/2016	1	NV	07:30	10:30	03:00	3.49	3.97	4.14	0.65	H
04/05/2016	2	NV	13:00	16:00	03:00	1.03	1.29	1.96	0.93	L
09/05/2016	1	NV	06:30	09:30	03:00	0.78	1.55	2.79	2.01	L
25/05/2016	1	NV	15:00	18:00	03:00	1.67	2.81	3.91	2.24	T
26/05/2016	2	NV	14:30	17:30	03:00	2.58	3.57	4.19	1.61	H
14/06/2016	1	NV	06:30	09:30	03:00	3.15	3.79	4.08	0.93	H
14/06/2016	2	NV	12:30	15:30	03:00	1.70	1.97	2.50	0.8	L
30/06/2016	1	NV	05:00	08:00	03:00	3.69	4.21	4.43	0.74	H
30/06/2016	2	NV	08:45	11:45	03:00	1.79	2.87	3.95	2.16	T
08/07/2016	2	NV	14:00	17:00	03:00	2.86	3.88	4.39	1.53	H
12/07/2016	2	NV	11:15	14:15	03:00	1.61	2.11	2.79	1.18	L
17/07/2016	2	NV	12:30	15:30	03:00	1.46	2.02	2.92	1.46	L
22/07/2016	2	NV	11:00	14:00	03:00	3.76	4.27	4.48	0.72	H
15/03/2017	1	NV	06:40	09:40	03:00	0.84	1.53	2.61	1.77	L

Date	VP ID	Surveyor*	Start Time	Finish Time	Survey Effort	Minimum Tide (m)	Mean Tide (m)	Maximum Tide (m)	Survey Tidal Range (m)	Survey Tidal State**
15/03/2017	2	NV	12:00	15:00	03:00	3.87	4.34	4.53	0.66	H
29/03/2017	2	NV	06:40	09:40	03:00	1.19	2.48	3.80	2.61	T
29/03/2017	1	NV	12:00	15:00	03:00	3.00	4.31	5.02	2.02	H
20/04/2017	1	NV	06:45	09:45	03:00	2.21	2.93	3.56	1.35	T
20/04/2017	2	NV	11:00	14:00	03:00	1.66	1.80	2.12	0.46	L
27/04/2017	1	NV	06:15	09:15	03:00	0.99	2.31	3.69	2.7	L
27/04/2017	2	NV	12:55	15:55	03:00	1.40	3.00	4.45	3.05	T
08/05/2017	1	NV	05:40	08:40	03:00	2.21	3.30	3.96	1.75	T
08/05/2017	2	NV	12:40	15:40	03:00	1.06	1.84	2.97	1.91	L
17/05/2017	1	NV	11:20	14:20	03:00	2.67	3.23	3.75	1.08	H
17/05/2017	2	NV	15:20	18:20	03:00	3.19	3.77	4.03	0.84	H
12/06/2017	2	NV	12:40	15:40	03:00	3.19	3.96	4.30	1.11	H
12/06/2017	1	NV	16:30	19:30	03:00	1.29	1.63	2.43	1.14	L
27/06/2017	2	NV	08:15	11:15	03:00	1.15	2.30	3.51	2.36	L
27/06/2017	1	NV	12:05	15:02	02:57	4.12	4.56	4.76	0.64	H
20/07/2017	2	NV	07:45	10:45	03:00	3.26	4.00	4.34	1.08	H
20/07/2017	1	NV	11:30	14:30	03:00	1.29	1.75	2.63	1.34	L
27/07/2017	1	NV	07:30	10:30	03:00	0.92	1.48	2.50	1.58	L
27/07/2017	2	NV	11:30	14:30	03:00	3.30	4.16	4.64	1.34	H
17/08/2017	1	NV	08:50	11:50	03:00	1.81	2.63	3.57	1.77	T
17/08/2017	2	NV	12:35	15:35	03:00	1.66	1.98	2.56	0.91	L
29/08/2017	2	NV	10:05	13:05	03:00	1.72	2.05	2.62	0.91	L
29/08/2017	1	NV	13:45	16:45	03:00	3.00	3.57	3.94	0.95	H
06/09/2017	2	NV	08:40	11:40	03:00	3.25	4.00	4.42	1.18	H
06/09/2017	1	NV	12:20	15:20	03:00	1.94	3.19	4.23	2.3	T
21/09/2017	1	NV	12:15	15:15	03:00	2.52	3.80	4.63	2.12	T
21/09/2017	2	NV	15:45	18:45	03:00	1.02	1.26	1.90	0.89	L
25/10/2017	2	NV	12:40	15:40	03:00	3.81	4.14	4.27	0.47	H
25/10/2017	1	NV	16:05	19:05	03:00	2.10	3.03	3.93	1.84	T
31/10/2017	1	NV	07:00	10:00	03:00	3.64	3.89	4.03	0.4	H
31/10/2017	2	NV	13:45	16:45	03:00	1.85	2.12	2.69	0.85	L
27/11/2017	1	NV	08:15	11:15	03:00	2.04	2.46	3.10	1.07	T
29/11/2017	1	NV	13:05	16:05	03:00	1.67	1.98	2.56	0.9	L
30/11/2017	2	NV	12:50	15:50	03:00	1.49	1.62	1.94	0.46	L
04/12/2017	1	NV	08:25	11:25	03:00	3.18	4.13	4.71	1.54	H
18/12/2017	2	NV	13:00	16:00	03:00	1.66	2.81	3.97	2.32	T
28/12/2017	1	NV	08:20	11:20	03:00	2.13	2.88	3.68	1.56	T
28/12/2017	2	NV	12:20	15:20	03:00	1.84	2.16	2.76	0.93	T
10/01/2018	1	NV	08:20	11:20	03:00	2.04	2.68	3.52	1.49	T
10/01/2018	2	NV	11:55	14:55	03:00	1.94	2.29	2.85	0.92	T
24/01/2018	2	NV	08:30	11:30	03:00	2.18	2.37	2.78	0.61	T
24/01/2018	1	NV	12:05	15:05	03:00	3.15	3.86	4.48	1.34	H
05/02/2018	1	NV	09:15	12:15	03:00	1.23	2.25	3.35	2.13	T

Date	VP ID	Surveyor*	Start Time	Finish Time	Survey Effort	Minimum Tide (m)	Mean Tide (m)	Maximum Tide (m)	Survey Tidal Range (m)	Survey Tidal State**
05/02/2018	2	NV	13:00	16:00	03:00	3.86	4.33	4.52	0.67	H
22/02/2018	1	NV	07:30	10:30	03:00	1.28	1.44	1.80	0.53	L
22/02/2018	2	NV	11:20	14:20	03:00	2.17	3.12	3.96	1.8	T
15/03/2018	1	NV	06:40	09:40	03:00	3.00	3.95	4.69	1.7	H
15/03/2018	2	NV	12:00	15:00	03:00	1.98	3.15	4.32	2.35	T
29/03/2018	2	NV	06:40	09:40	03:00	3.07	3.95	4.56	1.5	H
29/03/2018	1	NV	12:00	15:00	03:00	1.05	2.21	3.60	2.56	T

Notes:

* Surveyors: AMcC = Adam McClure, KM = Kevin Mawhinney, NV= Nick Veale.

** Tidal state for each survey is designated as follows. Surveys designated as 'high tide' (H) when survey mean tide >= mid height of the tide AND survey min tide >= highest low tide. Surveys designated as 'low tide'(L) when survey mean tide < the mid height of the tide AND survey max tide < lowest high tide. All other surveys are designate 'through the tide' 'T'

Table A10.5: Coastal and marine VP survey effort December 2014 to March 2018

APPENDIX 4 – MARINE VP RECORDS

Species	Ireland's Eye SPA	Howth Head Coast SPA	Number of Surveys Species Present (74 Surveys Total)	Total Number of Individuals Encountered on Sea During VP Surveys	Total Number of Individuals Encountered in Flight During VP Surveys	Peak VP Count (Birds on Sea in a Single Survey)	Peak VP Count (Birds in Flight in a Single Survey)	Peak VP Count (All Birds in a Single Survey)	Peak VP Month
Guillemot	SCI	Yes	60	1084	750	216	364	465	March
Razorbill	SCI	Yes	62	1557	771	388	188	453	March
Guillemot or razorbill	SCI	Yes	39	1089	218	400	33	424	October
Kittiwake	SCI	SCI	60	1207	1000	145	186	310	October
Herring gull	SCI	No	75	3709	1932	177	119	239	February
Fulmar	Yes	Yes	55	336	741	76	83	159	December
Great black-backed gull	Yes	No	74	746	746	61	43	97	February
Cormorant	SCI	No	73	476	472	47	34	69	January
Gannet	Yes	No	48	277	354	19	42	60	February
Shag	Yes	No	71	783	365	41	12	47	September
Cormorant or shag	Yes	No	3	31	3	29	3	29	October
Black guillemot	Yes	No	59	208	96	22	6	22	October
Peregrine	Yes	Yes	15	0	24	0	4	4	October
Puffin	Yes	No	4	2	4	1	2	2	March

Table A10.6: Frequency and number of species encounters and on sea/in flight/total peak counts from VP surveys during winter/passage season (species named in Ireland's Eye and/or Howth Head Coast SPA citations), sorted by peak VP count

Species	Baldoyle Bay SPA Citation Status	Number of Surveys Species Present (74 Surveys Total)	Number of Individuals Encountered on Sea During VP Surveys	Number of Individuals Encountered in Flight During VP Surveys	Peak VP Count (Birds on Sea in a Single Survey)	Peak VP Count (Birds in Flight in a Single Survey)	Peak VP Count (All Birds in a Single Survey)	Peak VP Month
Great crested grebe	Yes	46	1846	32	253	3	255	March
Oystercatcher	Yes	63	1383	912	187	109	210	January
Sanderling	Yes	17	453	230	82	51	105	December
Dunlin	Yes	9	146	235	80	100	100	January
Red-breasted merganser	Yes	39	456	99	72	18	90	March
Turnstone	Yes	16	203	70	33	19	44	March
Brent goose (LB)	SCI	39	107	569	39	39	39	February
Redshank	Yes	5	84	4	36	4	36	January
Ringed plover	SCI	5	0	89	0	21	21	March
Curlew	Yes	18	49	61	13	11	16	November
Lapwing	Yes	1	0	15	0	15	15	February
Bar-tailed godwit	SCI	3	27	0	14	0	14	October
Black-tailed godwit	Yes	1	0	12	0	12	12	November
Shelduck	SCI	3	9	8	9	4	9	November
Grey heron	Yes*	10	2	14	1	6	7	December
Mallard	Yes	1	0	2	0	2	2	February

Notes

*Listed as ‘other important species’ of Baldoyle Bay SPA.

Table A10.7: Frequency and number of species encounters and on sea/in flight/total peak counts from VP surveys during winter/passage season (species named in Baldoyle Bay SPA citation), sorted by peak VP count

Species	Number of Surveys Species Present (74 Surveys Total)	Number of Individuals Encountered on Sea During VP Surveys	Number of Individuals Encountered in Flight During VP Surveys	Peak VP Count (Birds on Sea in a Single Survey)	Peak VP Count (Birds in Flight in a Single Survey)	Peak VP Count (All Birds in a Single Survey)	Peak VP Month
Common scoter	64	5616	696	443	53	478	January
Black-headed gull	55	1759	753	121	102	223	October
Canada goose	2	204	3	203	3	203	January
Red-throated diver	63	617	73	112	5	112	March
Sandwich tern	8	77	89	37	23	58	September
Pink-footed goose	1	0	49	0	49	49	March
Whimbrel	4	3	80	3	38	38	March
Manx shearwater	1	0	35	0	35	35	September
Bar-tailed godwit	5	71	0	25	0	25	October
Lesser black-backed gull	28	97	33	18	7	25	November
Common gull	36	135	66	22	7	23	November
Common or Arctic tern	1	0	23	0	23	23	September
Swallow	2	0	36	0	18	18	March
Goldcrest	1	11	0	11	0	11	March
Great northern diver	37	85	9	8	2	9	December
Black-throated diver	6	11	0	5	0	5	February
Common tern	1	2	3	2	3	5	September
Common eider	1	4	0	4	0	4	December
Little grebe	2	0	8	0	4	4	March
Long-tailed duck	5	12	0	4	0	4	January
Purple sandpiper	2	0	8	0	4	4	March
Mediterranean gull	4	5	2	2	1	2	September
Blackbird	1	0	2	0	2	2	November
Ring-billed gull	1	2	0	2	0	2	March
Slavonian grebe	1	2	0	2	0	2	March
Arctic skua	1	0	1	0	1	1	September
Black-necked grebe	1	1	0	1	0	1	March

Table A10.8: Frequency and number of species encounters and on sea/in flight/total peak counts from VP surveys during winter/passage season (non-SPA species), sorted by peak VP count

Species	Number of Surveys Species Present (74 Surveys Total)	Number of Individuals Encountered on Sea During VP Surveys	Number of Individuals Encountered in Flight During VP Surveys	Peak VP Count (Birds on Sea in a Single Survey)	Peak VP Count (Birds in Flight in a Single Survey)	Peak VP Count (All Birds in a Single Survey)	Peak VP Month
Unidentified gull	3	205	0	142	0	142	January
Unidentified wader	4	28	0	24	0	31	November

Table A10.9: Number of partially identified bird encounters and on sea/in flight/total peak counts from VP surveys during winter/passage season, sorted by peak VP count

Species	Ireland's Eye SPA	Howth Head Coast SPA	Number of Surveys Species Present (56 Surveys Total)	Number of Individuals Encountered on Sea During VP Surveys	Number of Individuals Encountered in Flight During VP Surveys	Peak VP Count (Birds on Sea in a Single Survey)	Peak VP Count (Birds in Flight in a Single Survey)	Peak VP Count (All Birds in a Single Survey)	Peak VP Month
Guillemot	SCI	Yes	51	7882	4541	1051	462	1513	June
Razorbill	SCI	Yes	55	6683	3571	705	333	1038	May
Kittiwake	SCI	SCI	56	2988	1773	477	87	557	May
Guillemot or razorbill	Yes	Yes	38	795	534	184	161	244	July
Gannet	Yes	No	54	1055	1268	143	133	225	June
Herring Gull	SCI	No	56	3070	1889	129	86	185	June
Puffin	Yes	No	33	740	322	151	55	173	June
Shag	Yes	No	56	1208	1075	60	84	129	July
Great Black-backed Gull	Yes	No	56	692	905	32	66	87	June
Cormorant	SCI	No	56	501	791	37	49	63	June
Fulmar	Yes	Yes	51	197	516	23	40	63	May
Black Guillemot	Yes	No	51	204	114	10	6	14	June
Peregrine	Yes	Yes	18	0	18	0	2	2	May, July
Cormorant or shag	Yes	No	4	3	1	1	1	1	May, July, August

Table A10.10: Frequency and number of species encounters from VP surveys during breeding season (species named in Ireland's Eye/Howth Head Coast SPA citations), sorted by peak VP count

Species	Baldoyle Bay SPA Citation Status	Number of Surveys Species Present (56 Surveys Total)	Number of Individuals Encountered on Sea During VP Surveys	Number of Individuals Encountered in Flight During VP Surveys	Peak VP Count (Birds on Sea in a Single Survey)	Peak VP Count (Birds in Flight in a Single Survey)	Peak VP Count (All Birds in a Single Survey)	Peak VP Month
Oystercatcher	Yes	49	805	357	128	38	145	May
Ringed Plover	SCI	9	136	73	38	32	70	June
Red-breasted Merganser	Yes	15	117	22	37	7	44	August
Dunlin	Yes	4	80	37	40	26	40	June
Black-tailed Godwit	Yes	1	0	37	0	37	37	July
Curlew	Yes	9	21	20	7	10	16	August
Redshank	Yes	2	7	16	7	16	16	April
Great Crested Grebe	Yes	7	55	5	14	2	15	April
Shelduck	SCI	19	13	69	4	14	14	July
Brent Goose (light-bellied)	SCI	3	0	30	0	24	13	April
Turnstone	Yes	4	8	28	8	12	12	July
Bar-tailed Godwit	Yes	1	1	0	1	0	1	May
Grey Heron	Yes*	8	1	6	1	1	1	April, May, June, July, August

Notes

*Listed as ‘other important species’ of Baldoyle Bay SPA.

Table A10.11: Frequency and number of species encounters from VP surveys during breeding season (species named in Baldoyle Bay SPA citation), sorted by peak VP count

Species	Number of Surveys Species Present (56 Surveys Total)	Number of Individuals Encountered on Sea During VP Surveys	Number of Individuals Encountered in Flight During VP Surveys	Peak VP Count (Birds on Sea in a Single Survey)	Peak VP Count (Birds in Flight in a Single Survey)	Peak VP Count (All Birds in a Single Survey)	Peak VP Month
Black-headed gull	42	757	501	96	60	156	August
Manx shearwater	29	318	637	53	100	128	August
Common scoter	16	445	57	119	18	124	August
Common tern	23	123	435	17	94	109	August
Red-throated diver	13	122	13	52	3	52	April
Common gull	42	176	113	38	10	40	June

Species	Number of Surveys Species Present (56 Surveys Total)	Number of Individuals Encountered on Sea During VP Surveys	Number of Individuals Encountered in Flight During VP Surveys	Peak VP Count (Birds on Sea in a Single Survey)	Peak VP Count (Birds in Flight in a Single Survey)	Peak VP Count (All Birds in a Single Survey)	Peak VP Month
Sandwich tern	49	295	455	19	32	37	May
Common or Arctic tern	26	84	185	18	17	24	June
Lesser black-backed gull	48	119	92	12	7	14	May
Tufted duck	2	0	20	0	11	14	June
Whimbrel	5	7	18	4	11	11	April
Little tern	2	1	10	1	10	10	August
Mediterranean gull	3	2	12	2	10	10	July
Common eider	2	16	0	8	0	8	April
Roseate tern	7	3	15	2	8	8	August
Long-tailed duck	1	6	0	6	0	6	April
Mute swan	1	0	4	0	4	4	July
Arctic tern	8	4	12	2	3	3	May, June
Great skua	9	2	13	1	3	3	June, August
Kestrel	7	3	4	3	3	3	June
Blackbird	1	0	2	0	2	2	April
Feral pigeon	4	0	8	0	2	2	May, June
Greenfinch	2	1	2	1	2	2	July
Sparrowhawk	1	0	2	0	2	2	June
Arctic skua	4	0	4	0	1	1	July, August
Little stint	1	0	1	0	1	1	July
Great northern diver	1	1	0	1	0	1	August
Ring-billed gull	1	1	0	1	0	1	July
Storm petrel	1	0	1	0	1	1	May

Table A10.12: Frequency and number of species encounters and on sea/in flight/total peak counts from VP surveys during breeding season (non-SPA species), sorted by peak VP count

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	0	0	2	0	2
	DP	0	0	55	95	150
	FE	0	0	7	0	7
	LO	0	15	85	219	319
	PL	0	0	0	2	2
	RO	0	4	15	29	48
	SF	0	0	5	0	5
	SU	0	0	3	32	35
	Total	**0**	**19**	**172**	**377**	**568**
2	-	0	0	17	7	24
	DP	98	32	156	187	473
	FE	0	0	0	12	12
	LO	132	1176	940	564	2812
	PR	5	16	0	1	22
	RO	15	30	54	58	157
	SC	0	2	0	0	2
	SF	0	20	25	41	86
	SU	0	6	15	18	39
	Total	**250**	**1282**	**1207**	**888**	**3627**
Grand Total		**250**	**1301**	**1379**	**1265**	**4195**

Table A10.13: Kittiwake behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	0	1	4	3	8
	FE	4	41	257	157	459
	LO	1	38	126	135	300
	PR	0	5	8	0	13
	Total	**5**	**85**	**395**	**295**	**780**
2	-	74	63			137
	FE	46	271	581	253	1151
	LO	4150	1331	795	278	6554
	PL	0	0	0	1	1
	PR	122	27	6	0	155
	RO	181	7	0	0	188
	Total	**4573**	**1699**	**1382**	**532**	**8186**
Grand Total		**4578**	**1784**	**1777**	**827**	**8966**

Table A10.14: Guillemot behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	0	0	0	6	6
	FE	4	55	187	314	560
	LO	1	15	62	129	207
	PR	0	5	8	5	18
	Total	**5**	**75**	**257**	**454**	**791**
2	-	52	18			70
	FE	26	233	490	231	980
	LO	3900	1177	659	190	5926
	PR	139	53	9	7	208
	RO	223	42	0	0	265
	Total	**4340**	**1523**	**1158**	**428**	**7449**
Grand Total		**4345**	**1598**	**1415**	**882**	**8240**

Table A10.15: Razorbill behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	13	6	5	42	66
	DP			35	83	118
	FE				5	5
	LO	184	381	324	225	1114
	PR	10	3	0	2	15
	RL	40	26	65	84	215
	RO	394	374	527	443	1738
	SC	0	12	8	12	32
	SF	0	0	22	56	78
	SU	10	1	3	5	19
	Total	**651**	**803**	**989**	**957**	**3400**
2	-	28	12	6	7	53
	FE	10	1	0	6	17
	LO	970	590	205	182	1947
	PR	182	46	0	0	228
	RL	137	22	0	0	159
	RO	349	160	29	15	553
	SC	18	27	4	28	77
	SF	0	70	138	81	289
	SU	15	2	11	28	56
	Total	**1709**	**930**	**393**	**347**	**3379**
Grand Total		**2360**	**1733**	**1382**	**1304**	**6779**

Table A10.16: Herring gull behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	2	0	0	0	2
	FE	36	100	77	43	256
	LO	0	1	0	0	1
	PR	79	59	50	84	272
	RL	0	0	6	2	8
	RO	27	0	8	10	45
	SU	0	0	0	1	1
	Total	**144**	**160**	**141**	**140**	**585**
2	-	0	2	0	1	3
	FE	34	54	49	62	199
	LO	3	1	0	9	13
	PL	1	0	0	0	1
	PR	100	26	0	0	126
	RL	50	0	0	0	50
	Total	**188**	**83**	**49**	**72**	**392**
Grand Total		**332**	**243**	**190**	**212**	**977**

Table A10.17: Cormorant behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	0	0	7	11	18
	FE	0	0	2	0	2
	LO	17	24	90	203	334
	PR	4	0	0	3	7
	RL	2	3	6	4	15
	RO	32	16	45	101	194
	SC	0	0	0	10	10
	SF	0	0	12	21	33
	SU	0	0	2	0	2
	Total	**55**	**43**	**164**	**353**	**615**
2	-	8	0	7	8	23
	FE	3	0	0	9	12
	LO	57	106	143	239	545
	PR	25	15	1	0	41
	RL	8	0	0	0	8
	RO	3	0	7	5	15
	SC	2	9	0	12	23
	SF	0	29	47	66	142
	SU	2	0	4	8	14
	Total	**108**	**159**	**209**	**347**	**823**
Grand Total		**163**	**202**	**373**	**700**	**1438**

Table A10.18: Great black-backed gull behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	0	0	0	1	1
	LO	0	0	8	40	48
	PR	0	0	0	4	4
	SU	0	0	0	1	1
	Total	**0**	**0**	**8**	**46**	**54**
2	-	1	0	4	1	6
	LO	73	88	100	72	333
	PR	20	15	3	0	38
	RO	1	49	43	6	99
	SU	0	0	0	3	3
	Total	**95**	**152**	**150**	**82**	**479**
Grand Total		**95**	**152**	**158**	**128**	**533**

Table A10.19: Fulmar behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	1	5	0	11	17
	CN	0	1	0	0	1
	FE	148	323	104	48	623
	LO	0	6	3	0	9
	PR	6	15	3	9	33
	RL	0	0	0	5	5
	RO	2	0	0	0	2
	Total	**157**	**350**	**110**	**73**	**690**
2	-	6	1	1	2	10
	FE	334	265	140	69	808
	LO	20	0	0	0	20
	PR	297	49	0	0	346
	RL	108	0	0	0	108
	RO	0	8	0	0	8
	SF	0	1	0	0	1
	Total	**765**	**324**	**141**	**71**	**1301**
Grand Total		**922**	**674**	**251**	**144**	**1991**

Table A10.20: Shag behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	LO	0	0	7	43	50
	PL	0	0	20	66	86
	RO	0	0	0	1	1
	Total	**0**	**0**	**27**	**110**	**137**
2	-	0	0	1	3	4
	DP	0	0	2	0	2
	FE	0	9	0	2	11
	LO	80	144	124	170	518
	PL	12	60	133	204	409
	PR	134	76	9	3	222
	RO	0	0	1	6	7
	SF	0	3	0	0	3
	SU	7	0	10	2	19
	Total	**233**	**292**	**280**	**390**	**1195**
Grand Total		**233**	**292**	**307**	**500**	**1332**

Table A10.21: Gannet behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	FE	0	0	3	5	8
	LO	0	0	2	5	7
	Total	**0**	**0**	**5**	**10**	**15**
2	-	6	0	2	0	8
	FE	0	7	8	4	19
	LO	547	138	8	0	693
	PR	5	2	0	0	7
	Total	**558**	**147**	**18**	**4**	**727**
Grand Total		**558**	**147**	**23**	**14**	**742**

Table A10.22: Puffin behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	0	2	1	0	3
	FE	6	42	57	59	164
	RL	0	0	0	22	22
	Total	**6**	**44**	**58**	**81**	**189**
2	-	3	9	0	0	12
	FE	74	96	34	7	211
	Total	**77**	**105**	**34**	**7**	**223**
Grand Total		**83**	**149**	**92**	**88**	**412**

Table A10.23: Black guillemot behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	3	1	11	1	16
	FE	107	451	166	26	750
	LO	8	459	99	122	688
	PR	4	159	104	6	273
	RO	0	0	2	4	6
	SU	0	0	0	1	1
	Total	**122**	**1070**	**382**	**160**	**1734**
2	FE	3	13	30	107	153
	PR	0	4	0	10	14
	Total	**3**	**17**	**30**	**117**	**167**
Grand Total		**125**	**1087**	**412**	**277**	**1901**

Table A10.24: Great crested grebe behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	11	0	0	0	11
	FE	121	78	13	97	309
	LO	11	0	0	12	23
	RL	74	16	46	121	257
	RO	554	100	182	689	1525
	Total	**771**	**194**	**241**	**919**	**2125**
2	-	2	0	0	0	2
	FE	20	0	0	0	20
	LO	0	2	0	0	2
	RL	8	0	0	0	8
	RO	31	0	0	0	31
	Total	**61**	**2**	**0**	**0**	**63**
Grand Total		**832**	**196**	**241**	**919**	**2188**

Table A10.25: Oystercatcher behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	FE	163	23	53	152	391
	RO	0	0	0	18	18
	SU	0	22	0	22	44
	Total	**163**	**45**	**53**	**192**	**453**
2	**Total**	**0**	**0**	**0**	**0**	**0**
Grand Total		**163**	**45**	**53**	**192**	**453**

Table A10.26: Sanderling behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	FE	8	0	0	86	94
	RO	22	0	12	98	132
	Total	**30**	**0**	**12**	**184**	**226**
2	**Total**	**0**	**0**	**0**	**0**	**0**
Grand Total		**30**	**0**	**12**	**184**	**226**

Table A10.27: Dunlin behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	0	4	17	0	21
	FE	24	349	70	12	455
	LO	3	7	6	29	45
	PR	0	17	22	0	39
	Total	**27**	**377**	**115**	**41**	**560**
2	ED	2	0	0	0	2
	FE	0	0	0	11	11
	Total	**2**	**0**	**0**	**11**	**13**
Grand Total		**29**	**377**	**115**	**52**	**573**

Table A10.28: Red-breasted merganser behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	0	0	0	12	12
	FE	6	22	0	12	40
	PR	0	0	0	11	11
	RO	53	0	33	36	122
	Total	**59**	**22**	**33**	**71**	**185**
2	RL	4	0	0	0	4
	RO	21	0	0	0	21
	Total	**25**	**0**	**0**	**0**	**25**
Grand Total		**84**	**22**	**33**	**71**	**210**

Table A10.29: Turnstone behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	FE	0	0	0	8	8
	RL	0	0	0	27	27
	RO	0	0	4	52	56
	Total	**0**	**0**	**4**	**87**	**91**
2	**Total**	**0**	**0**	**0**	**0**	**0**
Grand Total		**0**	**0**	**4**	**87**	**91**

Table A10.30: Redshank behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	7	0	0	0	7
	FE	11	7	8	19	45
	RO	60	8	16	0	84
	Total	**78**	**15**	**24**	**19**	**136**
2	**Total**	**0**	**0**	**0**	**0**	**0**
Grand Total		**78**	**15**	**24**	**19**	**136**

Table A10.31: Ringed plover behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	7	6	2	0	15
	DP	2	0	0	0	2
	LO	192	165	82	75	514
	PR	5	0	0	0	5
	RL	22	34	80	93	229
	RO	338	317	438	428	1521
	SC	0	4	8	0	12
	SF	0	0	2	20	22
	SU	7	0	4	9	20
	Total	**573**	**526**	**616**	**625**	**2340**
2	-	0	1	0	0	1
	LO	4	7	63	40	114
	PR	0	0	3	0	3
	RO	0	0	15	27	42
	SC	0	6	0	0	6
	SF	0	0	7	3	10
	Total	**4**	**14**	**88**	**70**	**176**
Grand Total		**577**	**540**	**704**	**695**	**2516**

Table A10.32: Black-headed gull behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	4	0	0	0	4
	FE	0	0	1	0	1
	LO	16	9	9	14	48
	RL	2	0	22	4	28
	RO	30	47	38	38	153
	SC	0	0	0	2	2
	SF	0	0	0	3	3
	SU	1	0	0	0	1
	Total	**53**	**56**	**70**	**61**	**240**
2	LO	5	16	11	10	42
	RO	2	0	2	0	4
	SC	2	4	0	0	6
	SF	0	2	7	10	19
	Total	**9**	**22**	**20**	**20**	**71**
Grand Total		**62**	**78**	**90**	**81**	**311**

Table A10.33: Common gull behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	0	0	2	0	2
	LO	7	24	14	4	49
	RL	0	4	5	6	15
	RO	15	22	36	31	104
	SF	0	0	1	0	1
	Total	**22**	**50**	**58**	**41**	**171**
2	LO	2	6	10	8	26
	RL	2	0	0	0	2
	RO	5	3	0	0	8
	SF	0	0	2	7	9
	Total	**9**	**9**	**12**	**15**	**45**
Grand Total		**31**	**59**	**70**	**56**	**216**

Table A10.34: Lesser black-backed gull behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	0	2	1	2	5
	FE	17	102	184	38	341
	LO	0	39	93	87	219
	PR	0	5	15	14	34
	Total	**17**	**148**	**293**	**141**	**599**
2	-	0	0	1	2	3
	FE	1	6	34	87	128
	LO	0	1	0	5	6
	PR	0	2	0	1	3
	Total	**1**	**9**	**35**	**95**	**140**
Grand Total		**18**	**157**	**328**	**236**	**739**

Table A10.35: Red-throated diver behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	0	0	0	1	1
	FE	0	7	16	32	55
	LO	0	0	0	1	1
	PR	0	0	1	0	1
	Total	**0**	**7**	**17**	**34**	**58**
2	FE	0	3	10	14	27
	LO	0	0	1	0	1
	Total	**0**	**3**	**11**	**14**	**28**
Grand Total		**0**	**10**	**28**	**48**	**86**

Table A10.36: Great northern diver behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	-	16	0	0	89	105
	FE	8	429	75	495	1294
	LO	99	1175	256	1792	3531
	PR	0	44	0	4	48
	RO	15	0	0	29	44
	Total	**138**	**1648**	**331**	**2409**	**5022**
2	FE	0	91	45	350	441
	LO	0	47	0	546	598
	Total	**0**	**138**	**45**	**896**	**1039**
Grand Total		**138**	**1786**	**376**	**3305**	**6061**

Table A10.37: Common scoter behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	DP	0	5	5	0	10
	PL	9	51	13	16	89
	Total	**9**	**56**	**18**	**16**	**99**
2	DP	0	0	4	6	10
	PL	0	4	12	0	16
	Total	**0**	**4**	**16**	**6**	**26**
Grand Total		**9**	**60**	**34**	**22**	**125**

Table A10.38: Common tern behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

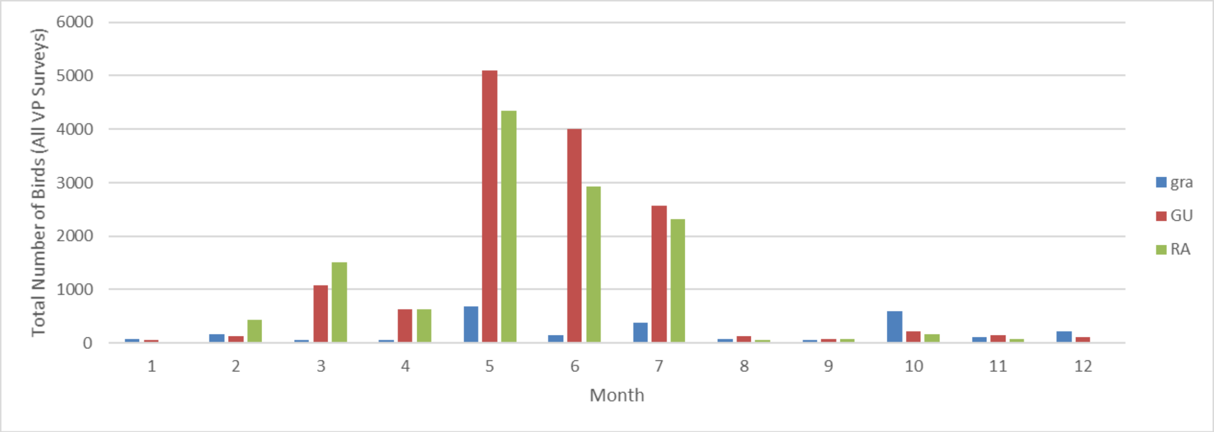
VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	DP	0	15	13	0	28
	LO	0	1	0	0	1
	PL	23	49	27	14	113
	RL	0	3	0	52	55
	RO	19	20	6	32	77
	Total	**42**	**88**	**46**	**98**	**274**
2	-	0	0	0	6	6
	DP	0	0	18	11	29
	PL	0	3	19	41	63
	Total	**0**	**3**	**37**	**58**	**98**
Grand Total		**42**	**91**	**83**	**156**	**372**

Table A10.39: Sandwich tern behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

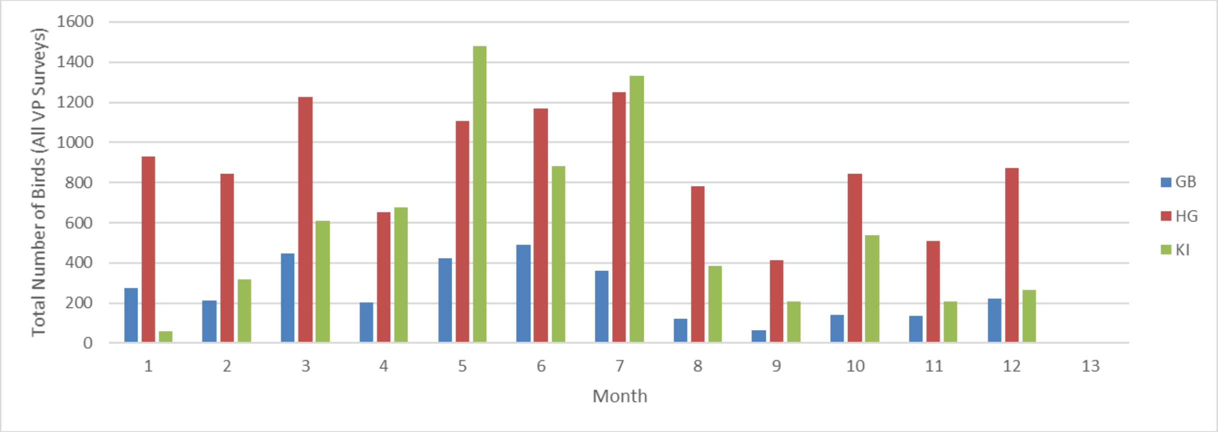
VP Number	Behaviour Code	VP Band 1	VP Band 2	VP Band 3	VP Band 4	Total
1	LO	0	0	0	27	27
	SU	0	0	0	27	27
	Total	**0**	**0**	**0**	**54**	**54**
2	FE	0	0	0	7	7
	LO	0	0	25	114	139
	RO	0	0	11	10	21
	SU	0	0	27	70	97
	Total	**0**	**0**	**63**	**201**	**264**
Grand Total		**9**	**60**	**63**	**255**	**318**

Table A10.40: Manx shearwater behaviour and distance band distribution recorded during VP surveys (all months, all survey years)

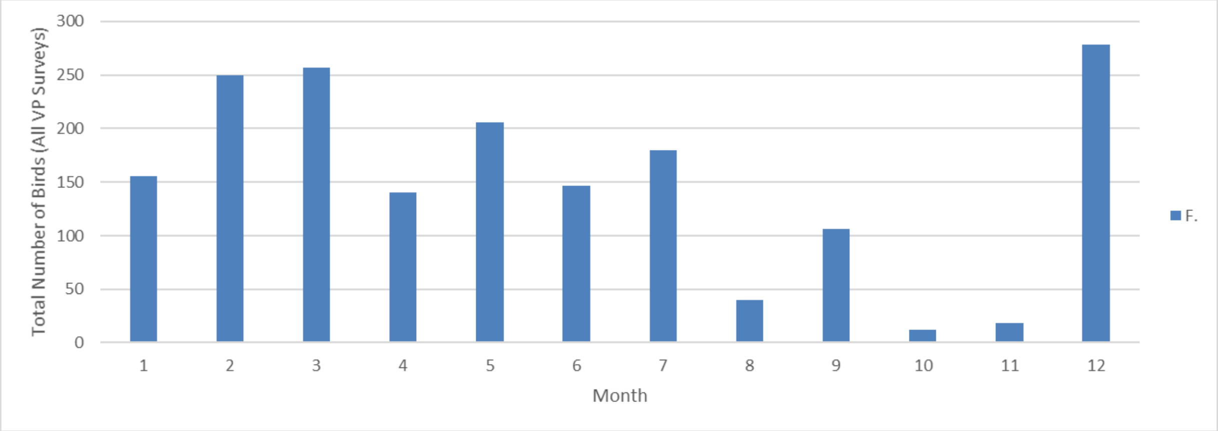
APPENDIX 5 – MARINE VP GRAPHS



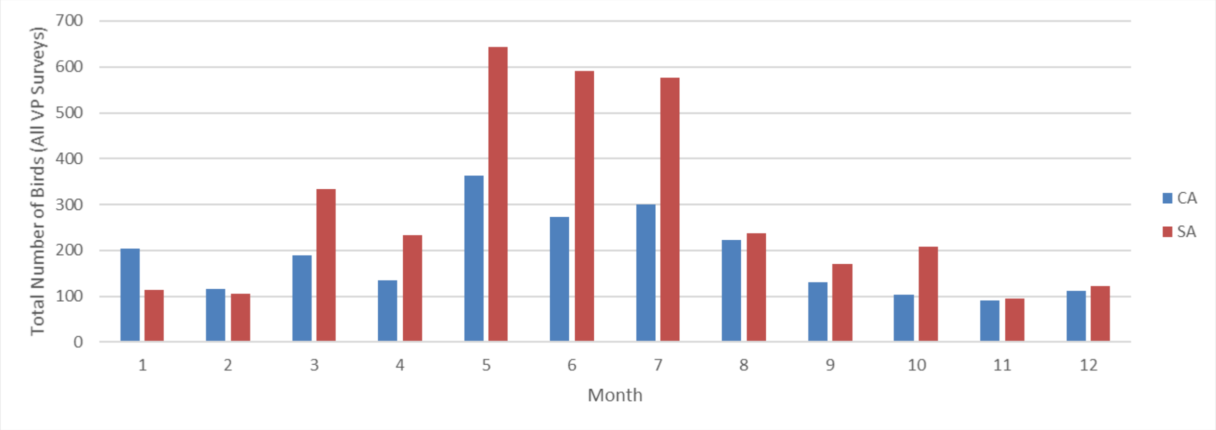
Graph A10.1: Total number of guillemots or razorbills (gra), guillemots (GU) and razorbills (RA) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



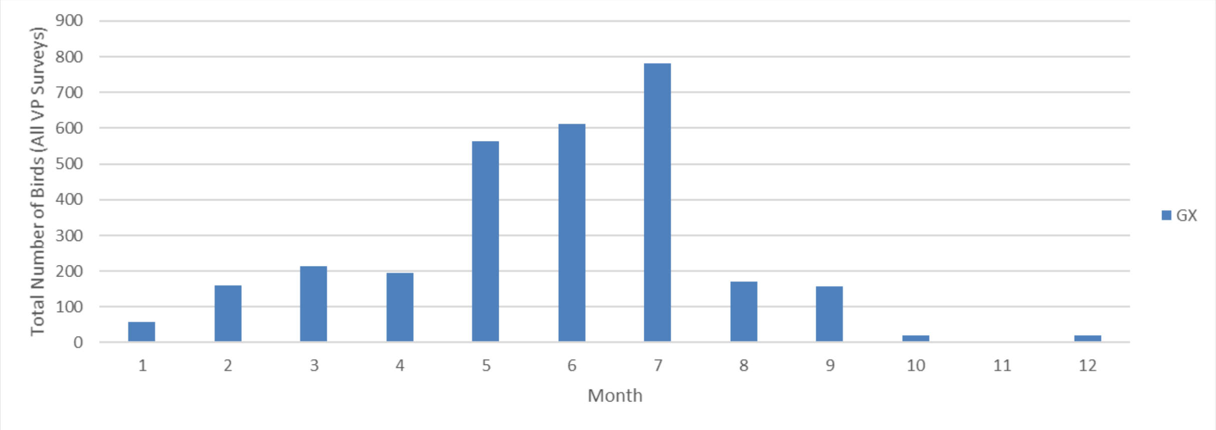
Graph A10.2: Total number of great black-backed gulls (GB), herring gulls (HG) and kittiwakes (KI) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



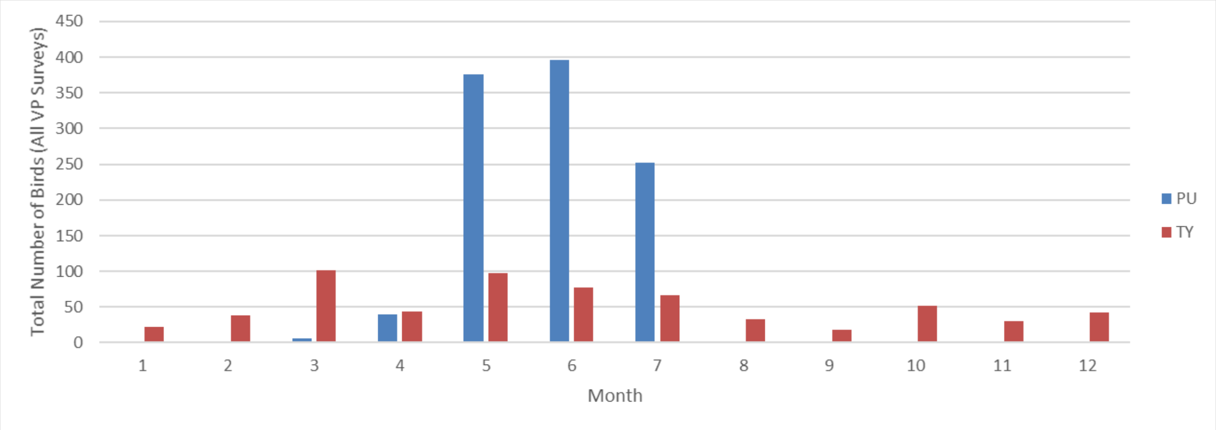
Graph A10.3: Total number of fulmars (F.) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



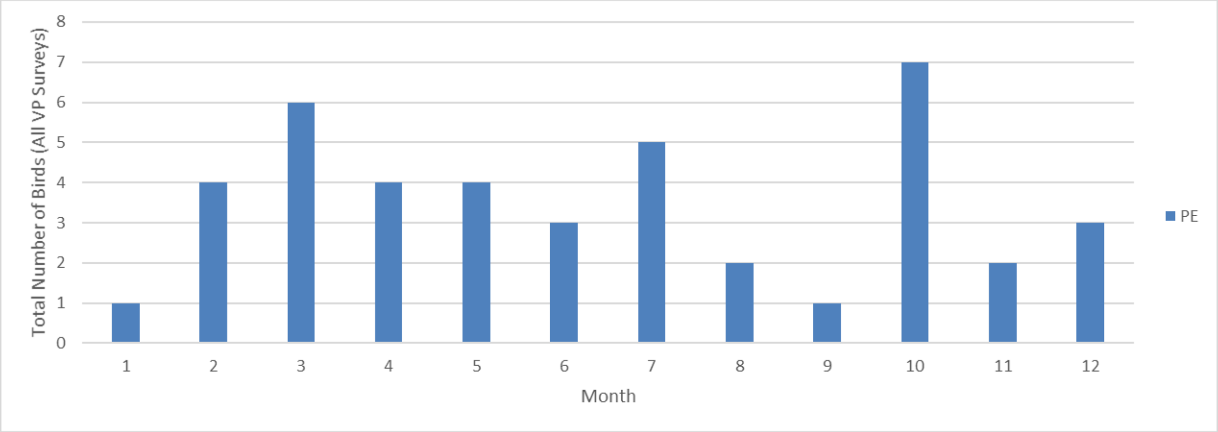
Graph A10.4: Total number cormorants (CA) and shags (SA) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



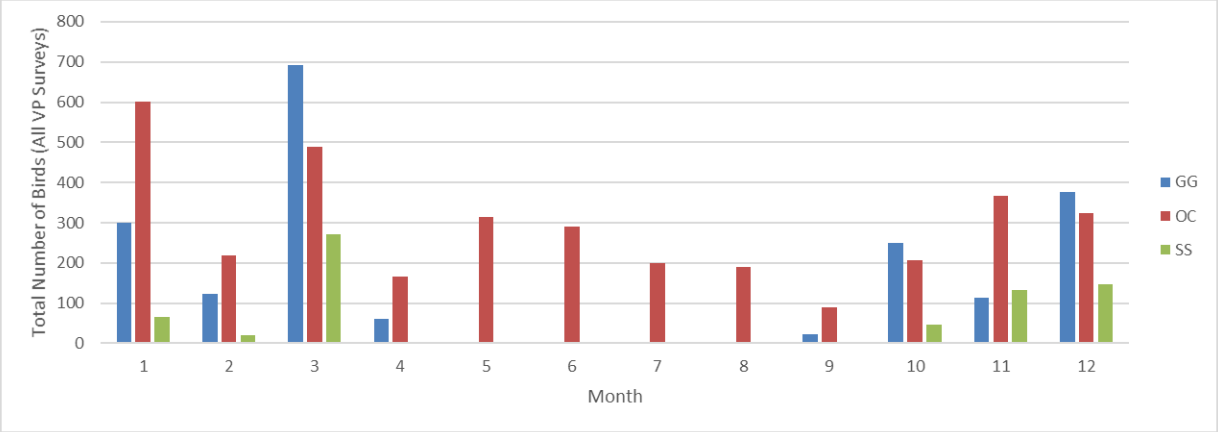
Graph A10.5: Total number of gannets (GX) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



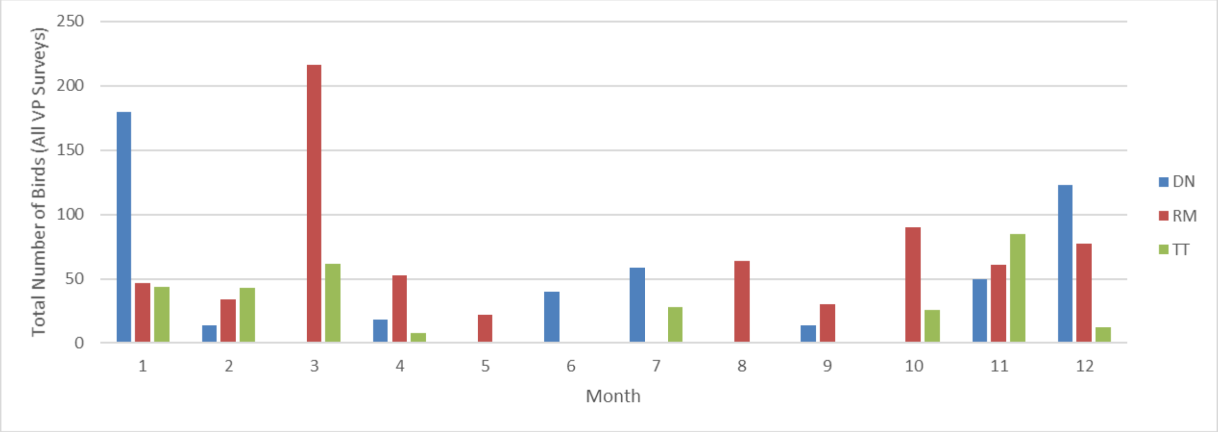
Graph A10.6: Total number of puffins (PU) and black guillemots (TY) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



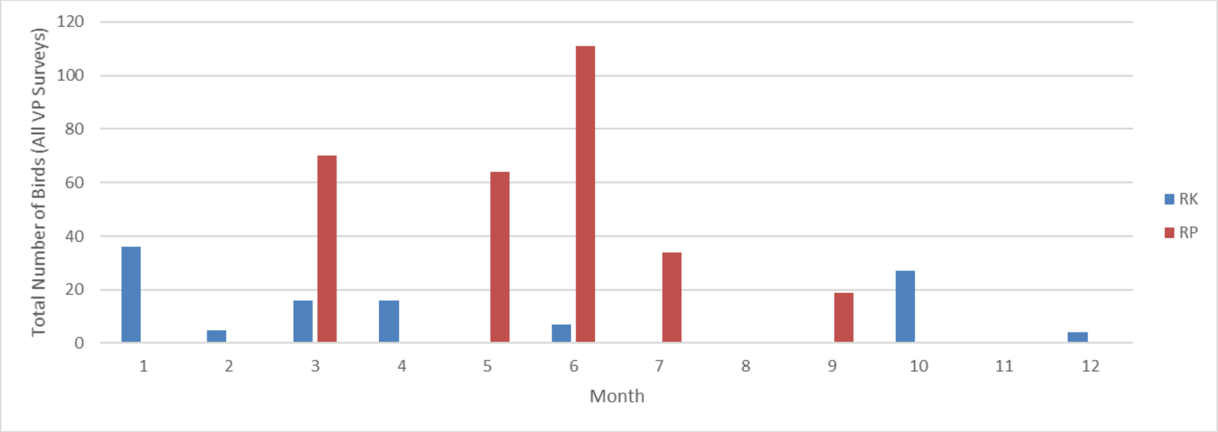
Graph A10.7: Total number of peregrines (PE) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



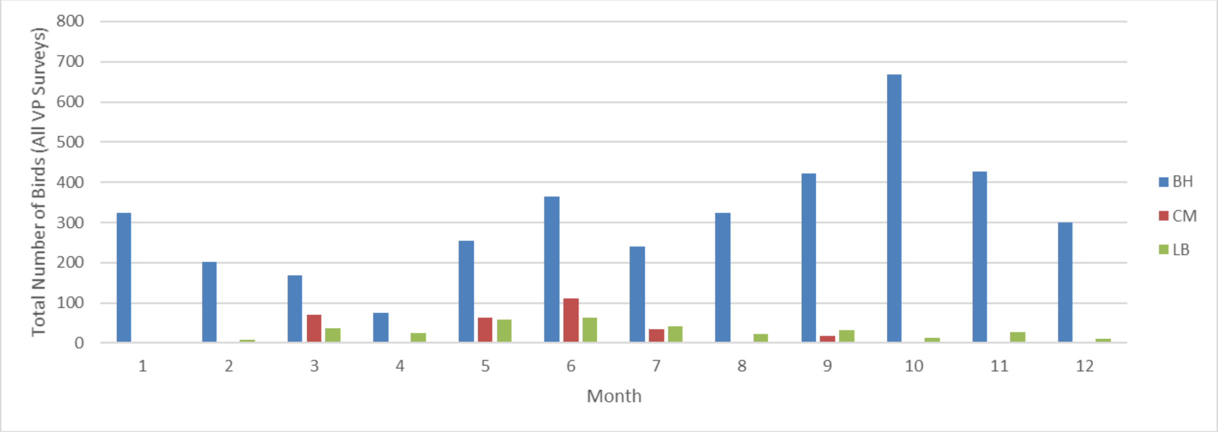
Graph A10.8: Total number of great crested grebes (GG), oystercatchers (OC) and sanderlings (SS) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



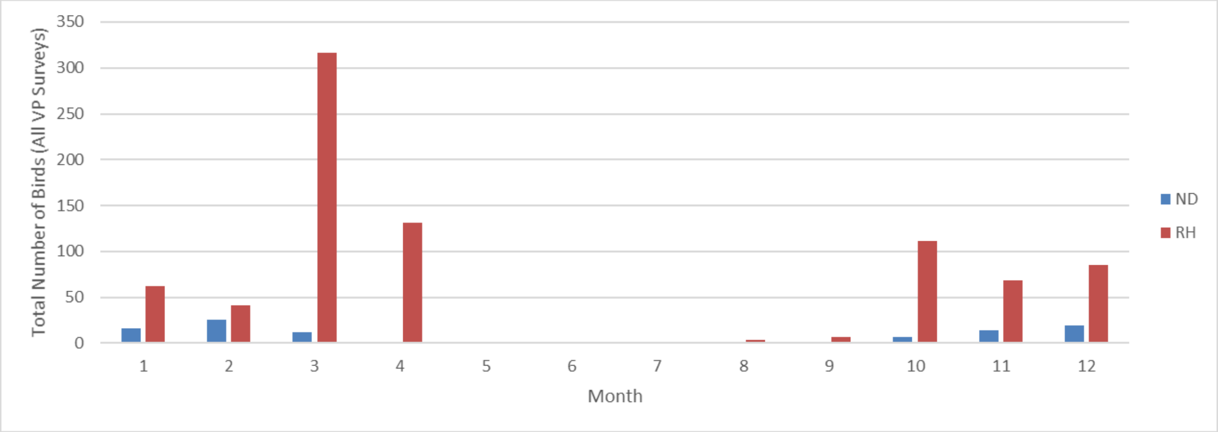
Graph A10.9: Total number of dunlins (DN), red-breasted mergansers (RM) and turnstones (TT) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



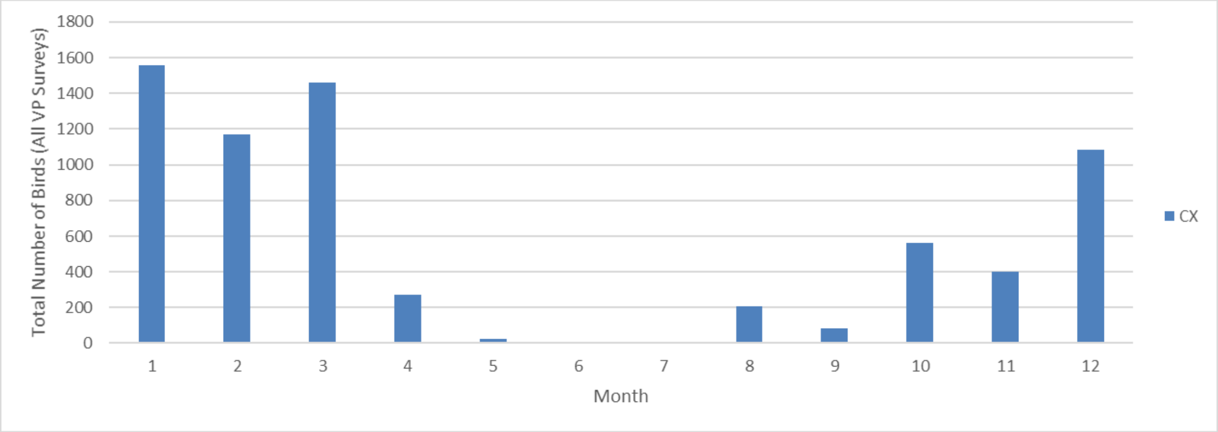
Graph A10.10: Total number of redshanks (RK) and ringed plovers (RP) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



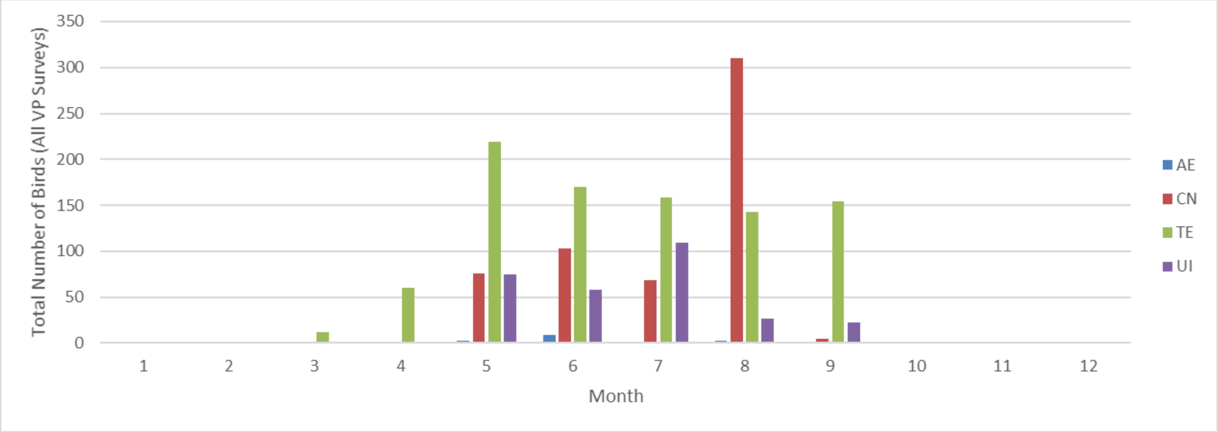
Graph A10.11: Total number of black-headed gulls (BH), common gulls (CM) and lesser black-backed gulls (LB) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



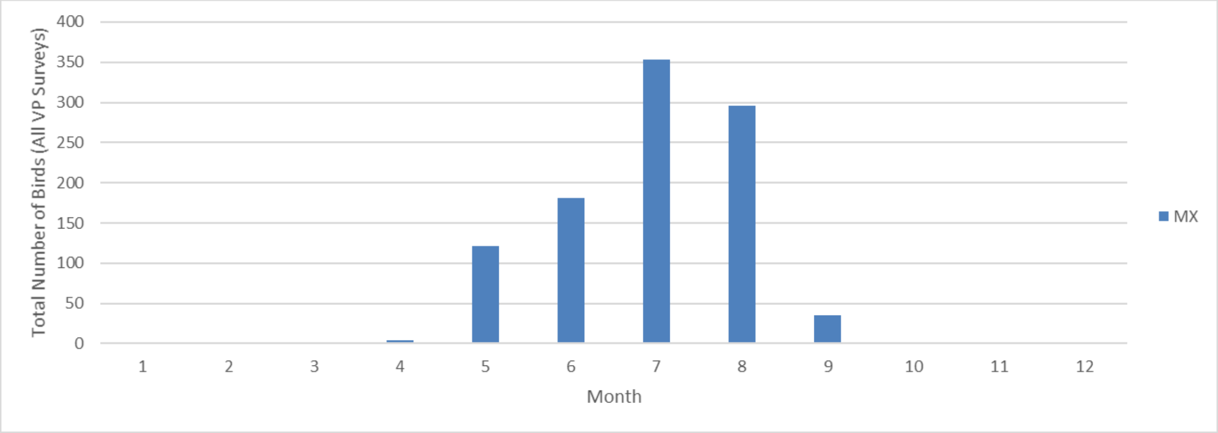
Graph A10.12: Total number of great northern divers (ND) and red-throated divers (RH) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



Graph A10.13: Total number of common scoters (CX) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



Graph A10.14: Total number of Arctic terns (AE), common terns (CN), Sandwich terns (TE) and 'commic' (common or Arctic) terns (UI) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme



Graph A10.15: Total number of Manx shearwaters (MX) recorded by month during VP surveys (Velvet Strand and Ireland's Eye) during entire survey programme

Appendix B Reef Assessment Reports

IRISH WATER

GREATER DUBLIN DRAINAGE

PHASE II IRELAND'S EYE REEF SURVEY

Date of Survey:

30/06/2015 - 02/07/2015

Prepared By:

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Disclaimer:

This report has been produced in line with the requirements and objectives of the scope of work and contractual terms between Benthic Solutions Limited and the Client. The results are based upon expert interpretation. All interpretation and opinions contained herein are provided based upon the data collated as part of the survey, and other data provided by the Client and available within the public domain.

Reference	Revision	Date	Issue Type	Author	QC	Approved
1502	00	08/11/2015	DRAFT	TM/KT/HL	HL	IW
1502	01	09/11/2015	FINAL	TM/KT/HL	HL	IW

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Abbreviations

Abbreviation	Meaning
ASML	Aquatic Survey and Monitoring Limited
BSL	Benthic Solutions Limited
CR.HCR.XFa.ByErSp.Sag	Mixed turf of bryozoans and erect sponges with *Sagartia elegans* on tide-swept ciraclittoral rock
CR.HCR.XFa.FluCoAs	*Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock
GDD	Greater Dublin Drainage
CR.HCR.XFa.FluCoAs.Paur	*Polyclinum aurantium* and *Flustra foliacea* on sand-scoured tide-swept moderately wave-exposed circalittoral rock
IR.HIR.KFaR.FoR	Foliose red seaweeds on exposed lower infralittoral rock
IR.HIR.KFaR.FoR.Dic	Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock
IR.MIR.KR.Ldig	*Laminaria digitata* on moderately exposed sublittoral fringe rock
IR.MIR.KR.Ldig.Ldig	*Laminaria digitata* on moderately exposed sublittoral fringe bedrock
LR.FLR.Lic.Pra	*Prasiola stipitata* on nitrate-enriched supralittoral or littoral fringe rock
LR.HLR.FR.Coff	*Corallina officinalis* on exposed to moderately exposed lower eulittoral rock
LR.HLR.FR.Mas	*Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock
LR.HLR.MusB	Mussel and/or barnacle communities
LR.HLR.MusB.Cht	*Chthamalus* spp. on exposed eulittoral rock
LR.HLR.MusB.Sem	*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock
LR.LLR.F.Asc.FS	*Ascophyllum nodosum* on full salinity mid eulittoral rock
LR.MLR.BF.Fser.R	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock
LR.MLR.BF.FspiB	*Fucus spiralis* on exposed to moderately exposed upper eulittoral rock
MDS	Multi-Dimensional Scaling
MERC	Marine and Environmental Resource Conservation Consultants
MNCR	Marine Nature Conservation Review
MDS	Multi-Dimensional Scaling
NPWS	National Parks & Wildlife Service
ODM	Ordnance Datum Malin
PRIMER	Plymouth Routines In Multivariate Ecological Research
RIB	Rigid-Inflatable Boat
SAC	Special Areas of Conservation
SACFOR	Superabundant, Abundant, Common, Frequent, Occasional and Rare
SD	Standard Deviation

1. Executive Summary

The Irelands Eye is a small uninhabited islands located to the north of Howth head, located within the Rockabill to Dalkey Island Special Area of Conservations (site code 3000), and is designated for Annex 1 qualifying interest Reefs. As the site is within close proximity to the proposed GDD outfall, these interests may be subject to plume effects from suspended sediment during parts of the construction operation whilst dredging or be impacted by the outfall plume itself. Field operations to acquire a detailed assessment of these qualifying habitats was carried out and completed successfully at three littoral and four sublittoral stations between the 30th June and 2nd of July 2015. These were based on a generic assessment of biotopes using the standard (Marine Nature Conservation Review) MNCR-style format. Identification and abundance of conspicuous fauna and flora were scaled onsite using the SACFOR scheme (e.g. superabundant, abundant, common, frequent, occasional and rare).

In the littoral zone, the biotopes '*Corallina officinalis* on exposed to moderately exposed lower eulittoral rock/*Laminaria digitata* on moderately exposed sublittoral fringe rock (*LR.HLR.FR.Coff/IR.MIR.KR.Ldig)* usually emerged from the sublittoral, followed by a zone covered by seaweeds to a faunally dominated shore consisting of limpets, barnacles and littorinids.

The sublittoral stations were characterised by *Laminaria digitata* forests in the shallower part (*IR.MIR.KR.Ldig.Ldig*) and were usually replaced by the biotope 'Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock' (*IR.HIR.KFaR.FoR.Dic)*. The deeper extend was dominated by a 'Mixed turf of bryozoans and erect sponges with *Sagartia elegans* on tide-swept circalittoral rock' (*CR.HCR.XFa.ByErSp.Sag*) or in the case of Sublittoral Station 2 '*Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock' (*CR.HCR.XFa.FluCoAs*). The deeper biotope at Sublittoral Station 4 was categorised as a possible '*Polyclinum aurantium* and *Flustra foliacea* on sand scoured tide-swept moderately wave-exposed circalittoral rock' (*HCR.XFa.FluCoAs.Paur*), probably due to the increased sedimentation noted at this station.

Univariate analyses showed clear differences between the littoral and sublittoral stations in terms of species richness with twice as many species recorded from the sublittoral area (88.3±19.2SD as opposed to 44.7±11.6SD). Both littoral and sublittoral environments indicated moderately high species diversity. Multivariate analyses revealed statistical separation of biotopes with the vertical zonation of the fauna (by water depth or height on the foreshore) constituting the dominant community patterns observed.

No species of particular nature conservation interest were noted during the any of the surveys and no rare or particularly fragile biotopes were recorded. However natural siltation levels were high in the sublittoral environment, a fact that has not appeared to have a significant impact to the biological diversity in this area. Whilst, siltation levels are high in the sublittoral environment, a significant increase in suspended sediment, particularly during the summer months during peak algal growth, might cause some damage to the algal biotopes present through reduced light penetration and availability. However, the moderately strong tidal currents experienced in this area are sufficient to prevent the deposition of significant silt material which might degrade the sublittoral benthic biotopes through smothering and burial of the infralittoral and circalittoral communities. No species of particular conservational interest were noted during the surveys and no rare or fragile biotopes recorded.

2. Scope of Work

The proposed outfall route of the Greater Dublin Drainage (GDD) scheme, terminates at the diffuser location 1km north-east of Ireland's Eye, and falls within the Rockabill to Dalkey Island SAC. The conservation objectives of the Rockabill to Dalkey Island SAC include Annex I qualifying Reefs (Figure 2.1). To maintain the favourable conservation conditions of these Reefs within the SAC, the following criteria are proposed by NPWS (as outlined in Table 2.1).

Table 2.1 Rockabill to Dalkey Island SAC Conservation Objectives

Attribute	Measure	Target	Notes
Habitat area	Hectares	The permanent area is stable or increasing, subject to natural processes. See Figure 2.1	Habitat area estimated as 182ha using 2010 and 2011 intertidal and subtidal reef survey data (MERC, 2010, 2012a, b), InfoMar bathymetry and the Arklow to Skerries Islands Admiralty Chart (1468_0)
Habitat distribution	Occurrence	Distribution is stable or increasing, subject to natural processes. See Figure 2.1	Distribution derived from 2010 and 2011 intertidal and subtidal reef survey data (MERC, 2010, 2012a, b), InfoMar bathymetry and the Arklow to Skerries Islands Admiralty Chart (1468_0).
Community structure	Biological composition	Conserve the following community types in a natural condition: Intertidal reef community complex; and Subtidal reef community complex. See Figure 2.1	Reef community mapping based on 2010 and 2011 intertidal and subtidal reef survey data (MERC, 2010, 2012a, b).

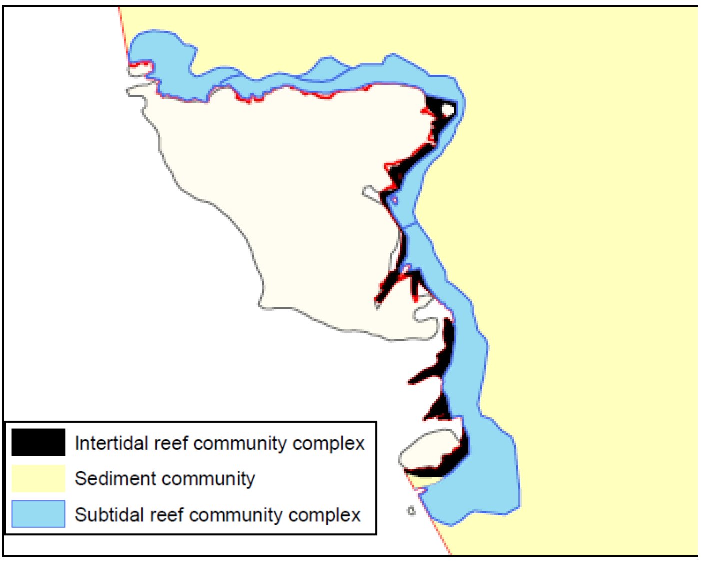


Figure 2.1 Ireland's Eye Marine Community Types Designated by Rockabill to Dalkey Island SAC

3. Historical Data

Within the Rockabill to Dalkey Island SAC, two community types were recorded within the Annex I habitat, namely the Intertidal reef community complex and the Subtidal reef community complex (Reefs 1170). Intertidal and subtidal surveys were undertaken in 2010 and 2011 (MERC, 2010, MERC 2012a and MERC 2012b). These data were used to determine the physical and biological nature of the Annex I habitat. Estimated areas of each community type within the Annex I habitat, are based on interpolation, and are shown in Figure 2.1.

The development of a community complex target arises when an area possesses similar abiotic features but records a number of biological communities that are not regarded as being sufficiently stable and/or distinct temporally or spatially to become the focus of conservation efforts. In this case, examination of the available data from Rockabill to Dalkey Island SAC identified a number of biological communities whose species composition overlapped significantly. Such biological communities are grouped together into what experts consider are sufficiently stable units (i.e. a complex) for conservation targets.

INTERTIDAL REEF COMMUNITY COMPLEX

This reef community complex is recorded on the eastern and southern shores of Ireland's Eye immediately south of the proposed outfall route and diffuser location. The exposure regime of the complex ranges from exposed to 'moderately exposed' reef for Ireland's Eye. The substrate here is that of flat and sloping bedrock, cobbles and boulders. Vertical cliff faces are found on the north and northeast shores of Ireland's Eye.

SUBTIDAL REEF COMMUNITY COMPLEX

This reef community complex is recorded off the northern, eastern and southern shores of Ireland's Eye immediately south of the proposed outfall route and diffuser location. The substrate ranges from that of flat and sloping bedrock, to bedrock with boulders and also a mosaic of cobbles and boulders. Vertical rock walls occur on the north and east of Ireland's Eye, whilst the northern reaches of the island both show sediment scouring and a thin veneer of silt on the reefs.

In general, previous surveys (MERC 2010, MERC 2012a and MERC 2012b) noted that where the reef was subjected to the effects of sediment, either through scouring or settlement of silt, low numbers of species and individuals were found.

4. Site Selection

Following a review and combination of existing and surveyed bathymetric datasets, the locations for sublittoral and littoral survey locations was based on a combination of seabed topography, and site exposure. A total of four sublittoral locations and three littoral locations were established for survey operations (outlined in Table 4.1, and presented in Figure 4.1).

Table 4.1 Proposed Littoral and Sublittoral Locations

Site	Transect	Easting	Northing	Description	Depth (ODM)
S1	Start	728470.3	741625.0	Sublittoral: Northwest stack and discrete sublittoral reef feature	-12.1
	End	728369.1	741589.2		0.34
S2	Start	728745.5	741626.2	Sublittoral: Standard slope with boulder field at base	-13.99
	End	728752.9	741526.2		1.13
S3	Start	729161.4	740937.5	Sublittoral: Exposed southeast island pinnacles	-11.81
	End	729060.2	740969.6		0.26
S4	Start	729187.4	740556.2	Sublittoral: Exposed southeast islet pinnacles	-10.50
	End	729102.2	740624.0		0.01
L1		729033.1	741472.4	Littoral: Exposed northeast channel between stack	0.04
L2		728910.9	741053.5	Littoral: Sheltered southeast inlet	0.80
L3		729077.5	740648.7	Littoral: Exposed southeast islet rocky coast	0.98

Geodesy based on Irish National Grid and vertical datum of Ordnance datum Malin Head (ODM)

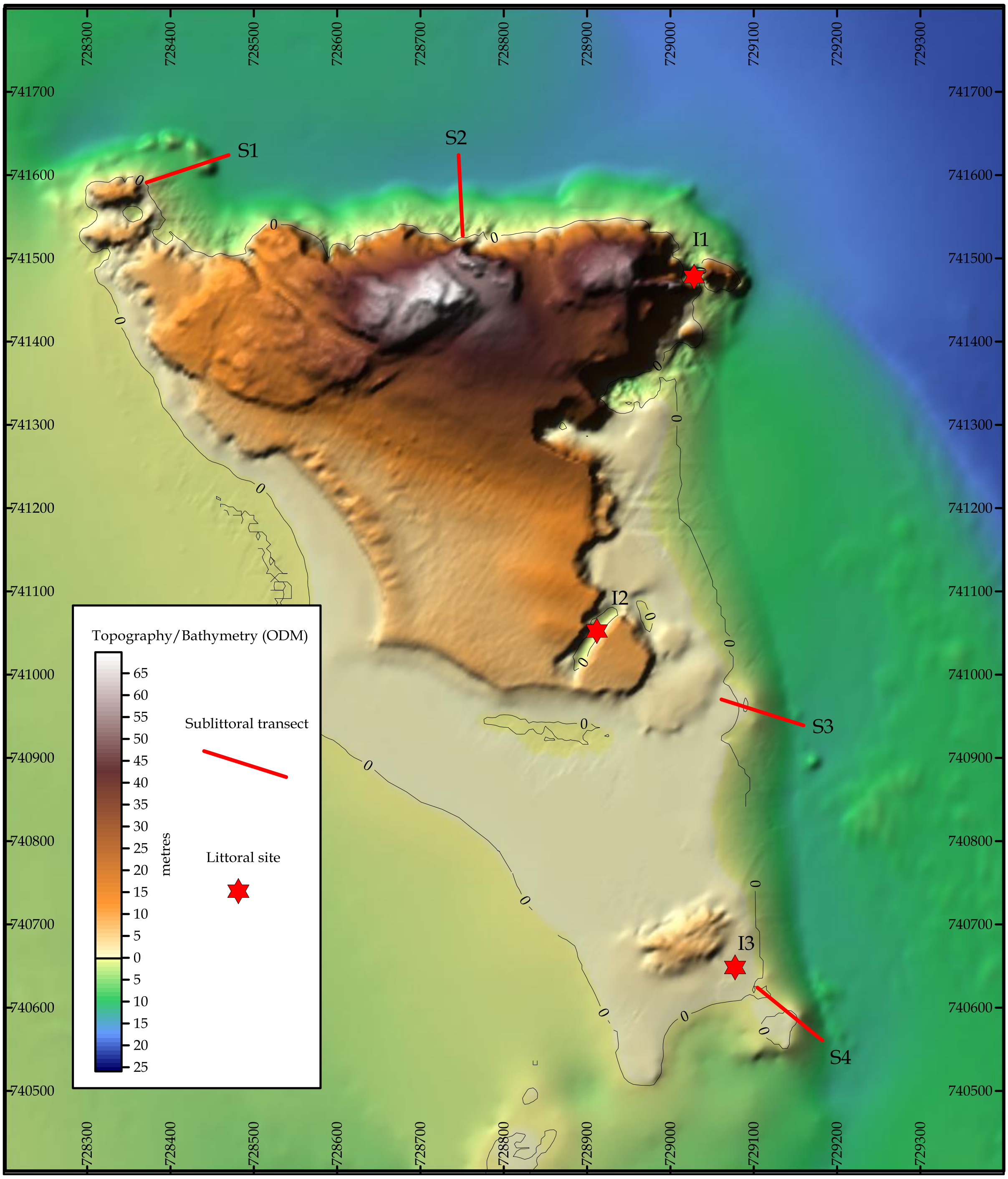


Figure 4.1 Composite Topography/Bathymetry of Irelands Eye with Proposed Survey Locations for Sublittoral Transects (lines) and Littoral Coastlines (Stars)

5. Field Operations Summary observations

Field survey operations were completed successfully at all proposed locations between the 30th June and 2nd of July 2015. A four man dive team, made up from representatives from both MERC and ASML, was mobilised to site on the 29th June, with operations carried out from an 8m RIB. Weather remained good throughout the survey period, with only localised periods of marginal winds occurring on a couple of days. Consequently operations were spread between the dive sites (four in total) and inter-tidal (three in total), to make the best use of the prevailing conditions.

A summary of the field operations is outlined in Table 5.1.

Table 5.1 Chronological Sequence of Field Operations

Day	Date	Operations	Comment
1	29/06/15	Mobilisation to Howth	ASML mobilised. MERC launched the 8m RIB service vessel locally (Howth harbour).
2	30/06/15	Ops: Diving and intertidal	2 diving sites and 1 intertidal completed.
3	01/07/15	Ops: Diving and intertidal	IW of BSL travels to site for oversight. 1 diving site and 1 intertidal site completed.
4	02/07/15	Ops: Diving and intertidal	1 dive site completed in the morning and 1 intertidal site completed in the afternoon. Vessel recovered and survey personnel demobilised. IW onsite for oversight.
5	03/07/15	Demobilisation from Howth	ASML team demobilised back to the UK.

Field operations were based on a generic assessment of biotopes using the standard MNCR-style (Marine Nature Conservation Review) format. Identification and abundance was scaled onsite using the SACFOR (e.g. superabundant, abundant, common, frequent, occasional and rare) scale on all the conspicuous flora and fauna within each biotope encountered. Taxa that could not be readily identified were removed and later identified under a microscope back at the field laboratory (i.e hotel).

During the intertidal survey, sites were selected from aerial photography to present different exposures and the vertical profiles completed along all of the lower, middle and upper shorelines at these locations. Each biological zone was photographed and surveyed. The floral and faunal taxa were identified and abundance scale values allocated also using the SACFOR protocol on all the conspicuous species in each biotope encountered.

6. Results and Discussion

This survey has collected semi-quantitative data from two moderately exposed littoral stations (L1 and L3) and a sheltered station (L2). L1 is slightly modified by shading, wave surge and nitrogenous enrichment and the L3 upper shore biotope was similarly enriched by roosting seabirds. In the sublittoral, four stations (S1 to S4) were investigated of which all were found to be heavily silted, but were moderately diverse. The photographs and data presented herein may act as a comparison, against which future gross changes could be qualitatively assessed.

In order to determine any significant differences between the stations surveyed, the SACFOR scale was additionally categorised from 1 (rare) to 6 (superabundant). Basic statistical analyses as well as multi-dimensional statistical techniques were applied to the dataset to present the data as a cluster diagram and MDS plot. While useful to present general trends within the datasets, due to the semi quantitative nature of the SACFOR classifications, not too much reliance should be placed on the statistical analyses.

6.1. Biotope Classification

6.1.1. Littoral Station 1

Littoral Station 1 was located in the gully between the northeast stack and the main island, and was characterised by a typically exposed shore, with the exposure to wave action amplified by the effect of surge through the gully. There was also an effect of shading which was apparent in a reduced algal component. The order of the biotopes ran from an algae dominated *LR.HLR.FR.Coff/IR.MIR.KR.Ldig* (vi) through the lower middle shore *LR.HLR.FR.Mas* (v) to a faunally dominated *LR.HLR.MusB.Sem* (iv) in the upper middle shore. Then through the barnacles *LR.HLR.MusB.Cht* (iii)*,* followed by a LR.HLR.MusB (ii) *Porphyra* sp. band to a nitrate enriched *LR.FLR.Lic.Pra* (i) zone in the supralittoral where the copious bird droppings from the nesting and roosting seabirds made their impact on the littoral ecology.

Photographs from each littoral zone/biotope are shown in Figure 6.1, while a full species list with the SACFOR classification is presented in Table 6.1.


vi: *LR.HLR.FR.Coff/IR.MIR.KR.Ldig* v: *LR.HLR.FR.Mas*


iv: *LR.HLR.MusB.Sem* iii: *LR.HLR.MusB.Cht*

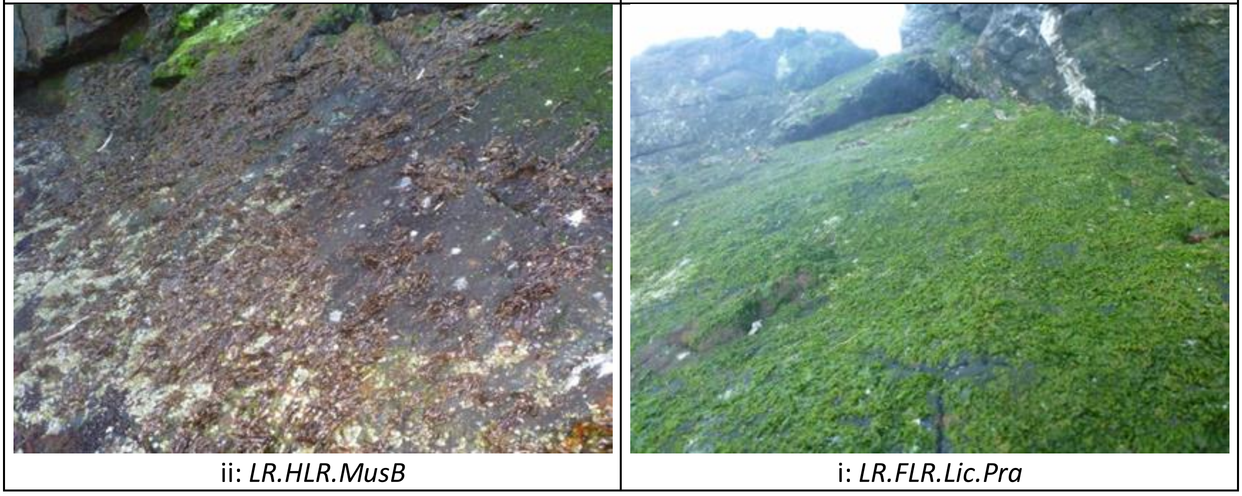

ii: *LR.HLR.MusB* i: *LR.FLR.Lic.Pra*

Figure 6.1 Littoral Zones and Biotopes for Station L1

Table 6.1 Species List for Station L1 with SACFOR Abundance Classifications for Each Biotope

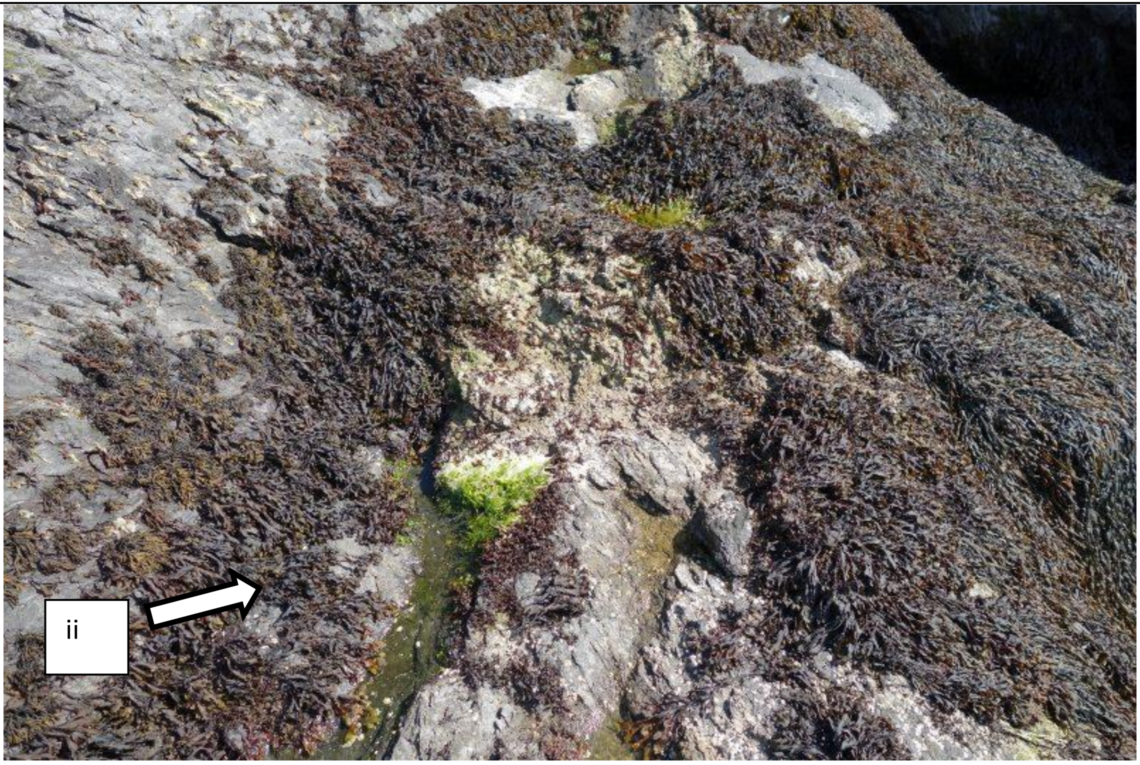
MCS Code	Taxa	L1					
		vi	v	iv	iii	ii	i
	Porifera						
C05230	*Hymeniacidon perlevis*	R					
	Cnidaria						
D11510	*Actinia equina*			O			
	Annelida						
P23040	*Spirobranchus triqueter*	F					
P02770	*Eulalia viridis*	F					
	Arthropda						
R00720	*Chthamalus montagui*				F	R	
R01080	*Semibalanus balanoides*	A	C		S	R	
S26900	*Carcinus maenas*	R					
	Mollusca						
W00500	Polyplacophora	O					
W01340	*Patella vulgata*	C	A	F	C		
W02390	*Lacuna pallidula*		O				
W02500	*Littorina littorea*		C				
W02520	*Melarhaphe neritoides*				R	R	
W02630	*Littorina saxatilis*				R	R	
W08170	*Nucella lapillus*			R			
W16500	*Mytilus edulis*	O	R	R			
	Bryozoa						
Y06780	*Electra pilosa*	O					
	Rhodophyta						
ZM00900	*Porphyra umbilicalis*					A	R
ZM02420	*Palmaria palmata*	R	O	R			
ZM03790	*Hildenbrandia rubra*	O					
ZM03840	Corallinaceae (enc)	A					
ZM04010	*Corallina caespitosa*		R				
ZM06050	*Mastocarpus*			R			
ZM06050	*Mastocarpus stellatus*	C	S	A	R		
ZM07510	*Lomentaria articulata*	R	R				
ZM08240	*Ceramium shuttleworthianum*		R	R	R	R	
ZM09900	*Membranoptera alata*	R					
ZM10800	*Osmundea pinnatifida*		R				
ZM11170	*Polysiphonia fucoides*		R				
	Ochrophyta						
ZR06320	*Laminaria digitata*	S					
	Chlorophyta						
ZS02400	*Ulva* sp. (flat)	R	R			R	
ZS02890	*Prasiola stipitata*						A
ZS03560	*Cladophora rupestris*		F			R	
	Ascomycota						
	Verrucaria maura					C	F

6.1.2. Littoral Station 2

The shore at Littoral Station 2 was a more sheltered inlet on the east coast of the island. The protection from wave action afforded by the sheltering intertidal reef has allowed a series of algal dominated biotopes to develop. Initially the *LR.HLR.FR.Coff/IR.MIR.KR.Ldig* (v) emerged from the sublittoral and passes through a typical *Fucus serratus* and red seaweeds *LR.MLR.BF.Fser.R* (iv) zone, to an *Ascophyllum nodosum* and *Fucus vesiculosus LR.LLR.F.Asc.FS* (iii) biotope. Above this the spiral wrack and channel wrack mixed together and form an *LR.MLR.BF.FspiB* (ii) biotope with limpets, barnacles and littorinids found amongst the algae. This shore finished with a typical lichen zone dominated by the nitrophilous yellow lichen *Xanthoria parietina* and the green algae *Pasiola stipitata LR.FLR.Lic.Pra* (i) previously seen at station L1.

Photographs from each littoral zone/biotope are shown in Figure 6.2, while a full species list with SACFOR classification is presented in Table 6.2.

v: *LR.HLR.FR.Coff/IR.MIR.KR.Ldig*, iv: *LR.MLR.BF.Fser.R* and iii: *LR.LLR.F.Asc.FS*



ii: *LR.MLR.BF.FspiB*

i: *LR.FLR.Lic.Pra*

Figure 6.2 Littoral Zones and Biotopes for Station L2

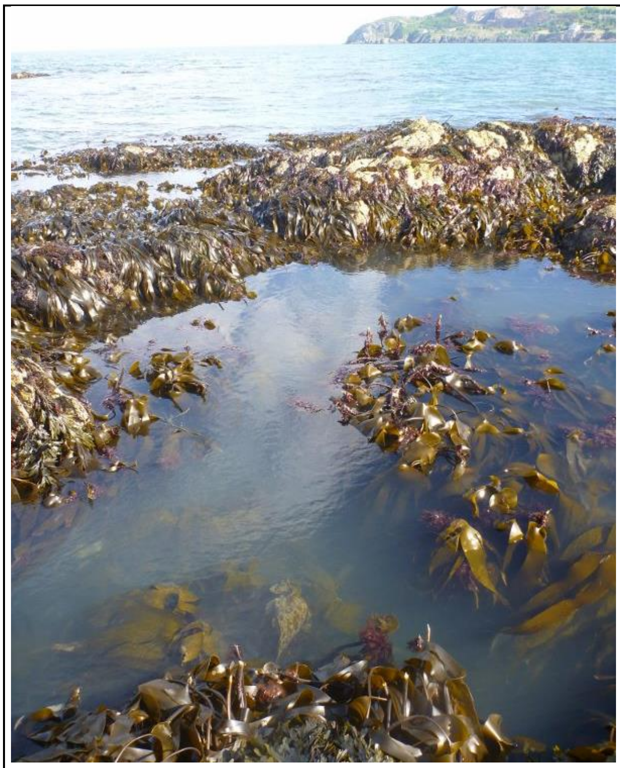
Table 6.2 Species List for Station L2 with SACFOR Abundance Classifications for Each Biotope

MCS Code	Taxa	L2				
		i	ii	iii	iv	v
	Annelida					
P23040	*Spirobranchus triqueter*					R
	Arthropoda					
R01080	*Semibalanus balanoides*	R		O	O	
R01200	*Austrominius modestus*		R			
S01660	Amphipoda		R	R		
	Anurida maritima		R	R		
	Mollusca					
W01340	*Patella vulgata*		R	O	O	
W02500	*Littorina littorea*			R		
W02630	*Littorina saxatilis*			R		
W08170	*Nucella lapillus*				R	
	Bryozoa					
Y01390	*Alcyonidium hirsutum*			R		
Y06780	*Electra pilosa*					R
	Rhodophyta					
ZM00900	*Porphyra umbilicalis*		R			
ZM01160	*Rhodothamniella floridula*				R	
ZM02160	*Gelidium spinosum*				R	
ZM02420	*Palmaria palmata*			R	O	F
ZM03840	Corallinaceae (enc)			O		
ZM06050	*Mastocarpus stellatus*			O	C	
ZM07510	*Lomentaria articulata*				O	
ZM08240	*Ceramium shuttleworthianum*			R	R	
ZM08830	*Plumaria plumosa*				R	
ZM09850	*Hypoglossum hypoglossoides*					R
ZM09900	*Membranoptera alata*				R	
ZM10780	*Osmundea hybrida*				R	
ZM11150	*Vertebrata lanosa*			F		
	Ochrophyta					
ZR02490	*Elachista fucicola*				O	
ZR06320	*Laminaria digitata*					S
ZR06640	*Ascophyllum nodosum*			S	R	
ZR06740	*Fucus serratus*			R	S	
ZR06750	*Fucus spiralis*		C			
ZR06760	*Fucus vesiculosus*			F	R	
ZR06810	*Pelvetia canaliculata*		C			
	Chorophyta					
ZS02400	*Ulva* sp. (tubular)			O		
ZS02400	*Ulva* sp. (flat)		R		R	
ZS02890	*Prasiola stipitata*	C				
ZS03400	*Cladophora albida*			R		
ZS03560	*Cladophora rupestris*			R		
	Ascomycota					
	Verrucaria maura	F	O		R	
	Caloplaca thallincola	A				
	Caloplaca marina	O				
	Tephromela atra var. atra	R				
	Xanthoria parietina	R				
	Tracheophyta					
	Armeria maritima	R				

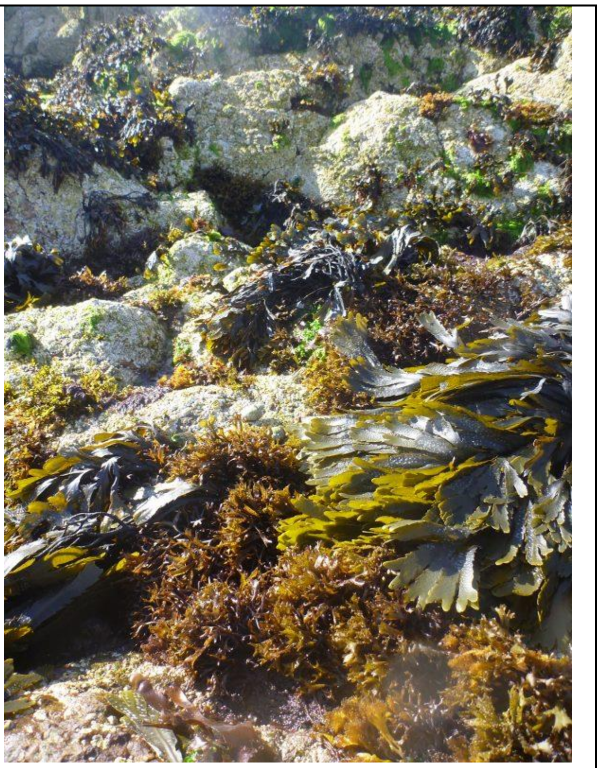
6.1.3. Littoral Station 3

Littoral Station 3 was located at the southeast tip of the island partially separated from the main island by a connecting intertidal reef. Here the type and order of the biotopes up to the shore from the low tide level were somewhat similar to those of station L1, with the addition of several other common algae species, probably present due to the improved light regime on the open coast. The order of the biotopes again ran up from an algae dominated *LR.HLR.FR.Coff/IR.MIR.KR.Ldig* (vi), *Laminaria digitata* forest (with occasional *L. hyperborea*) with frequent patches of red algae dominated by coralline crusts. The lower middleshore was dominated by *Fucus serratus, Osmundea pinnatifida* and *Mastocarpus stellatus* *LR.HLR.FR.Mas* (v) and this continued into to a faunally dominated middle shore of *LR.HLR.MusB.Sem* (iv), limpets, and *Semibalanus balanoides* barnacles, with a patchy canopy of the bladderless 'Bladder wrack' *Fucus evesiculosus.* Above this mixed algae and barnacle biotope, a barnacle dominated zone of *LR.HLR.MusB.Cht* (iii) was found, with all three common native littoral barnacle species present (the two *Chthamalus* and one *Semibalanus* species). Above this biotope, as with station L1, there was a *LR.HLR.MusB* (ii) *Porphyra sp.* and *Verrucaria maura* band with sparse barnacles and littorinids sheltered in the crevices. Finally, at the top of the shore, there was another nitrate enriched *LR.FLR.Lic.Pra* (i) *Prasiola stipitata* zone found in the supralittoral.

Photographs from each littoral zone/biotope are shown in Figure 6.3, while a full species list with SACFOR classification is presented in Table 6.3.

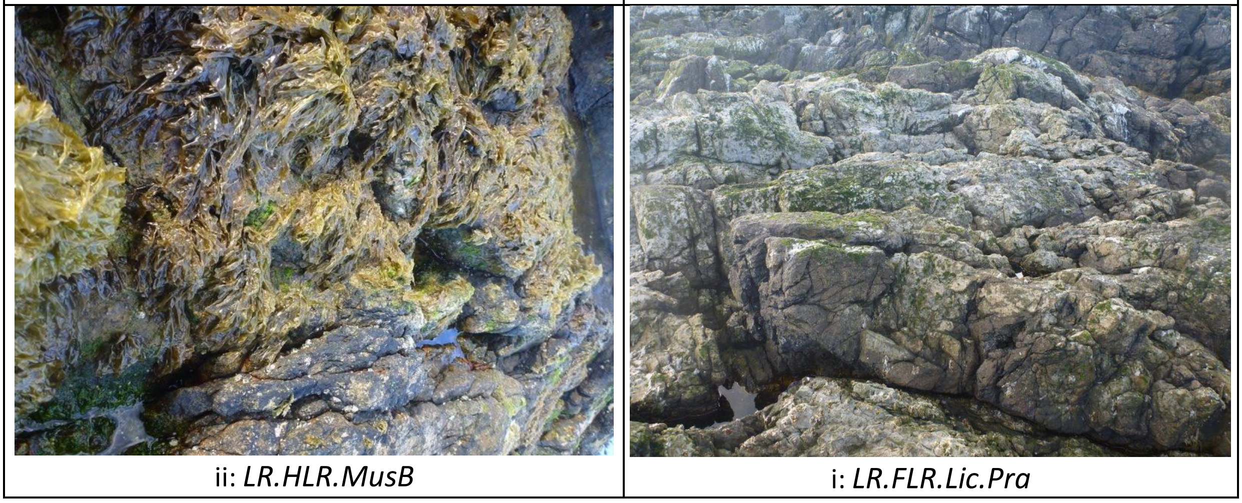


vi: *LR.HLR.FR.Coff/ IR.MIR.KR.Ldig*



v: *LR.HLR.FR.Mas*

iv: *LR.HLR.MusB.Sem* iii: *LR.HLR.MusB.Cht*



ii: *LR.HLR.MusB* i: *LR.FLR.Lic.Pra*

Figure 6.3 Littoral Zones and Biotopes for Station L3

Table 6.3 Species List for Station L3 with SACFOR Abundance Classifications for each Biotope

MCS Code	Taxa	L3					
		i	ii	iii	iv	v	vi
	Porifera						
C04840	*Halichondria panicea*						R
C05230	*Hymeniacidon perlevis*						R
	Cnidaria						
D06480	*Dynamena pumila*						R
	Annelida						
P23020	*Spirobranchus* sp.						R
	Arthropoda						
R00720	*Chthamalus montagui*		R	O			
R00730	*Chthamalus stellatus*			R			
R01080	*Semibalanus balanoides*			S	S	A	A
R01100	*Balanus crenatus*						O
R01200	*Austrominius modestus*				F	R	
R01940	Copepoda (in small pools)		P*				
S26460	*Cancer pagurus*						O
S26900	*Carcinus maenas*						O
	Mollusca						
W00740	*Lepidochitona cinerea*					R	
W01320	*Patella depressa*					F	

MCS Code	Taxa	L3					
		i	ii	iii	iv	v	vi
W01340	*Patella vulgata*			C	C	C	F
W02520	*Melarhaphe neritoides*		R	C			
W02562	*Littorina obtusata/ mariae*					O	
W02630	*Littorina saxatilus*	R	R	C			
W07360	*Trivia* sp.						R
W08170	*Nucella lapillus*				F		
W16500	*Mytilus edulis*			R	R		
	Bryozoa						
Y06640	*Membranipora*						O
Y06780	*Electra pilosa*						F
Y08720	*Bugulina flabellata*						R
	Chordata						
ZD00060	*Clavelina lepadiformis*						R
	Rhodophyta						
ZM00020	Rhodophyceae						R
ZM00870	*Porphyra linearis*			F			
ZM00900	*Porphyra umbilicalis*	R	A				
ZM02420	*Palmaria palmata*				O	R	F
ZM02660	*Dumontia contorta*				R	R	
ZM03790	*Hildenbrandia rubra*		O		R	O	
ZM03840	Corallinaceae (enc)				R	O	C
ZM04010	*Corallina caespitosa*					R	
ZM04040	*Corallina officinalis*					R	
ZM06050	*Mastocarpus*					R	
ZM06050	*Mastocarpus stellatus*		R	R	O	C	O
ZM07510	*Lomentaria articulata*					R	R
ZM08239	*Ceramium secundatum*					R	
ZM08240	*Ceramium shuttleworthianum*				R	R	
ZM09850	*Hypoglossum hypoglossoides*						R
ZM09900	*Membranoptera alata*						O
ZM10120	*Phycodrys rubens*						R
ZM10800	*Osmundea pinnatifida*				O	C	
	Ochrophyta						
ZR02810	*Leathesia marina*					R	
ZR06320	*Laminaria digitata*						A
ZR06330	*Laminaria hyperborea*						F
ZR06740	*Fucus serratus*					A	
ZR06760	*Fucus vesiculosus*					O	
ZR06760	*Fucus evesiculosus*			R	A		
	Chlorophyta						
ZS02400	*Ulva* sp. (tubular)				C		
ZS02400	*Ulva* sp. (flat)		O	F		O	R
ZS02890	*Prasiola stipitata*	A					
ZS03400	*Cladophora albida*					R	
ZS03560	*Cladophora rupestris*				R	O	O
	Ascomycota						
	Verrucaria mucosa					O	
	Verrucaria maura	F	A	O			
	Lichina pygmaea		R				

6.1.4. Sublittoral Station 1

This station was situated off the north-west corner of the island and here the reef ran on to the muddy gravel at approximately 10.5m ODM. The rock surface in this vicinity was found to be considerably silted. Just above the sediment interface this biotope was found to be dominated by the feather-star *Antedon bifida*, the plumose anemone *Metridium dianthus*, the common starfish and the barnacle *Balanus crenatus.* Other anemones such as *Sagartia elegans* and *Urticina felina*, the soft coral *Alcyonium digitatum* were also frequently encountered along with several sponge species (*Haliclona simulans*, *Suberites ficus, Halichondria panicea* and *Amphilectus fucorum).* The hydroids (*Obelia dichotoma*) and bryozoans (*Flustra foliacea* and *Scrupocellaria* spp.) were also common and the overall biotope make-up was similar to the *CR.HCR.XFa.ByErSp.Sag* biotope – a 'Mixed turf of bryozoans and erect sponges with *Sagartia elegans* on tide-swept circalittoral rock'.

Above this community, the next biotope (ii) lay between 6-6.5m ODM and here the foliose algae began to colonise the rock surface. This biotope was also heavily silted. This biotope was characterised by the foliose brown algae *Dictyota dichotoma* and the foliose red algae *Delesseria sanguinea* with numerous other small foliose species encountered as well, along with the occasional large sugar kelp plant, *Saccharina latissima*. The faunal component of this biotope was characterised by the anemones *Urticina felina* and *Sagartia elegans,* with the brittle-star *Ophiothrix fragilis,* the hydroids *Obelia* spp., mussels, *Balanus crenatus* and *Pomatoceros* spp. all of which were found within the silty sward. The biotope was situated close to a *IR.HIR.KFaR.FoR.Dic* or Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock.

The final biotope encountered at S1 above the foliose algal zone, was a zone of stunted *Laminaria digitata* kelp plants, with several other foliose red algae, such as *Palmaria palmata* and *Delesseria sanguinea.* Beneath these algae, crusts of mussels and barnacles were found, often being predated by the common starfish *Asterias rubens*. A probable biotope for this assemblage is *IR.MIR.KR.Ldig.Ldig*.

Photographs from each littoral zone/biotope are shown in Figure 6.4, while a full species list with SACFOR classification is presented in Table 6.4.

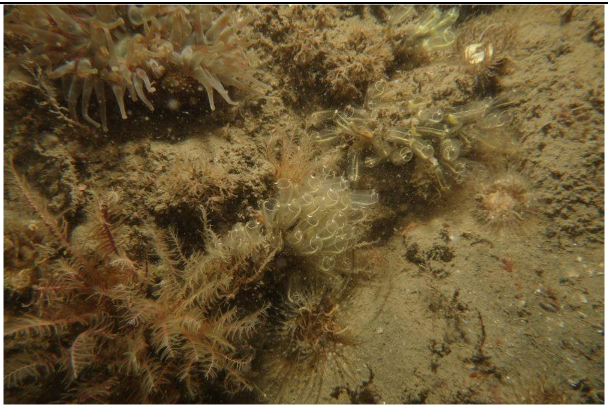
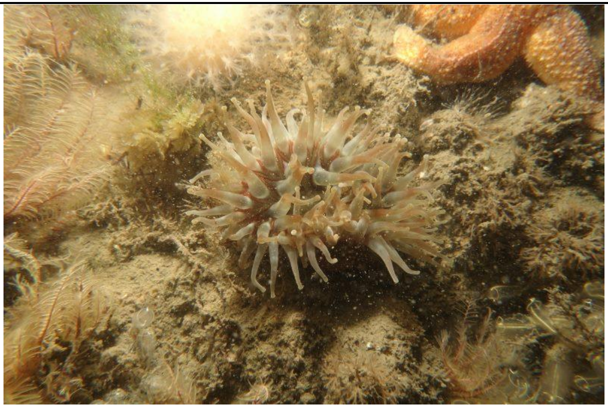
 iii: *CR.HCR.XFa.ByErSp.Sag*	 iii: *CR.HCR.XFa.ByErSp.Sag*
 iii: *CR.HCR.XFa.ByErSp.Sag*	 ii: *IR.HIR.KFaR.FoR.Dic*
 ii: *IR.HIR.KFaR.FoR.Dic*	 i: *IR.MIR.KR.Ldig.Ldig*

Figure 6.4 Sublittoral Zones and Biotopes for Station S1

Table 6.4 Species List for Station S1 with SACFOR Abundance Classifications for Each Biotope

MCS Code	Taxa	S1		
		i	ii	iii
	Porifera			
C00350	*Sycon ciliatum*	F	R	
C02210	*Suberites ficus*			R
C04840	*Halichondria panicea*	R	O	O
C05960	*Amphilectus fucorum*		O	O
C08630	*Haliclona simulans*		F	O
	Red sponge crust		R	
	Cnidaria			
D01440	*Tubularia indivisa*			O
D06760	*Sertularia argentea*			O
D07300	*Obelia dichotoma*		O	O
D07310	*Obelia geniculata*	F	O	R
D10240	*Alcyonium digitatum*		C	C
D11580	*Anemonia viridis*		F	
D11680	*Urticina felina*	O	C	A
D12250	*Metridium dianthus*		C	C
D12310	*Sagartia elegans*	O	C	C
D13700	*Caryophyllia smithii*			R
	Annelida			
P23040	*Spirobranchus triqueter*	F	O	
	Arthropda			
R01100	*Balanus crenatus*		C	S
S25020	*Pisidia longicornis*		R	R
S26460	*Cancer pagurus*		F	
S26720	*Necora puber*	F	A	C
	Mollusca			
W12740	*Doto coronata*		O	O
W14030	*Doris pseudoargus*	R		
W16500	*Mytilus edulis*	S	R	
	Bryozoa			
Y06640	*Membranipora membranaceae*	F		
Y06780	*Electra pilosa*	F		
Y06940	*Flustra foliacea*			O
Y08360	*Scrupocellaria* sp.			F
Y08720	*Bugulina flabellata*			R
	Echinodermata			
ZB00110	*Antedon bifida*		C	S
ZB01900	*Asterias rubens*	C	A	C
ZB02350	*Ophiothrix fragilis*			O
ZB02680	*Ophiactis balli*			R
ZB03000	*Amphipholis squamata*		R	
	Chordata			
ZD00060	*Clavelina lepadiformis*	O	R	C
ZD00460	*Morchellium argus*	O	R	R
ZD00640	*Aplidium punctum*	O	R	R
ZD02090	*Botryllus schlosseri*		R	
ZG01500	Gadidae	P	R	
ZG04380	*Taurulus bubalis*	R	R	
ZG07050	Gobiidae	R		

MCS Code	Taxa	S1		
		i	ii	iii
	Rhodophyta			
ZM02080	*Bonnemaisonia asparagoides*	O	O	
ZM03230	*Callophyllis laciniata*	O		
ZM04040	*Corallina officinalis*	R		
ZM06310	*Plocamium cartilagineum*	O	O	
ZM06820	*Calliblepharis ciliata*	R	R	
ZM06880	*Cystoclonium purpureum*	O	F	
ZM06930	*Rhodophyllis divaricata*	O	F	
ZM08070	*Ceramium* sp.	O	O	
ZM08460	*Halurus flosculosus*		R	
ZM09500	*Cryptopleura ramosa*	F	R	
ZM09550	*Delesseria sanguinea*	F	F	
ZM09850	*Hypoglossum hypoglossoides*	O	O	
ZM09900	*Membranoptera alata*	R		
	Brogniartella byssoides	O		
ZM10120	*Phycodrys rubens*	R	F	
ZM10180	*Erythroglossum laciniatum*		R	
ZM11050	*Polysiphonia elongata*		R	
	Ochrophyta			
ZR04570	*Dictyota dichotoma*	R	C	
ZR04780	*Taonia atomaria*		R	
ZR04970	*Desmarestia aculeata*	O	O	
ZR04990	*Desmarestia ligulata*	R		
ZR05000	*Desmarestia viridis*	R		
ZR06320	*Laminaria digitata*	S		
ZR06360	*Saccharina latissima*	O	R	
	Chlorophyta			
ZS02400	*Ulva* sp. (flat)	R		
ZS03920	*Bryopsis plumosa*	R		

6.1.5. Sublittoral Station 2

This station was situated in the middle of the north coast of the island and again, there was evidence of a heavy silt burden. Here, the deeper sediment plains gave way to a steeply inclined reef at a depth of circa 15.5m ODM. The reef is initially broken, with deposits of muddy gravel lying between boulders and outcrops of sloping bedrock. The biotope on these outcrops was dominated by the bryozoans *Flustra foliacea, Scupocellaria* sp. and *Bugulina flabellata.* Other sub-dominant taxa of note were the hydroid *Nemertesia antennina* and the soft coral *Alcyonium digitatum,* frequent erect sponges *Hymeniacidon perlevis*, *Amphilectus fucorum* and *Haliclona simulans*, the hydroids *Nemertesia antennina* and *Obelia dichotoma* as well as the tunicate *Clavelina lepadiformis.* A possible biotope tag for this assemblage was *CR.HCR.XFa.FluCoAs*, or *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock.

Above this biotope, at 8.5m ODM, the *Dictyota* and foliose red algae biotope was again found, as recorded at station L1. However, several new algal species were noted such as

Rhodymenia holmesii, Sphondylothamnion multifidum and *Apoglossum ruscifolium* amongst the sward. Several new species of fish were also noted in this biotope, such as the ling (*Molva molva*), the black goby (*Gobius niger*) as well as the Greater pipefish (*Syngnathus acus*). Hence, the biotope was found to be close to *IR.HIR.KFaR.FoR.Dic* or Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock.

As with station L1, above the foliose algal zone, there was again a zone of stunted *Laminaria digitata* kelp plants, with numerous foliose red algae, mussels and starfish. The biotope being *IR.MIR.KR.Ldig.Ldig* or *Laminaria digitata* on moderately exposed sublittoral fringe rock.

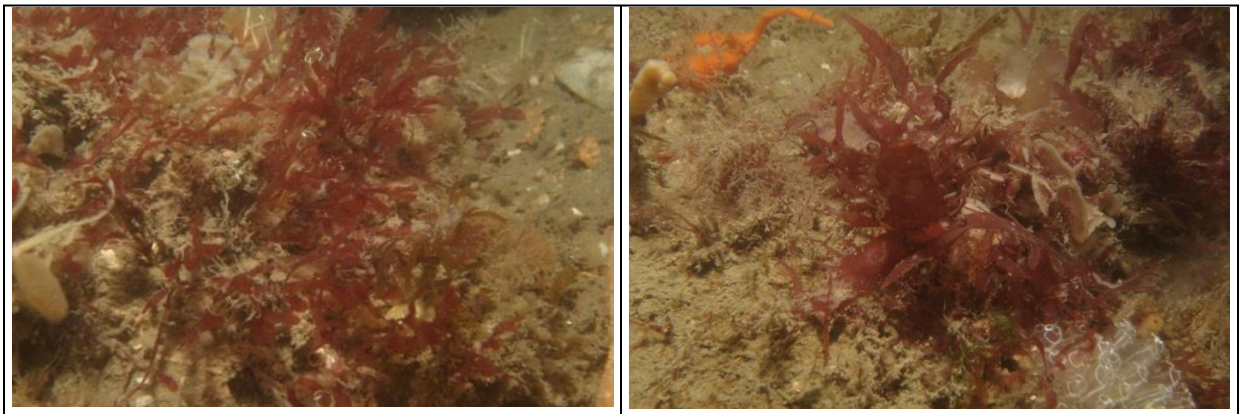
Photographs from each littoral zone/biotope are shown in Figure 6.5, while a full species list with SACFOR classification is presented in Table 6.5.


iii: *CR.HCR.XFa.FluCoAs*

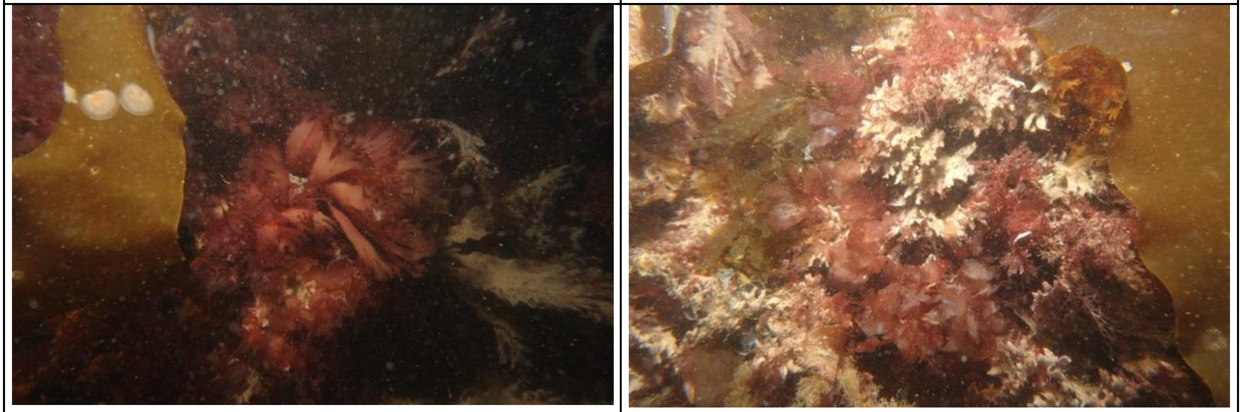

iii: *CR.HCR.XFa.FluCoAs*


iii: *CR.HCR.XFa.FluCoAs*


iii: *CR.HCR.XFa.FluCoAs*



ii: *IR.HIR.KFaR.FoR.Dic* ii: *IR.HIR.KFaR.FoR.Dic*



i: *IR.MIR.KR.Ldig.Ldig* i: *IR.MIR.KR.Ldig.Ldig*

Figure 6.5 Sublittoral Zones and Biotopes for Station S2

Table 6.5 Species List for Station S2 with SACFOR Abundance Classifications for each Biotope

MCS Code	Taxa	S2		
		i	ii	iii
	Porifera			
C00350	*Sycon ciliatum*	F		F
C02210	*Suberites ficus*		R	R
C04810	*Halichondria bowerbanki*			O
C04840	*Halichondria panicea*	F		
C05230	*Hymeniacidon perlevis*	O	F	F
C05960	*Amphilectus fucorum*	O	F	F
C06420	*Myxilla* sp.	R		R
C06840	*Iophon hyndmani*		O	
C08630	*Haliclona simulans*		F	F
	Cnidaria			
D01440	*Tubularia indivisa*			R
D05260	*Halecium halecinum*		O	O
D05500	*Aglaophenia* sp.		R	R
D05780	*Halopteris catharina*			F
D05970	*Nemertesia antennina*		F	F
D05990	*Nemertesia ramosa*		O	R
D06690	*Sertularella polyzonias*			O
D06760	*Sertularia argentea*	R		
D07300	*Obelia dichotoma*	O	F	F
D07310	*Obelia geniculata*	F		
D07320	*Obelia longissima*			O

MCS Code	Taxa	S2		
		i	ii	iii
D10240	*Alcyonium digitatum*	F	C	F
D11680	*Urticina felina*			R
D12310	*Sagartia elegans*		R	R
	Annelida			
P23020	*Spirobranchus* sp.			F
P23040	*Spirobranchus triqueter*	F	R	
	Arthropoda			
R01090	*Balanus balanus*		R	O
R01100	*Balanus crenatus*	C	F	O
S01660	Amphipoda	C	C	F
S10700	Caprellidae	C	C	
S22100	*Palaemon serratus*	O	F	F
S23220	*Pandalus montagui*	F		
S23600	*Homarus gammarus*			R
S24650	*Pagurus bernhardus*			R
S25850	*Macropodia rostrata*	O	O	
S26460	*Cancer pagurus*	R	O	O
S26720	*Necora puber*	O	O	O
S26900	*Carcinus maenas*	O		
	Mollusca			
W12720	*Doto* sp.		R	R
	Diapharodoris luteocincta			R
W16500	*Mytilus edulis*	C		
	Bryozoa			
Y00030	Crisiidae	F	O	O
Y01370	*Alcyonidium diaphanum*		F	F
Y06640	*Membranipora* sp.	C		
Y06780	*Electra pilosa*	A	F	
Y06940	*Flustra foliacea*		F	C
Y07050	*Chartella papyracea*		R	O
Y07100	*Securiflustra securifrons*		R	
Y08360	*Scrupocellaria* sp.	F	C	
Y08410	*Scrupocellaria scruposa*			A
Y08530	*Bicellariella ciliata*			O
Y08720	*Bugulina flabellata*	R	O	C
Y08750	*Bugulina plumosa*			R
	Echinodermata			
ZB00110	*Antedon bifida*	R	O	O
ZB01900	*Asterias rubens*	C	C	C
ZB02350	*Ophiothrix fragilis*	C		O
ZB03620	*Echinus esculentus*	R	R	O
ZB04950	*Thyone fusus*		O	
	Chordata			
ZD00060	*Clavelina lepadiformis*	R	F	F
ZD00640	*Aplidium punctum*	R	O	O
ZD01880	*Polycarpa scuba*			O
ZD01940	*Dendrodoa grossularia*		R	R
ZD02090	*Botryllus schlosseri*	R	R	
ZG01500	Gadidae		R	R
ZG01960	*Molva molva*		R	

MCS Code	Taxa	S2		
		i	ii	iii
ZG03760	*Syngnathus acus*		R	
ZG04340	*Myoxocephalus scorpius*			R
ZG06050	*Ctenolabrus rupestris*		R	
ZG07000	*Callionymus lyra*		R	O
ZG07050	Gobiidae			R
ZG07230	*Gobius niger*		R	R
ZG07440	*Pomatoschistus pictus*			R
	Rhodophyta			
ZM02080	*Bonnemaisonia asparagoides*	O	R	
ZM02420	*Palmaria palmata*	O		
ZM02560	*Dilsea carnosa*	O	R	
ZM03230	*Callophyllis laciniata*	O	R	
ZM03840	Corallinaceae (enc)	F	O	
ZM05840	*Phyllophora crispa*	F	O	
ZM05860	*Phyllophora pseudoceranoides*	C		
ZM06110	*Chondrus crispus*	C		
ZM06310	*Plocamium cartilagineum*	F	O	
ZM06820	*Calliblepharis ciliata*	F	A	
ZM06880	*Cystoclonium purpureum*		O	
ZM06930	*Rhodophyllis divaricata*		F	
ZM07230	*Rhodymenia holmesii*		C	
ZM07530	*Lomentaria orcadensis*	R	R	
ZM07860	*Aglaothamnion tenuissimum*		R	
ZM08239	*Ceramium secundatum*		R	
ZM08460	*Halurus flosculosus*	R		
ZM09230	*Sphondylothamnion multifidum*		R	
ZM09400	*Apoglossum ruscifolium*		R	
ZM09500	*Cryptopleura ramosa*	F	C	
ZM09550	*Delesseria sanguinea*	F	F	
ZM09850	*Hypoglossum hypoglossoides*		C	
ZM09900	*Membranoptera alata*	O		
ZM10120	*Phycodrys rubens*	F	F	
ZM10180	*Erythroglossum laciniatum*		F	
ZM10390	*Heterosiphonia plumosa*	R	R	
	Brogniartella byssoides	O	O	
ZM11050	*Polysiphonia elongata*		R	
ZM11170	*Polysiphonia fucoides*		R	
ZM11370	*Pterosiphonia parasitica*		R	
	Ochrophyta			
ZR04570	*Dictyota dichotoma*	F	C	
ZR04780	*Taonia atomaria*		R	
ZR04970	*Desmarestia aculeata*	O		
ZR04990	*Desmarestia ligulata*	F		
ZR06310	*Laminaria sporelings*		R	
ZR06320	*Laminaria digitata*	S		
ZR06330	*Laminaria hyperborea*	A		
ZR06360	*Saccharina latissima*	C		

6.1.6. Sublittoral Station 3

This station was located off the east coast of the island, slightly south of station L2. It was exposed to the easterly winds and therefore moderately exposed to wave action. The reef appeared out of the sediment at approximately 13.5m ODM and slopes gently up towards the island. Again, the reef was heavily silted and the initial biotope was dominated by erect sponges and hydroids, with species of note being *Haliclona simulans, Halichondria panicea* and *Nemertesia antennina.* Also dominant were the hydrozoan *Halecium halecinum*, *Alcyonium digitatum,* the anemones *Sagartia elegans* and *Urticina felina*, whilst the decapods, *Palaemon serratus, Cancer pagurus, Macropodia rostrata* and *Necora puber* were frequent constituent in this zone. The overall biotope make-up of this biotope was similar to the *CR.HCR.XFa.ByErSp.Sag* biotope – a 'Mixed turf of bryozoans and erect sponges with *Sagartia elegans* on tide-swept circalittoral rock'.

Above this biotope at 8.5m ODM was the *Dictyota dichotoma* and foliose red algal assemblage previously found at S1 and S2. Here the silt still formed a thick covering and the *Dictyota* was possibly less abundant and hence several more delicate red algae were more prominent, such as *Rhodymenia ardissonei*, *Phycodrys rubens* and *Apoglossum ruscifolium*. As a result the community was possibly more similar to the *IR.HIR.KFaR.FoR* biotope or Foliose red seaweeds on exposed lower infralittoral rock.

Finally at station S3 from 6.5m ODM upwards was a kelp zone with a dense understory of foliose red algae and barnacles. Dominant red algae included *Ploccamium cartilagineum*, *Delesseria sanguinea* and *Cryptopleura ramosa*, whilst the foliose brown algae were dominated by *Desmarestia spp*. and *Ectocarpaceae* indet. Although the dominant kelp was *Laminaria digitata, L. hyperborea* was present in the kelp forest. Hence the biotope was consistent with S1 and S2, being *IR.MIR.KR.Ldig.Ldig* or *Laminaria digitata* on moderately exposed sublittoral fringe rock.

Photographs from each littoral zone/biotope are shown in Figure 6.6, while a full species list with SACFOR classification is presented in Table 6.6.

iii: *CR.HCR.XFa.ByErSp.Sag*

iii: *CR.HCR.XFa.ByErSp.Sag*

ii: *IR.HIR.KFaR.FoR*

ii: *IR.HIR.KFaR.FoR*

i: *IR.MIR.KR.Ldig.Ldig*

Figure 6.6 Sublittoral Zones and Biotopes for Station S3

Table 6.6 Species List for Station S3 with SACFOR Abundance Classifications for Each Biotope

MCS Code	Taxa	S3		
		i	ii	iii
	Porifera			
C00350	*Sycon ciliatum*			R
C02210	*Suberites ficus*		R	R
C04810	*Halichondria bowerbanki*			R
C04840	*Halichondria panicea*	O	R	O
C05230	*Hymeniacidon perlevis*	O		
C05960	*Amphilectus fucorum*		R	R
C06450	*Myxilla incrustans*		R	
C06780	*Iophon nigricans*		R	R
C08630	*Haliclona simulans*		R	A
	Cnidaria			
D01440	*Tubularia indivisa*	R	R	
D05260	*Halecium halecinum*		R	O
D05970	*Nemertesia antennina*	R	R	C
D05990	*Nemertesia ramosa*		R	R
D06760	*Sertularia argentea*		R	
D07300	*Obelia dichotoma*		R	
D07310	*Obelia geniculata*	F		O
D07430	*Rhizocaullus verticillatus*		R	R
D10240	*Alcyonium digitatum*		F	C
D11580	*Anemonia viridis*	O		
D11680	*Urticina felina*		R	F
D12310	*Sagartia elegans*	O	F	C
	Nemertea			
G00780	*Lineus longissimus*			R
	Annelida			
P23040	*Spirobranchus triqueter*	O	F	O
	Arthropoda			
R01090	*Balanus balanus*	R	R	R
R01100	*Balanus crenatus*	C	C	R
S01660	Amphipoda			O
S22100	*Palaemon serratus*	O	C	C
S23220	*Pandalus montagui*	R		
S23600	*Homarus gammarus*	R		R
S25020	*Pisidia longicornis*		O	
S25850	*Macropodia rostrata*	O	C	A
S26460	*Cancer pagurus*	C	F	R
S26720	*Necora puber*	A	C	A
S26900	*Carcinus maenas*	C		
	Mollusca			
W16500	*Mytilus edulis*	R	O	
	Bryozoa			
Y00001	Bryozoa		O	O
Y01370	*Alcyonidium diaphanum*		C	C
Y06640	*Membranipora* sp.	O		
Y06780	*Electra pilosa*	O		
Y06940	*Flustra foliacea*		O	R
Y07050	*Chartella papyracea*		O	

MCS Code	Taxa	S3		
		i	ii	iii
Y08790	*Bugulina turbinata*			O
	Echinodermata			
ZB00110	*Antedon bifida*	R	O	C
ZB01900	*Asterias rubens*	C	C	C
ZB02350	*Ophiothrix fragilis*	R		
	Chordata			
ZD00060	*Clavelina lepadiformis*		F	F
ZD00460	*Morchellium argus*			R
ZD00640	*Aplidium punctum*	R	R	O
ZD01940	*Dendrodoa grossularia*	R	F	C
ZG02080	*Pollachius pollachius*	R	R	R
ZG04380	*Taurulus bubalis*	R	R	R
ZG07050	Gobiidae	R	O	R
ZG07400	*Pomatoschistus*		R	R
	Rhodophyta			
ZM02420	*Palmaria palmata*	O		
ZM03840	Corallinaceae (enc)	F	O	
ZM04040	*Corallina officinalis*	R		
ZM06310	*Plocamium cartilagineum*	C		
ZM06820	*Calliblepharis ciliata*	R		
ZM06880	*Cystoclonium purpureum*	R		
ZM07230	*Rhodymenia holmesii*		R	
ZM07260	*Rhodymenia ardissonei*		R	
ZM07510	*Lomentaria articulata*	R		
ZM08239	*Ceramium secundatum*		R	
ZM09400	*Apoglossum ruscifolium*		R	
ZM09500	*Cryptopleura ramosa*	A	R	
ZM09550	*Delesseria sanguinea*	A	R	
ZM09850	*Hypoglossum hypoglossoides*	R	R	
ZM09900	*Membranoptera alata*	R		
ZM10120	*Phycodrys rubens*		R	
ZM10180	*Erythroglossum laciniatum*	F		
ZM11050	*Polysiphonia elongata*	R	R	
	Ochrophyta			
	Chrysophyceae	A		
ZR00030	Ectocarpaceae indet.	C		
ZR04570	*Dictyota dichotoma*	O	F	
ZR04970	*Desmarestia aculeata*	R		
ZR04990	*Desmarestia ligulata*	O		
ZR06320	*Laminaria digitata*	A		
ZR06330	*Laminaria hyperborea*	R		

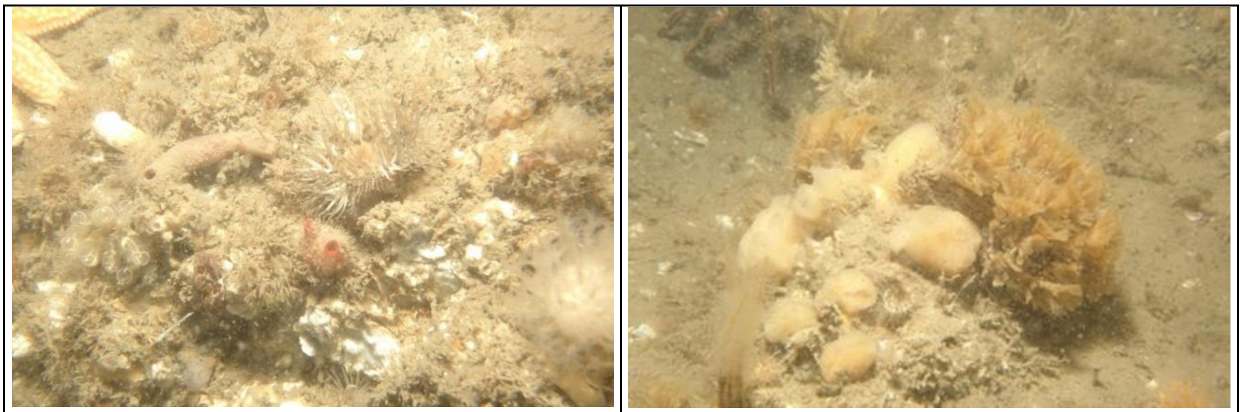
6.1.7. Sublittoral Station 4

This station was located off the south east corner of the island, adjacent to station L3. The reef emerged out of the sediment at approximately 14.9m ODM and rose at a shallow angle towards the shore. Initially the reef sloped shore-wards relatively smoothly and latterly in a series of steep ridges and gullies. Again the silt covering was significant but where rock surfaces were less impacted by siltation, the community was again relatively rich, comprising of encrusting assemblages of hydroids and bryozoans with frequent erect sponges and anemones. The deepest reef biotope (iii) were dominated by the anemones *Urticina felina* and *Metridium dianthus* and the bryozoans *Flustra foliacea*, *Bugulina flabellata* and *Scrupocellaria* spp., whilst the sponges *Halichondria bowerbanki, Amphilectus fucorum* and *Haliclona simulans* were also present. Several ascidian species also occurred in the biotope, *Polycarpa scuba* and *Dendrodoa grossularia* being the most common along with *Polyclinum aurantium* and *Aplidium punctum* which were also present. The biotope therefore could be *HCR.XFa.FluCoAs.Paur* – '*Polyclinum aurantium* and *Flustra foliacea* on sand scoured tide-swept moderately wave-exposed circalittoral rock'. This difference from the other stations was probably brought about by the increased sedimentation regime noted at this station.

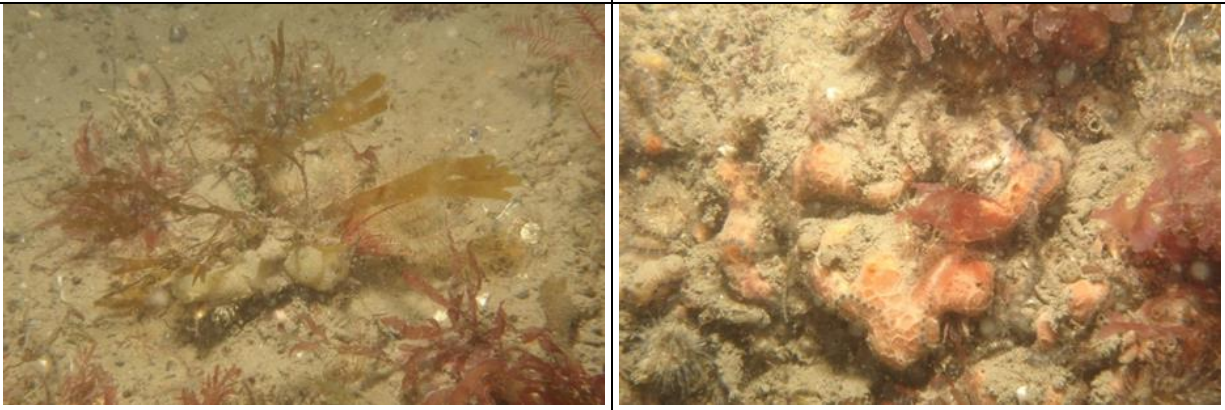
Above this biotope, at 9m ODM, was the *Dictyota dichotoma* and foliose red algal assemblage previously found at S1 and S2. Here again the silt still formed a thick covering but the *Dictyota* was accompanied by numerous small foliose red algal species, such as *Hypoglossum hypoglossoides, Erythroglossum laciniatum* and *Rhodomenia holmesii.* On the vertical faces, *Schottera nicaensis* was noted and the delicate brown algae *Taonia atomaria* was also recorded. Beneath the silt, a crust of the solitary ascidian *Dendrodoa grossularia* and the barnacle *Balanus crenatus* was found along with the frequent clumps of sponges, hydroids and bryozoans. The less common sponge *Hemimycale columella* was evident for the first time in this biotope, as shown in the photo below. However, the biotope was still found to be close to *IR.HIR.KFaR.FoR.Dic* or Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock.

Above the foliose algal zone, the *Laminaria digitata* forest was again present, with understorey dominants of *Phyllophora crispa* and *Chondrus crispus*, amongst a crust of mussels and the barnacle *Balanus crenatus*. The bryozoans *Electra pilosa* and *Membranipora membranaceae* were frequently recorded on the algal thalli and *Asterias rubens* was also present, feeding on the mussels. Occasional sugar kelp plants of *Saccarhina lattissima* were also noted within the kelp forest, however the biotope would still be recorded as *IR.MIR.KR.Ldig.Ldig* or *Laminaria digitata* on moderately exposed sublittoral fringe rock.

Photographs from each littoral zone/biotope are shown in Figure 6.7, while a full species list with SACFOR classification is presented in Table 6.7.



iii: *HCR.XFa.FluCoAs.Paur* iii: *HCR.XFa.FluCoAs.Paur*



ii: *IR.HIR.KFaR.FoR.Dic* ii: *IR.HIR.KFaR.FoR.Dic*

Figure 6.7 Sublittoral Zones and Biotopes for Station S4

Table 6.7 Species List for Station S4 with SACFOR Abundance Classifications for Each Biotope

MCS Code	Taxa	S4		
		i	ii	iii
	Porifera			
C00350	*Sycon ciliatum*	O	O	
C02210	*Suberites ficus*		R	R
C04810	*Halichondria bowerbanki*		O	O
C04840	*Halichondria panicea*	F	O	
C05230	*Hymeniacidon perlevis*	F		
C05960	*Amphilectus fucorum*		O	O
C06450	*Myxilla incrustans*	R		
C06780	*Iophon nigricans*		O	O
C07750	*Hemimycale columella*		R	
C08630	*Haliclona simulans*		F	F
C08900	*Dysidea fragilis*			R
	Red sponge crust		O	
	Cnidaria			
D05260	*Halecium halecinum*			O
D05780	*Halopteris catharina*		O	O
D05970	*Nemertesia antennina*		O	F
D05990	*Nemertesia ramosa*		O	O
D06690	*Sertularella polyzonias*			O
D06760	*Sertularia argentea*			R
D07300	*Obelia dichotoma*	O	F	F
D07310	*Obelia geniculata*	O		

MCS Code	Taxa	S4		
		i	ii	iii
D07430	*Rhizocaullus verticillatus*			O
D10240	*Alcyonium digitatum*	O	C	F
D11680	*Urticina felina*	R	F	C
D12250	*Metridium dianthus*		O	C
D12310	*Sagartia elegans*	R	F	F
D12480	*Sagartiogeton undatus*			R
	Annelida			
P23040	*Spirobranchus triqueter*	R		
P20310	*Lanice conchilega*		O	O
P23090	*Serpula vermicularis*		O	
	Arthropoda			
R01090	*Balanus balanus*		R	C
R01100	*Balanus crenatus*	C	F	C
S01660	Amphipoda		F	F
S23600	*Homarus gammarus*			R
S24650	*Pagurus bernhardus*			O
S25850	*Macropodia rostrata*			F
S26460	*Cancer pagurus*	O	F	F
S26690	*Liocarcinus depurator*			O
S26720	*Necora puber*	F	C	C
	Mollusca			
W14030	*Doris pseudoargus*		R	
W16500	*Mytilus edulis*	F		O
	Bryozoa			
Y00030	Crisiidae	F	F	F
Y01370	*Alcyonidium diaphanum*	F	F	F
Y06640	*Membranipora* sp.	F		
Y06780	*Electra pilosa*	C	O	
Y06940	*Flustra foliacea*		O	O
Y08360	*Scrupocellaria*		F	F
Y08530	*Bicellariella ciliata*			O
Y08720	*Bugulina flabellata*		O	F
	Porifera			
ZB00110	*Antedon bifida*	O	F	R
ZB01900	*Asterias rubens*	C	C	C
ZB02350	*Ophiothrix fragilis*			O
ZB02680	*Ophiactis balli*		O	O
ZB02780	*Ophiopholis aculeata*		O	O
ZB03000	*Amphipholis squamata*		O	R
	Chordata			
ZD00060	*Clavelina lepadiformis*	O	O	O
ZD00340	*Polyclinum aurantium*			O
ZD00640	*Aplidium punctum*	F	O	O
ZD00680	Didemnidae indet.			R
ZD01880	*Polycarpa scuba*		R	R
ZD01940	*Dendrodoa grossularia*		F	O
ZD02090	*Botryllus schlosseri*	O	R	
ZD02140	*Botrylloides leachii*	R		
	Rhodophyta			
ZM02080	*Bonnemaisonia asparagoides*		O	

MCS Code	Taxa	S4		
		i	ii	iii
ZM02420	*Palmaria palmata*	F		
ZM02560	*Dilsea carnosa*		O	
ZM03230	*Callophyllis laciniata*	O	O	
ZM03840	Corallinaceae (enc)	F		
ZM04040	*Corallina officinalis*	O		
ZM05840	*Phyllophora crispa*	F	F	
ZM05860	*Phyllophora pseudoceranoides*	F		
ZM05940	*Schottera nicaeensis*		O	
ZM06110	*Chondrus crispus*	F		
ZM06310	*Plocamium cartilagineum*	F	O	
ZM06820	*Calliblepharis ciliata*		R	
ZM06880	*Cystoclonium purpureum*	F	F	
ZM06930	*Rhodophyllis divaricata*		F	
ZM07230	*Rhodomenia holmesii*		F	R
ZM07530	*Lomentaria orcadensis*		R	
ZM08070	*Ceramium* sp.	O	O	
ZM08460	*Halurus flosculosus*		R	
ZM09500	*Cryptopleura ramosa*	O	F	
ZM09550	*Delesseria sanguinea*	F	F	
ZM09850	*Hypoglossum hypoglossoides*		F	
ZM10120	*Phycodrys rubens*	F		
ZM10180	*Erythroglossum laciniatum*		F	
	Brogniartella byssoides	O	F	
ZM11160	*Polysiphonia nigra*		R	
	Ochrophyta			
	Chrysophyceae	A		
ZR00030	Ectocarpaceae indet.	C		
ZR04570	*Dictyota dichotoma*	C	C	
ZR04780	*Taonia atomaria*		R	
ZR04970	*Desmarestia aculeata*	O	R	
ZR04990	*Desmarestia ligulata*	R		
ZR05000	*Desmarestia viridis*	R	R	
ZR06310	*Laminaria sporelings*		O	R
ZR06320	*Laminaria digitata*	S		
ZR06330	*Laminaria hyperborea*	O		
ZR06360	*Saccharina latissima*	F		
ZS03920	*Bryopsis plumosa*		R	

6.2. Univariate Analyses

Univariate analyses revealed clear differences between the number of species from the littoral and sublittoral stations. As expected, species richness was on average higher (twice as high) in the sublittoral stations (88.3±19.2SD) compared to the numbers found in the littoral stations (44.7±11.6SD; Table 6.8 & Figure 6.8). Nemerteans and echinoderms were restricted to the sublittoral stations whereas Ascomycota and Tracheophyta were only recorded in the littoral zones. The highest species richness was encountered at Sublittoral

Station S2 (109 species) with the lowest number of species being counted at Littoral Station L1 (34 species).

Table 6.8 Number of Species per Phyla and Station

Phylum	**Littoral Station**			**Sublittoral Station**			
	L1	**L2**	**L3**	**S1**	**S2**	**S3**	**S4**
Porifera	1	0	2	6	9	9	12
Cnidaria	1	0	1	10	14	12	14
Nemertea	0	0	0	0	0	1	0
Annelida	2	1	1	1	2	1	3
Arthropoda	3	4	8	4	12	11	9
Mollusca	9	5	9	3	3	1	2
Bryozoa	1	2	3	5	12	7	8
Echinodermata	0	0	0	5	5	3	6
Chordata	0	0	1	7	14	8	8
Rhodophyta	12	13	18	17	30	18	25
Ochrophyta	1	7	6	7	8	7	11
Chlorophyta	3	5	5	2	0	0	1
Ascomycota	1	5	3	0	0	0	0
Tracheophyta	0	1	0	0	0	0	0
TOTAL	**34**	**43**	**57**	**67**	**109**	**78**	**99**
Average	**44.7**			**88.3**			
Standard Deviation	**11.6**			**19.2**			

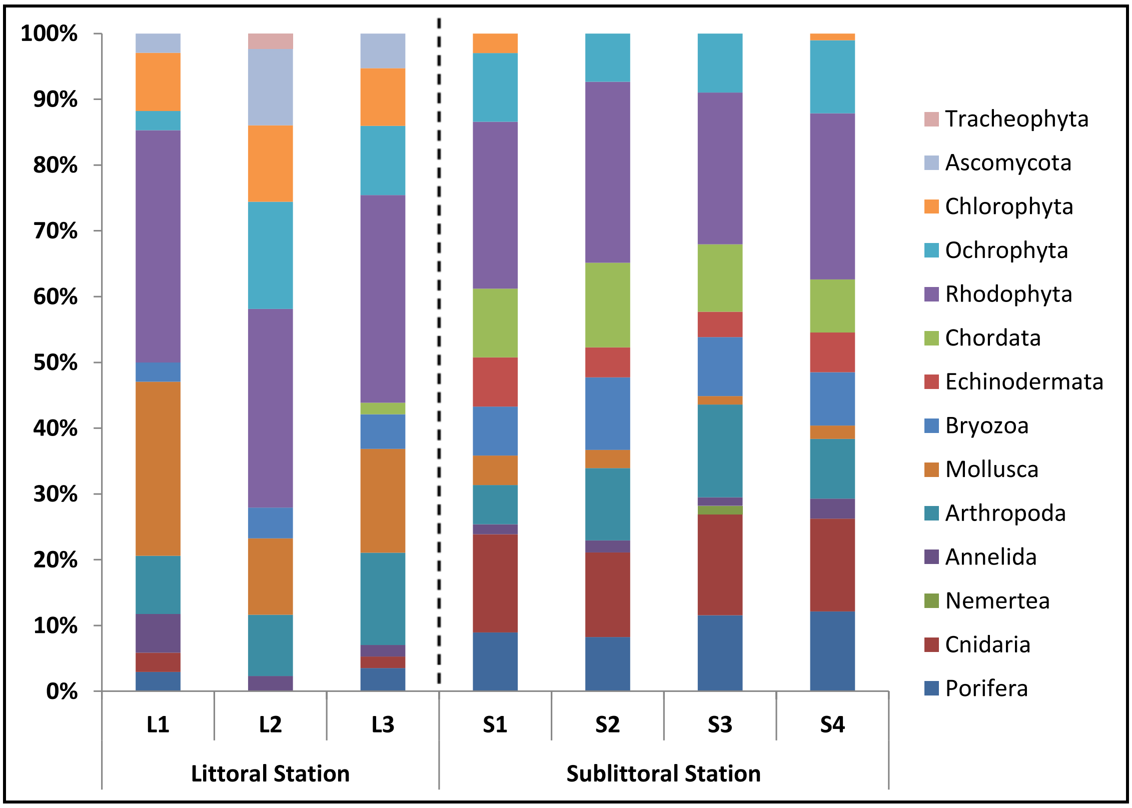


Figure 6.8 Distribution of Species per Phyla and Station

6.3. Multivariate Analyses

6.3.1. Littoral Stations

Multivariate analyses (PRIMER; Clarke and Warwick, 1994) of the littoral stations indicated some statistical separation of biotopes such as *LR.FLR.Lic.Pra* and *LR.HLR.FR.Coff/IR.MIR.KR.Ldig.* While the biotopes *LR.HLR.MusB.Sem, LR.HLR.FR.Mas, LR.LLR.F.Asc.FS* and *LR.MLR.BF.Fser.R* could not be statistically distinguished (Figure 6.9).

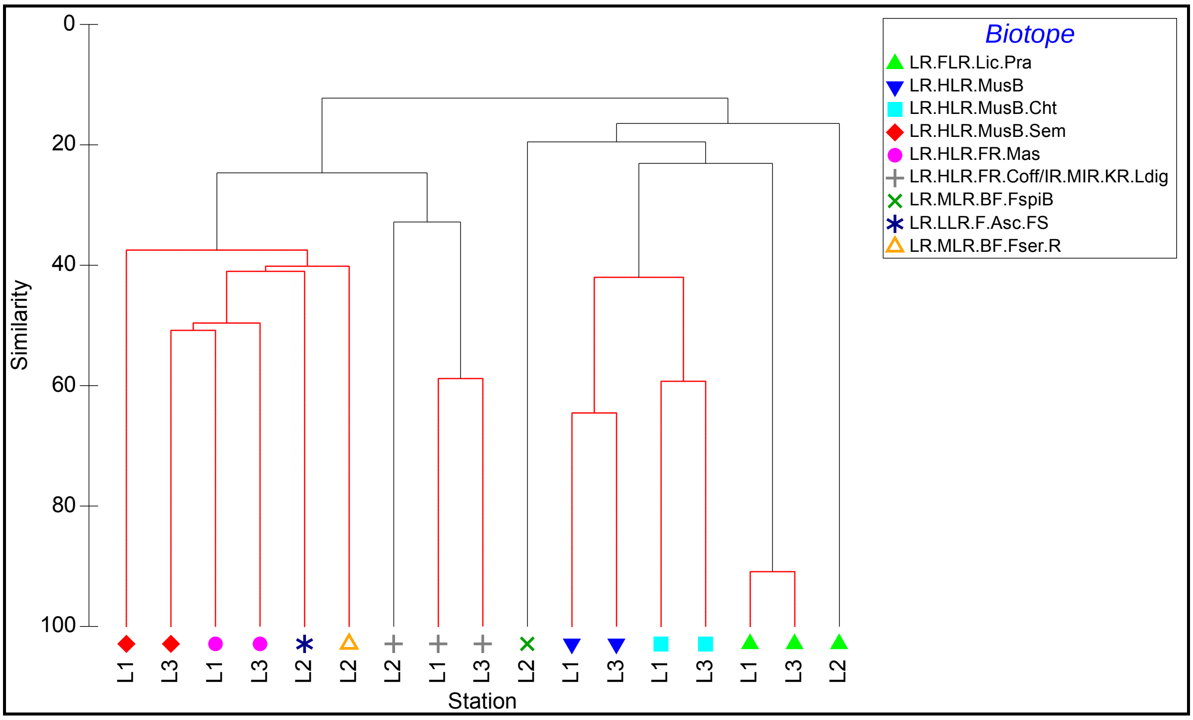


Figure 6.9 Dendrogram of Biotopes Recorded at the Littoral Stations

The MDS plot indicated that throughout the Littoral stations, greater similarities existed between the exposed stations L1 and L3, than compared with the more sheltered station L2, although vertical zonation indicated similar biotopes throughout all three stations (Figure 6.10). Station L2 was located within a gully where water movement/wave exposure was limited to the northeast direction only area and probably responsible for the absence of sponge and cnidarian species.

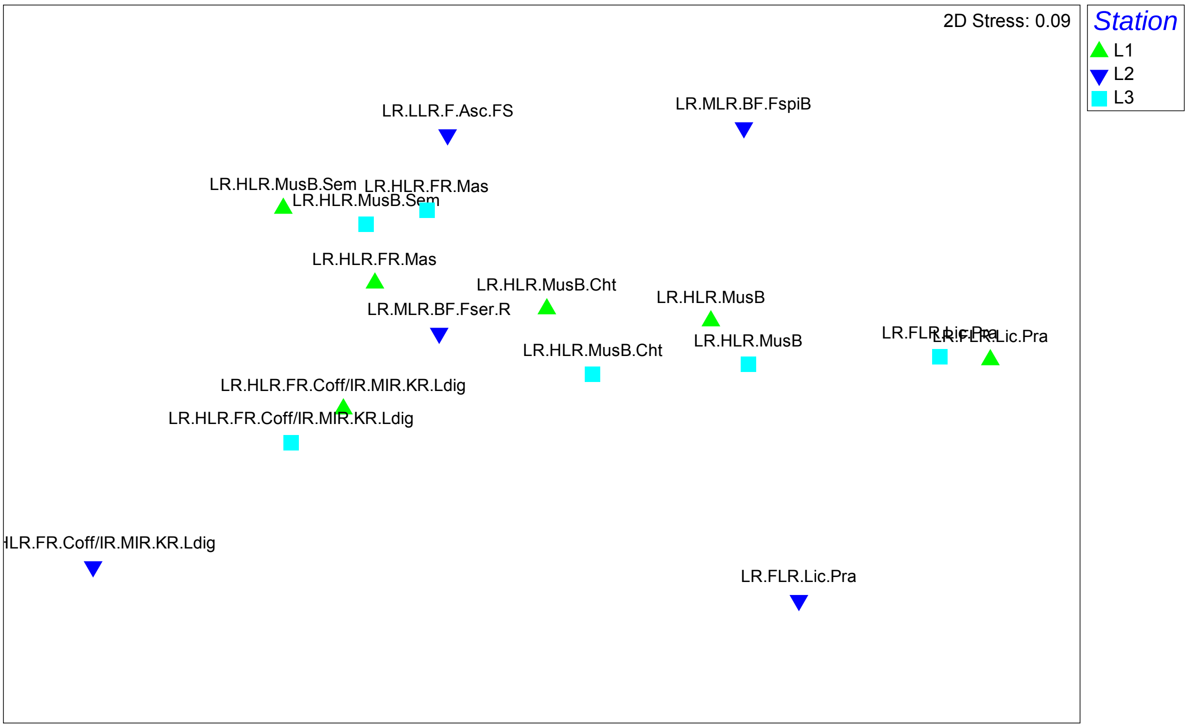


Figure 6.10 MDS of Biotopes Recorded at the Littoral Stations

6.3.2. Sublittoral Stations

All four stations in the sublittoral areas were characterised by *Laminaria digitata* forest in the shallows (*IR.MIR.KR.Ldig.Ldig*), below this zone, three of the four stations recorded the biotope *IR.HIR.KFaR.FoR.Dic.* The deepest extent of the reef was the most variable, with three different biotopes recorded at the four stations, with only Sublittoral Stations S1 and S3 characterised by the same biotope of 'Mixed turf of bryozoans and erect sponges with *Sagartia elegans* on tide-swept circalittoral rock'.

The cluster and MDS plot for the sublittoral stations indicated some statistical separation of biotopes, most notably that of *IR.MIR.KR.Ldig.Ldig*, with all four occurrences being statistically indistinguishable (Figure 6.11). Stations S2 and S4 showed statistical separation of biotopes from the other stations, whilst these two stations were also statistically indeterminate within each depth zone (Figure 6.12). The subtle variations in biotope composition geographically is probably due to differences within the seabed profiles and morphology.

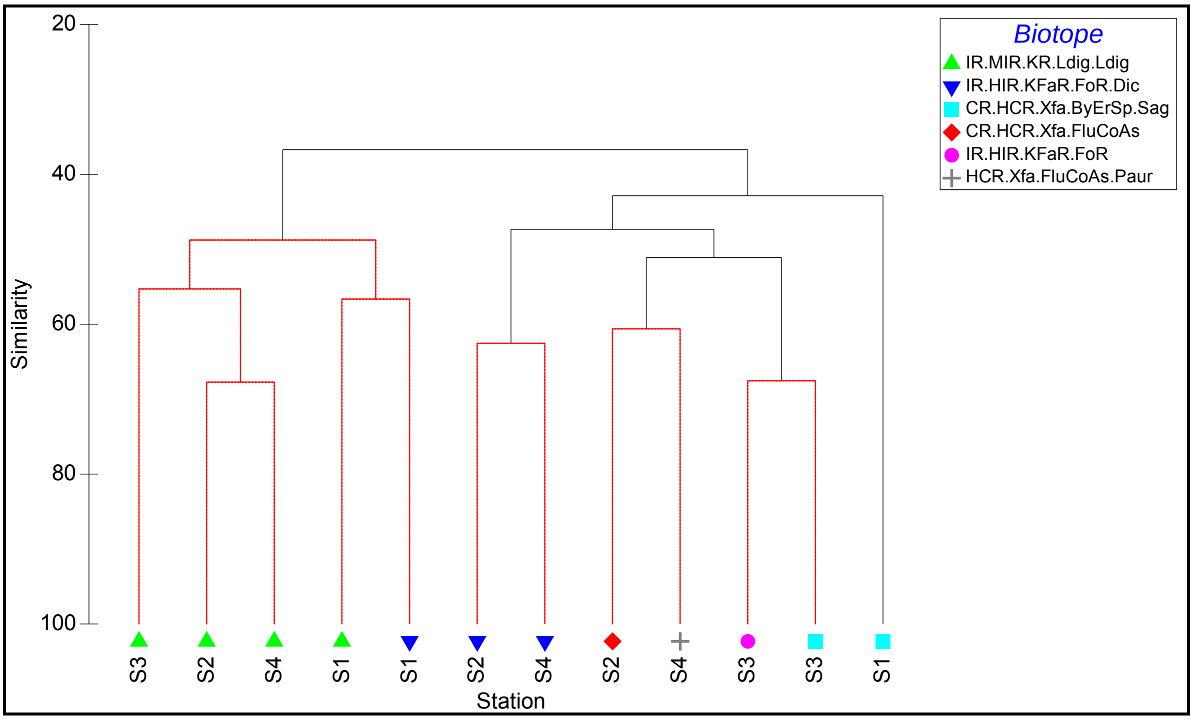


Figure 6.11 Dendrogram of Biotopes Recorded at the Sublittoral Stations

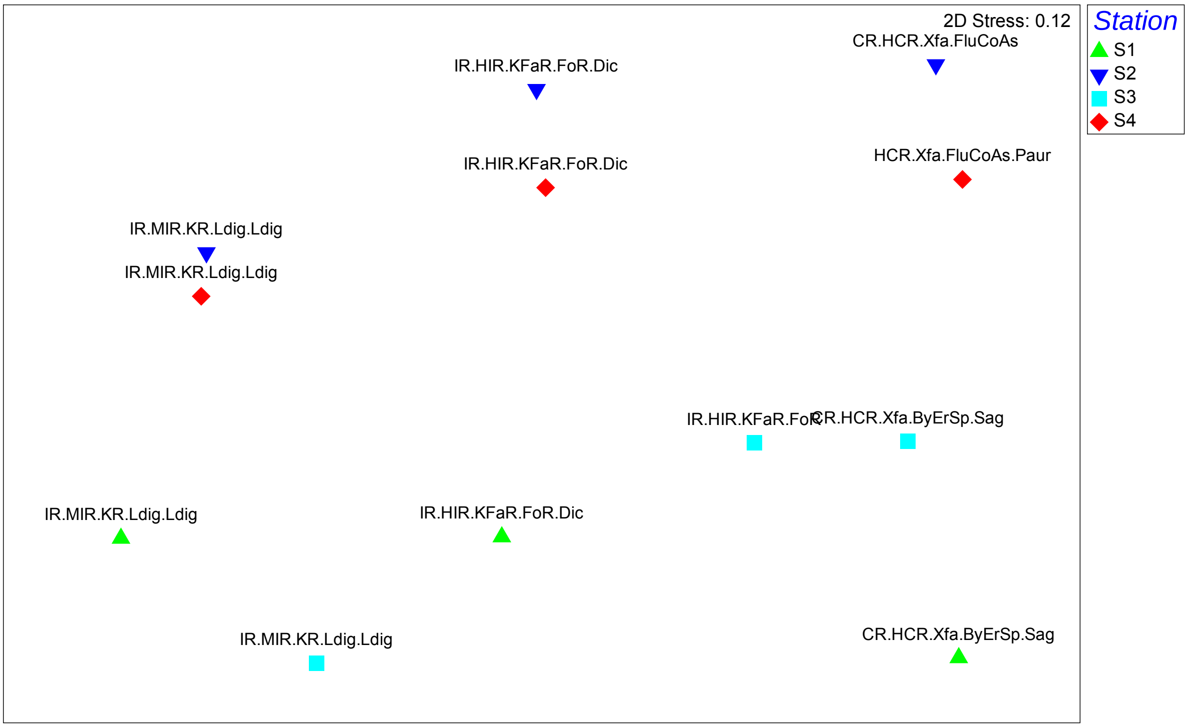


Figure 6.12 MDS of Biotopes Recorded at the Sublittoral Stations

7. Conclusion

The results showed clear separation between the littoral and sublittoral stations in terms of species composition and biotopes with on average of twice as many species found in the sublittoral environment. This survey has collected semi-quantitative data from two moderately exposed littoral sites (L1 and L3) and a sheltered site (L2). L1 was slightly modified by shading, wave surge and nitrogenous enrichment and the L3 uppershore biotope was similarly enriched by roosting seabirds. The photographs and data collected may act as a comparison, against which future gross changes could be qualitatively assessed.

In the sublittoral zone, four sites were surveyed and similar semi-quantitative data collected along with photographs. Overall, all sublittoral environments indicated the presence of significant siltation in the deeper zones. However, the faunal populations of both littoral and sublittoral zones showed well represented and moderately diverse habitats containing many of the common species found along the Irish Sea coastline. Stations S2 and S3 indicated greater habitats similarity recorded within their vertical zonation.

The result of a moderately high diversity is similar to that recorded in the macro-invertebrate population previously recorded within the soft sediments north of this island as part of the outfall route baseline surveys (BSL, 2013), and is probably indicative for the survey area as a whole. The presence of significant siltation at all locations within the survey would indicate that this phenomenon is ubiquitous in the waters surrounding this island and has subsequently created a habitat with limited sensitivity to suspended sediments in this area. Whilst, siltation levels are high in the sublittoral environment a significant increase in suspended sediment, particularly during the summer months during peak algal growth, might cause some damage to the algal biotopes present through reduced light penetration and availability. However, the moderately strong tidal currents experienced in this area are sufficient to prevent the deposition of significant silt material which might degrade the sublittoral benthic biotopes through smothering and burial of the infralittoral and circalittoral communities. No species of particular conservational interest were noted during the surveys and no rare or fragile biotopes recorded.

8. References

Benthic Solutions Limited, 2013. Baseline benthic environmental survey along the proposed Greater Dublin Drainage scheme outfall locations. Survey data reported within Environmental Impact Statement.

Clarke, K. R. and Warwick, R. M. (1994). Similarity-based testing for community pattern: the 2-way layout with no replication. Mar. Biol. 118: 167-176.

MERC (2010). Irish Sea Reef Survey Project Report. Carried out by MERC on behalf of National Parks and Wildlife Service, Department of Environment, Heritage and Local Government.

MERC (2012a). Intertidal Reef Survey of Lambay Island SAC and SPA, Rockabill Island SPA, Ireland's Eye SAC, Dalkey Islands SPA and Muglins. Carried out by MERC on behalf of the Marine Institute in partnership with National Parks and Wildlife Service, Department of Environment, Heritage and Local Government.

MERC (2012b). Subtidal Reef Survey of Lambay Island SAC and SPA, Rockabill Island SPA, Ireland's Eye SAC, Dalkey Islands SPA and Muglins. Carried out by MERC on behalf of the Marine Institute in partnership with National Parks and Wildlife Service, Department of Environment, Heritage and Local Government.

Appendix C IWDG Report on Marine Mammals

Greater Dublin Drainage Project, Co. Dublin

Report on Marine Mammal Surveys

Final Report

Rossa Meade, Joanne O'Brien and Simon Berrow

Merchants Quay
Kilrush, Co Clare

http://consulting.iwdg.ie

April 2017

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EXECUTIVE SUMMARY

A marine mammal survey using visual and static acoustic monitoring methodology was conducted between March 2015 and September 2015 off Loughshinny and March 2015 and March 2017 off Portmarnock, North Co. Dublin as part of the Greater Dublin Drainage (GDD) project. The study aimed to assess the distribution, habitat use, seasonal occurrence and behaviour of marine mammals in the study area and if possible derive density and abundance estimates for harbour porpoise.

Three integrated methods were used in line with best practice, these were land-based vantage point surveys, boat-based transects and Static Acoustic Monitoring. Visual surveys were only carried out in favourable weather conditions (Beaufort sea-state <2 and visibility >6km). Monthly land-based surveys were conducted from sites at Loughshinny and Howth Head. Single platform line-transect boat surveys were conducted bi-monthly following a pre-determined route and standardised design. Static acoustic monitoring using C-PODs was conducted for six months at a single site off Loughshinny and for 24 months at three locations off Portmarnock.

The software programme DISTANCE was used for calculating detection functions, which is the probability of detecting an object a certain distance from the track-line and used to calculate the density of animals on the track-line of the vessel. A detection function was calculated from each boat survey, providing sufficient number of sightings were made to provide a robust estimate.

All C-POD data were analysed using only high probability clicks, which reduced the possibility of false positives (i.e. recorded as present when there were in fact no dolphins or porpoise present). Harbour porpoise detections were extracted as detection positive minutes per day and were analysed statistically for temporal and geographical trends. Porpoise detections were analysed with respect to season (spring, summer, autumn and winter), diel cycle (day and night-time), tidal state (ebb, flood, slack high, slack low) and tidal phase (spring, neap) at a resolution of one hour. A Generalised Linear Mixed Model (GLMM) was fitted to the binomial data using the glmer function in the *lme4 package* developed for the statistical program *R*. Details of individual harbour porpoise click trains were extracted and analysed.

Six monthly land-based surveys were conducted from the Martello Tower at Loughshinny. Twenty hours of land-based monitoring was conducted over six survey days. The weather was favourable throughout all surveys with no swell, sea state ≤2 and visibility of 6-20km. Precipitation was recorded on two days in July and September. Marine mammals were sighted on 86% of land-based survey days

with harbour porpoise present on 67% and seal species present on 67% of days. Eleven (11) sightings of harbour porpoise (23 individuals) and 12 seal sightings (12 individuals) were recorded. Ten (10) of the seal sightings were identified as grey seals while two could not be identified to species level. Harbour porpoise numbers peaked in September, however there was no peak in seal numbers.

Land-based survey effort conducted from Howth Head amounted to around 144 hours (23 surveys) between 18 March 2015 and 11 March 2017. Environmental conditions were favourable with no swell, sea-state <2 for 99% and visibility >6km for 97% of survey effort. Marine mammals were sighted on 100% of survey days with grey seals present on 100% and harbour porpoise present on 83% of days. Two-hundred and sixty (260) sightings of grey seals totalling 325 individual animals, comprising 323 adults and two juveniles, were recorded with an average group size of one individual. Sighting rate for grey seals was greatest in April 2015 although high numbers were also recorded in September 2015, January 2016 and October 2016. One-hundred and sixty-seven (167) sightings of harbour porpoise totalling 293 individual animals were recorded comprising 237 adults, 41 juveniles and 15 calves. Mean group size for harbour porpoise from land-based watches was two individuals. Calves were present between September and November 2015 and in August 2016. Harbour porpoise sighting rate was greatest between August and January 2015 and August and October 2016 with mean group size also increasing during this period.

A total of 897km of track-line was surveyed during eleven independent surveys, carried out from April 2015 to January 2017. Environmental conditions were favourable with visibility of >6km for 91% and swell of <1m for 100% of survey effort. Sea-state <2 was recorded for all of eight of the eleven surveys however sea-state of >2 was recorded for 8% of the survey carried out in April 2015, 36% in June 2015 and 46% during the December 2016. Marine mammals were sighted on all survey days with a total of 192 sightings of 251 individual animals. Four marine mammal species were recorded; harbour porpoise, grey seal, harbour seal and minke whale. Seals were recorded on 91% of survey days with the highest numbers of individuals recorded in November 2015. Grey seal sightings were distributed evenly across the study area and all sightings recorded were of single adults. Two harbour seals were sighted, one each in April and August 2015, both of which were of single adults. Single minke whales were recorded in June 2015 and August 2016. Harbour porpoise were recorded on 100% of survey days with the greatest number of sightings recorded in November 2015 and August 2016. Group size also increased between August and November 2015 and in August 2016 with calves recorded during these three surveys. The lowest number of sightings were in June 2015, June 2016 and December 2016.

Density estimates for harbour porpoises were calculated for seven of the eleven boat survey days but not for surveys in June 2015, March 2016, June 2016 and December 2016 as the total number of sightings during each survey were less than 10, which is considered too few to derive a reliable density estimate. Mean group size was greater in August 2015 and August 2016 compared to other surveys, suggesting a peak occurred in late summer, which was consistent with land-based observations. Within the area surveyed, the density of harbour porpoise varied from 0.61 to 2.29 per km^2 per survey with a mean density of 1.32 harbour porpoise per km^2, which is high for coastal sites in Ireland and similar to previous surveys in the area. Density estimates increased during summer and early winter (August-November) in 2015 and in August 2016, with lowest densities recorded in April 2015 and February 2016.

A total of 189 days of Static Acoustic Monitoring data was collected off Loughshinny. Harbour porpoise detections were recorded on 100% of days. The number of Porpoise Positive Minutes (PPM) ranged from 8 to 475 per day with a mean of 139 PPM. Results showed that season had a significant effect on the presence of porpoises at the site with a peak in autumn. Most porpoise detections were recorded during early morning suggesting they were more active at the site during night-time and in the early morning. Tidal cycle was not found to be a significant factor but tidal phase was, with highest detections during spring cycles. A total of 100,421 porpoise click trains were recorded at Loughshinny over the six month deployment, with 95% (95,509 trains) consistent with foraging, highlighting Loughshinny as a very important feeding site.

Static Acoustic Monitoring was carried out at three sites simultaneously off Portmarnock for a total duration of 750 days, between March 2015 and March 2017. All three sites were along the proposed route of the discharge pipe ranging from 2.5km (GDD1) to 5km (GDD3) offshore. Detections were recorded on average between 96-99% of days at each site. The number of PPM ranged from 3690 to 25089 per year between sites, with the mean ranging between 41.3 to 94.3 per day. The highest detection rate was recorded across the autumn and winter months, during the hours of darkness (incl. at dawn and dusk), during high tide and at the furthest offshore station (GDD3) during the neap cycle of the tidal phase. The site in the middle of the SAM array (GDD2) had the highest overall detection rate.

This survey, carried out over two years, using a range of survey techniques, has clearly demonstrated that North County Dublin is a very important area for marine mammals. The waters off Loughshinny are an important feeding area for harbour porpoise, especially during the autumn months, and at night and during early morning and spring tides. The area off Portmarnock is important for both grey seals and harbour porpoise, both of which were recorded throughout the year. Grey seals were regularly present in small numbers and distributed throughout the survey area. Peaks in sightings from Howth Head occurred during spring and autumn, coinciding with pupping and post-moult periods at the local well-known breeding and haul out sites at Lambay Island, Skerries and Irelands Eye. Harbour porpoise were also distributed throughout the site, with numbers increasing during late summer and autumn in both 2015 and 2016, which may be due to seasonally abundant food sources such as sprat, herring, *Trisopterus spp.* and gadoid species. Lower numbers were recorded during late spring/early summer (March-June) which may be linked to an offshore movement of this species before calving. Density estimates of harbour porpoise were high compared to coastal sites elsewhere in Ireland, and emphasizes the importance of this site for this species as these were some of the highest densities for this species recorded in Ireland to date. Static Acoustic Monitoring provided a high resolution (hourly) insight into the use of this habitat across time and throughout the day and night. Harbour porpoise were present almost daily at Portmarnock but were strongly influenced by seasonal, diel and tidal factors.

Harbour porpoises and grey seals are both listed on Annex II of the Habitats Directive and are thus entitled to strict protection, including their habitats. Extreme care must be taken to ensure the proposed development does not degrade this habitat or cause undue disturbance to marine mammals.

INTRODUCTION

The Irish Whale and Dolphin Group (IWDG) were sub-contracted by Techworks Marine to establish the extent and nature of marine mammals in north County Dublin in connection with the Greater Dublin Drainage (GDD) project. The GDD project proposes a new marine outfall pipe discharging 1km north-east of Ireland's Eye in north Dublin and 6km out to sea. The discharge is within the recently designated Rockabill to Dalkey Island Special Area of Conservation which lists harbour porpoise as a qualifying interest. The study aimed to assess the distribution, habitat use, seasonal occurrence and behaviour of marine mammals in the study area and derive density and abundance estimates for harbour porpoise. The results of this survey will be used to inform the most appropriate construction methodology for the marine outfall pipe while minimising any impacts on marine mammals. The survey commenced in March 2015 for two years within two defined study areas; i) Portmarnock and ii) Loughshinny. The Portmarnock site was monitored for two years while Loughshinny for six months from March 2015.

The survey used three independent methods: land-based, boat-based and Static Acoustic Monitoring (SAM) to ensure a robust assessment was carried out. This is in line with best practice which recommends a combination of visual and acoustic techniques especially if harbour porpoise (*Phocoena phocoena*) are known to occur in the area, as they can be very difficult to observe in even moderate sea conditions. Land-based observations were conducted from vantage points with a good field of view over the core study area, which avoided the possibility of disturbance and potential displacement during boat-based surveys (David, 2002). Boat-based line transect surveys were conducted to describe the broader -scale distribution and to derive density and abundance estimates. Boat-based surveys can cover a large area including sites which are difficult to observe from land even with good optics. However, all visual monitoring techniques can be influenced by variables such as sea-state (Evans and Hammond, 2004; Teilmann, 2003; Palka, 1996; Clarke, 1982), observer variability (Young and Peace, 1999), optics and height above sea level. Evans and Hammond (2004) recommended that visual surveys should generally not be carried out in sea-states above Beaufort 2, as the probability of detecting animals is markedly reduced above this. Static Acoustic Monitoring (SAM) is a very useful tool for monitoring small cetaceans since it can be carried out without these visual constraints, and does not influence their behaviour. SAM involves the detection and recording of odontocete vocalisations or echolocation clicks and is especially useful for defining fine-scale habitat use. Additionally, SAM can be used to study behaviour, such as foraging, approach behaviour and communication. SAM however is spatially constrained as the detection distance for harbour porpoise can be as little as 200-300m and it cannot provide information on density or abundance but can provide robust information on spatial and temporal trends. This report provides a detailed exploration of marine mammal activity off Loughshinny Co. Dublin over a 6-month period and Portmarnock Co. Dublin over a 24-month period.

METHODS

2.1 Study Area

The study area in north County Dublin, where the proposed outfall pipe will be constructed and operated is adjacent to a number of high nature conservation sites for marine mammals, protected under EU legislation. One of the three Special Areas of Conservation (SACs) which include harbour porpoise as a qualifying interest; occurs within the study area. Rockabill to Dalkey Island SAC (Site Code: 003000) was designated in 2012 while Lambay Island SAC (Site Code: 000204) with both grey and harbour seal as qualifying interests also lies within the study area (Figure 1). The boundaries of the current survey included both these protected sites and adjacent waters including the route of the proposed outfall pipe.

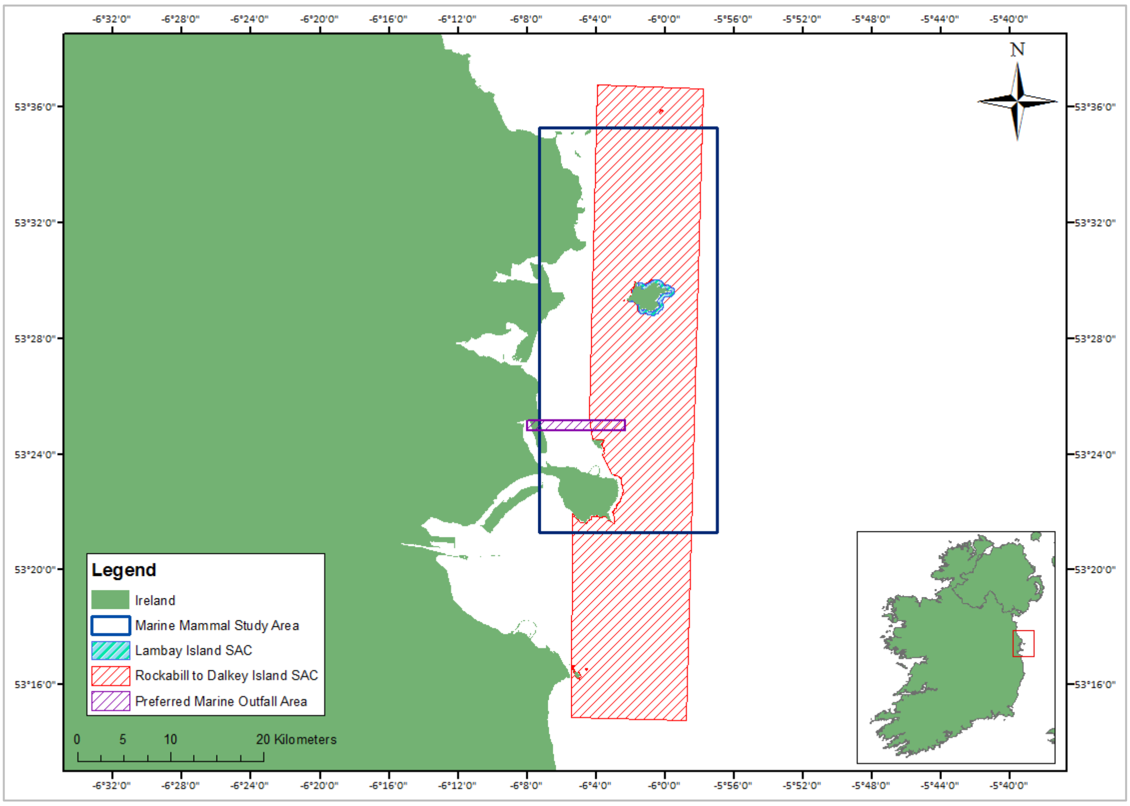


Figure 1. Study area for GDD Marine Mammal Surveys showing the GDD Preferred Marine Outfall Area and SACs within the Study Area ©National Parks and Wildlife Services SAC

2.2 Land-based Surveys

2.2.1 Land-based Observation Site

Land based observations were carried out from the Martello Tower at Loughshinny and from the north-eastern cliffs of Howth Head. Both sites were selected as a suitable vantage points for land-based observations based on their height above sea level and the field of view over the survey area (Figure 2).

Figure 2. Location of Loughshinny and Howth Head land-based survey sites

2.2.2 Land-based Methodology

Land based observations were carried out for a duration of six months from Loughshinny and 24 months from Howth Head. Quantified effort watches, where time spent watching and weather conditions are recorded, were carried out once a month during suitable weather conditions defined as Beaufort sea-state <2 and in visibility of >6km. Each watch lasted for 420-560 minutes (7-8 hours) and were carried out in 100 minute samples in accordance with IWDG standardised methodology for their Inshore Cetacean Monitoring Programme (Berrow et al. 2010). Two observers were present at the observation site to maximise search effort and assist in tracking as well as compliance with health and safety.

Visual observations were made using a tripod-mounted scope (Opticron) equipped with a 20-60x wide-angle eyepiece and handheld binoculars (7 x 50; Opticron). Environmental conditions (sea-state, wind and weather variables) were recorded at the start of each observation and every 30 minutes throughout the watch or when weather conditions changed. During watches, two types of visual observations were conducted: scan sampling and focal follow observations (Mann, 1999).

2.2.2.1 Scan Sampling

During scan sampling, the study area (up to 5km from the observation site) was systematically scanned using the telescope (observer 1) and binoculars (observer 2). For each sighting species, group size, group composition, location, direction of travel and behaviour were recorded. The geographical location of each sightings was recorded using a T107 Leica theodolite or, when the use of the theodolite was restricted, by estimating distance (km) and bearing (degrees) from the observation site using reticule binoculars.

2.2.2.2 Focal Follow Observations

Harbour porpoise were tracked using a T107 Leica theodolite to determine their habitat use. During each surfacing the group size, composition, location and direction of travel were recorded along with the behaviours described by Mann (1999). Focal follow observations or tracks began at the first sighting of harbour porpoise and continued for as long as possible. Tracks ended when individuals either moved out of sight, weather conditions deteriorated or when darkness fell. If the use of the theodolite was restricted, location was determined by estimating distance (km) and bearing (degrees) from the observation site using reticule binoculars.

2.3 Boat-based Surveys

Conventional single line-transect marine mammal surveys were carried out aboard MV *Beluga* along a predetermined route. Four different routes were used; surveys 1-4 included coverage of the waters off Loughshinny while surveys 5-11 targeted the Portmarnock area after surveys had been completed off Loughshinny (Figure 3).

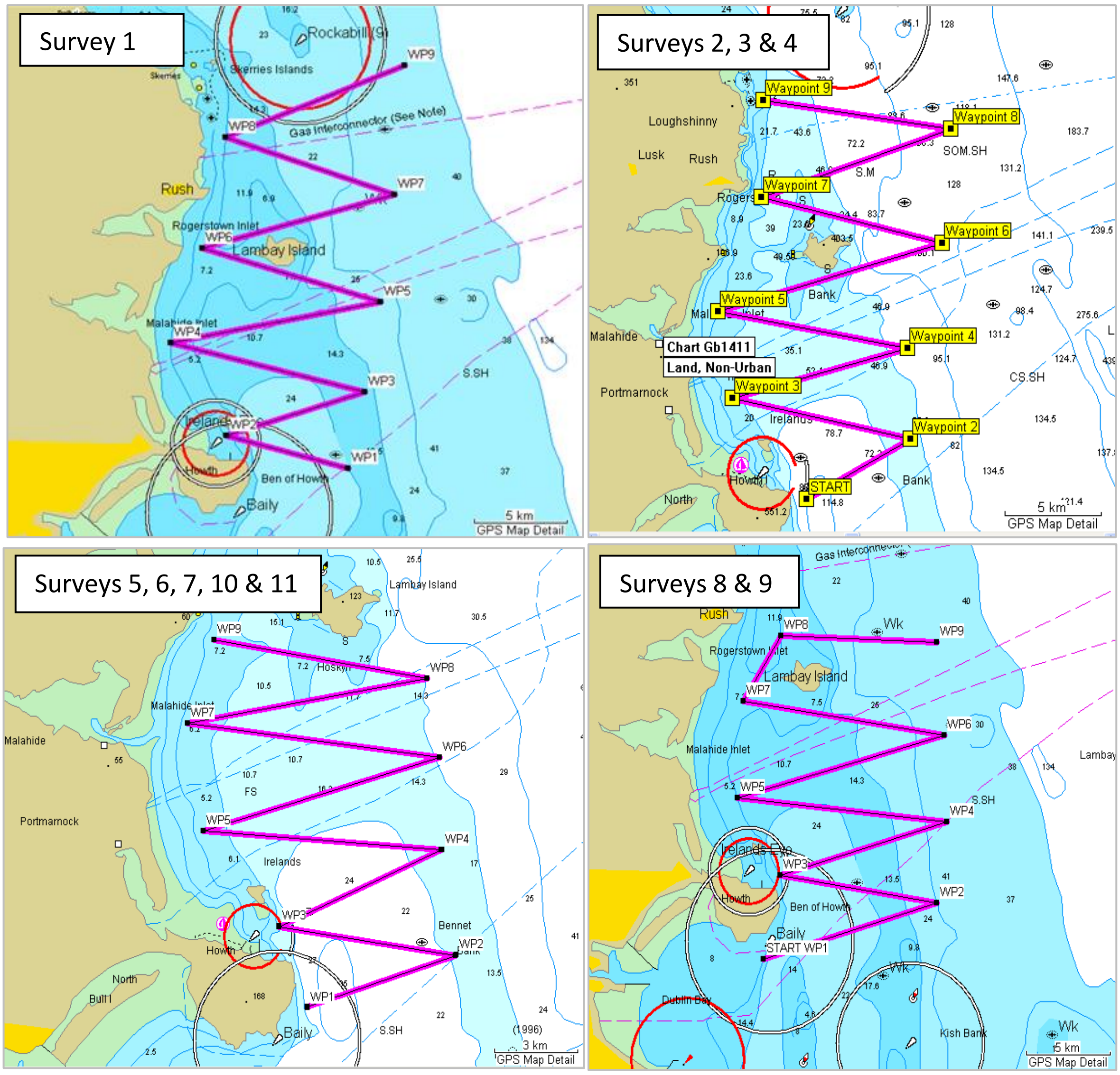


Figure 3. Line Transect Route for boat-based marine mammal surveys

2.3.1 Line Transect Methodology

Single platform line transect surveys were conducted every two months onboard a 13m cruiser with flying bridge, MV *Beluga* which has a platform height of 3.1m. Surveys were carried out in sea-state ≤2 and in visibility ≥6km. The vessel travelled at a speed of 9-10 knots, which was 2-3 times the typical average speed of the target species as recommended by Dawson et al. (2008). This helped minimise any potential missed sightings due to avoidance behaviour.

Three people were required on each survey; two primary observers and one operating the software programme LOGGER (©IFAW). The primary observers were positioned on the flying bridge, which provided an eye-height above sea-level of between 4-5m depending on the height of the observer. Primary observers scanned with the naked eye from dead ahead to 90º to port or starboard depending on which side of the vessel they were positioned. During all transects, the position of the survey vessel was tracked continuously through a GPS receiver fed directly into LOGGER software via a laptop. Survey effort, including environmental conditions (sea-state, wind strength and direction, glare etc.) were recorded directly onto LOGGER every 15 minutes.

When a sighting of a marine mammal was made, the position of the vessel and the angle and distance of the sighting from the track of the vessel were recorded. The angle to the sighting from the vessels course was recorded via an angle board attached to the vessel immediately in front of each observer. Binoculars (Opticron 10x50 Marine, with graduated reticle) or a range-finder stick (JNCC approved) were used to estimate distance to sighting, while the binoculars were used to confirm species identification, group numbers, composition and behaviour. This data was communicated to the LOGGER operator in the wheelhouse via a VHF radio. The team of three observers rotated positions between each side of the vessel and LOGGER every hour to avoid bias on one side of the track line or a decline in sighting detections due to fatigue.

2.4 Static Acoustic Monitoring

2.4.1 Study Area

Two CPODs were moored in one site (one as a control) around 3km east of Loughshinny, Co. Dublin and approximately 6km north of Lambay Island (Figure 4). Additional deployments took place off Portmarnock, Co. Dublin just north of Ireland’s Eye. Three locations, (GDD1, GDD2 and GDD3) were monitored here with GDD1 closest to land at 2.5km offshore, GDD2 was 1km to the east of GDD2, while GDD3 was a further 1.5 km from GDD2 and thus 5km offshore (Figure 4).

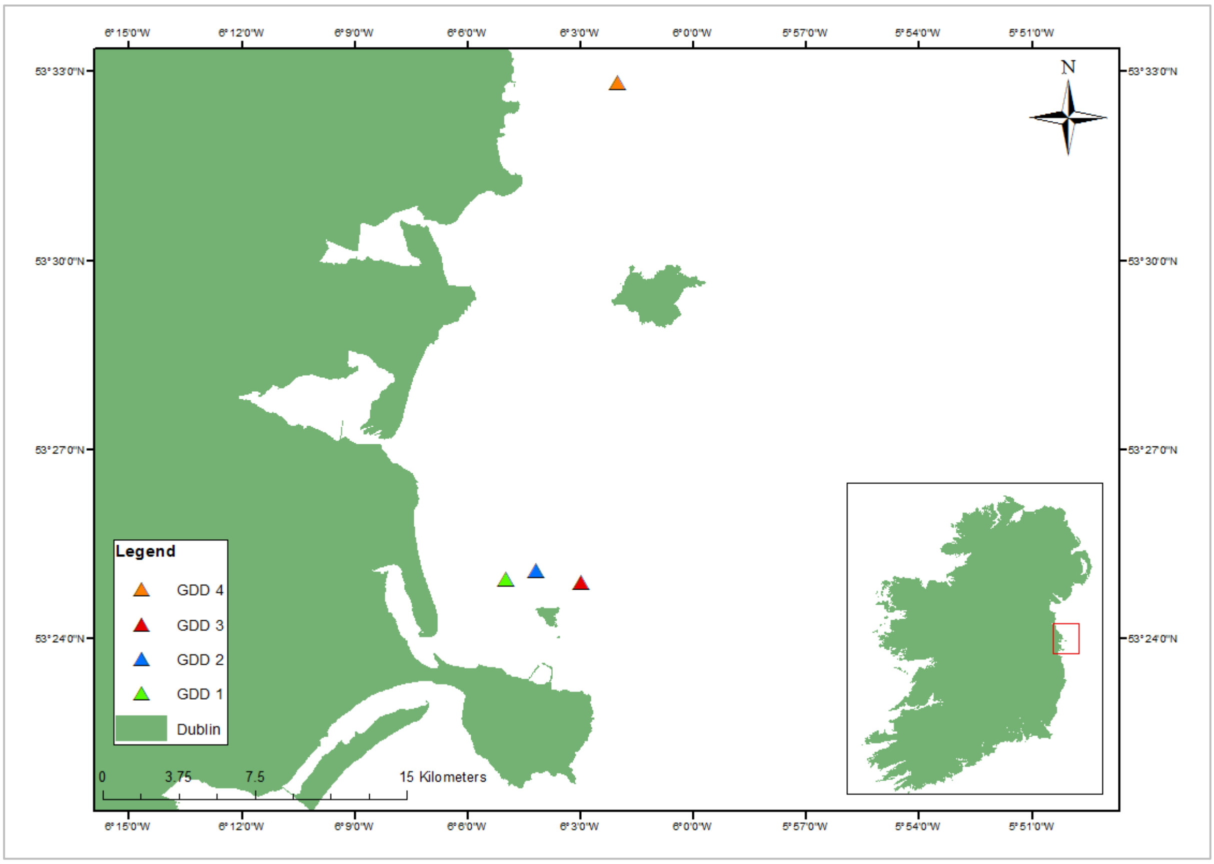


Figure 4. Map of deployment locations of C-PODs off Portmarnock (GDD1, GDD2 and GDD3) and Loughshinny (GDD4)

2.4.2 Static Acoustic Monitoring (SAM) Equipment

2.4.2.1 C-PODs

Once deployed at sea, the C-POD operates in a passive mode and is constantly listening for tonal clicks within a frequency range of 20 to 160 kHz (Figure 5). When a tonal click is detected, the C-POD records the time of occurrence, centre frequency, intensity, duration, bandwidth and frequency of the click (Chelonia Ltd). Internally, the C-POD is equipped with a Secure Digital (SD) flash card, and all data are stored on this card. Dedicated software, CPOD.exe, provided by the manufacturer, is used to process the data from the SD card when connected to a PC via a card-reader. This allows for extraction of data files under pre-determined parameters, as set by the user. C-PODs also record temperature at its deployment depth. It should be noted that the C-POD does not record actual sound files, only information about the tonal clicks it detects. The C-POD is a sound pressure level detector with a threshold of 1Pa peak to peak at 130 kHz, with the frequency response shown below (Figure 6, www.chelonian.co.uk). An estimated detection distance of 797.6m ±61m (75% of groups recorded<400m) for C-PODs and bottlenose dolphins was generated in the Shannon Estuary, while distances estimates of 441m ±42m (92% <400m) were calculated for harbour porpoise in Galway Bay (O’Brien et al., 2013).

Figure 5. C-POD unit by Chelonia Ltd

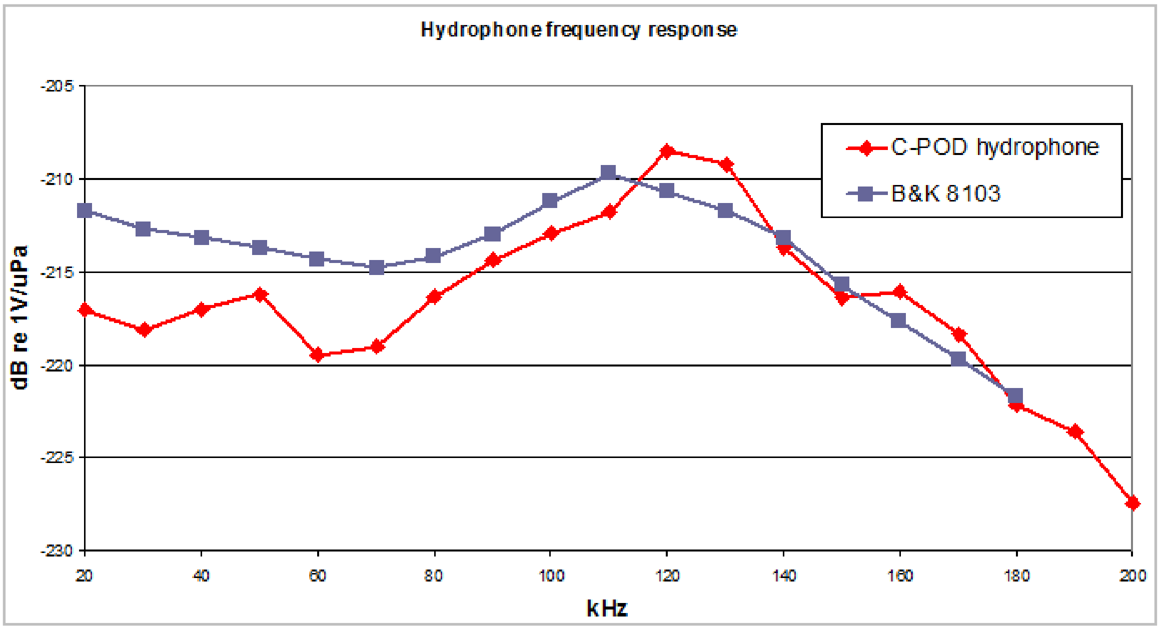
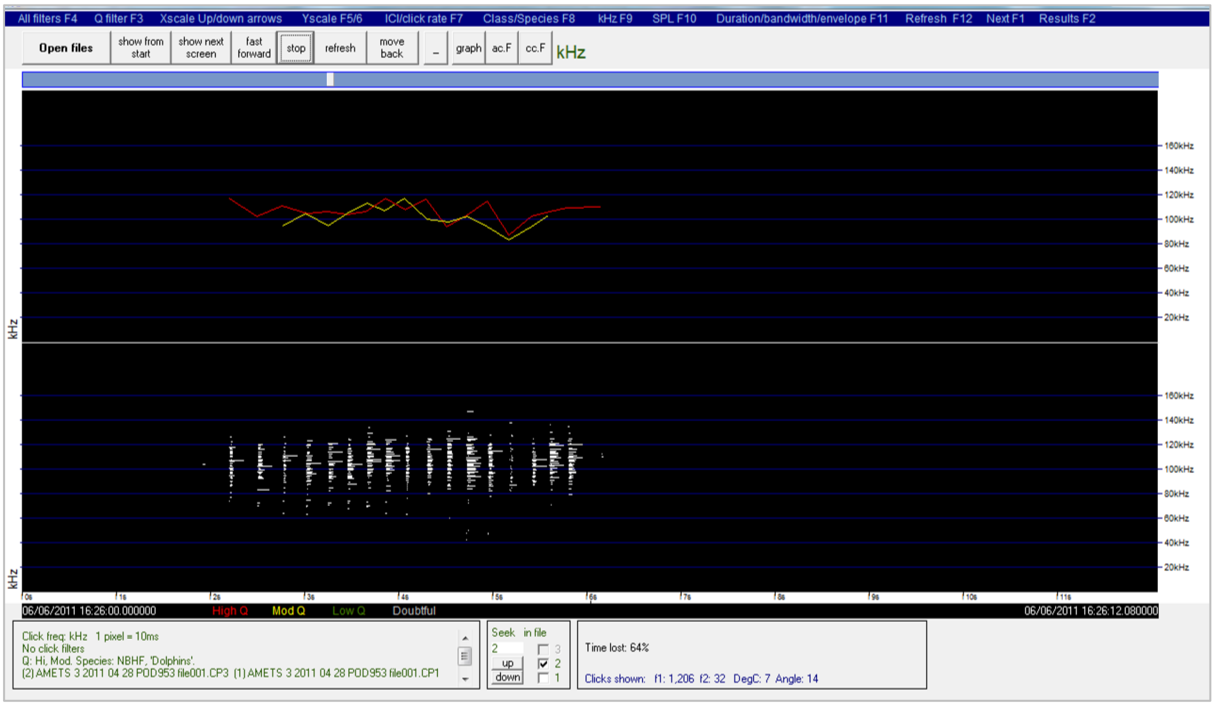


Figure 6. Threshold for detection across various frequency bands between 20 and 200 kHz for the C-POD (note 1Pa p-p is the SI unit for pressure and correctly represents the threshold) © Chelonia Ltd.

Through the C-POD.exe software, data can be viewed, analysed and exported. Additionally, the software can be used to change settings of individual SD cards. The C-POD.exe software includes automatic click train detection, which is continually evolving as Chelonia Ltd receives more feedback from their clients. C-POD.exe can be run on any version of Windows and requires an external USB card reader, which reads the SD card into the directory. Version 2.044 (October, 2014) was used for all analyses. C-POD.exe software allows the user to extract click trains under five classification parameters but only the porpoise like category was used for this analyses of the long-term dataset (Figure 7).



Click freq: kHz 1 pixel = 10ms
No click filters
Q: Hi, Mod. Species: NBHF, 'Dolphins'.
(2) AMETS 3 2011 04 28 POD953 file001.CP3 (1) AMETS 3 2011 04 28 POD953 file001.CP1

Time lost: 64%
Clicks shown: f1: 1,206 f2: 32 DegC: 7 Angle: 14

Figure 7. Screen grab of C-POD.exe, showing a harbour porpoise click train

2.4.3 C-POD Calibration

Calibration of C-PODs is important in order to facilitate a comparison of acoustic detection results collected by different units across various locations. Chelonia Ltd calibrates all units to a standard prior to dispatch. These calibrations are carried out in the lab under controlled conditions and thus Chelonia highly recommends that further calibrations are carried out in the field prior to their employment in monitoring programmes instead of further tank tests (Nick Tregenza, Chelonia Ltd., *pers. comm.*). Field calibrations are especially important where projects use several units aimed at comparing detections across a number of sites. If units of differing sensitivities are used, then these data do not truly reflect the activity at a site. For example, a low detection rate may be attributed to a less sensitive C-POD, with a lower detection threshold, which in turn leads to a lower detection range, while the opposite holds for a very sensitive unit. It is fundamental that differences between units are determined prior to their deployment as part of any project, to allow for the generation of correction factors which can be applied to the resulting data. Field trials should be carried out in high density areas in order to determine the detection function (O'Brien et al. 2013). The field calibration of new units should be carried out in conjunction with a reference C-POD, where a single unit is used solely for calibrations and is deemed a reference. This allows for the incidence where new units are acquired over the course of a project to be calibrated with the reference.

All units used to carry out SAM during the present project were deployed together in the Shannon Estuary prior to monitoring. C-PODs 549, 795, 796,950 and 1524 were deployed for a total of 13 days (Figure 33), and a second deployment consisting of C-PODs 169, 172, 173, 487 and 1147 for a total of 23 days (Figure 34). This allowed enough time to establish if sensitivity would be a confounding factor between units before been deployed as part of the present study.

Upon recovery of the units during monitoring, data were extracted under two categories, 1) NBHF (porpoise band) and 2) Other (dolphin band) using the C-POD.exe software (Version 2.044, October, 2014). These data were in the form of Excel.xlsx files using C.POD.exe software and analysed as Detection Positive Minutes (DPM) across hourly segments. Statistical analyses were carried out using the program *R* (R Development Core Team, 2011). All combinations of C-POD pairs were modelled using an orthogonal regression of DPM across hourly segments. This was compared to a null model, assuming no variation in C-POD detections, a = 0 and b = 1, and used to assess C-POD performance. An error margin of ±20% DPM per hour was plotted along the null model to distinguish between an acceptable level of variation in C-POD performance and problematic variation due to faulty or highly sensitive units (Tregenza *pers comm.).* From these graphs it is possible to determine successful or unsuccessful C-POD combinations. The mean intercept and gradient values of the orthogonal model for each C-POD pair were extracted and used to create centipede plots where, deviation from 0 on the horizontal axis, of mean intercept values and deviation from 1 on the horizontal axis, of mean gradient values indicated deviations from the null model. This was also used to identify if only one or two POD combinations were unsuccessful and also the extent of variability within the intercept and gradient values. Results were then used to highlight poor performing units or very sensitive units, if they existed and a correction factor can be generated and applied to the data.

2.4.4 Moorings

C-PODs were deployed as part of Techworks Marine's heavy weight mooring systems deployed to monitor current and turbidity over the same duration (Figure 8).

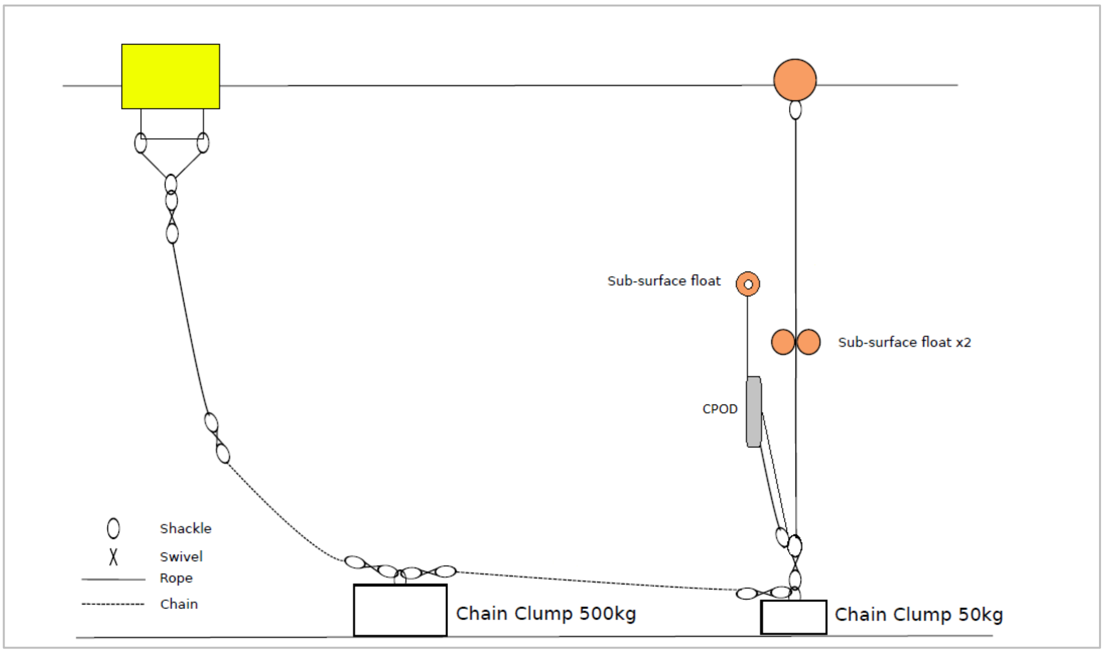


Figure 8. Heavy weight mooring deployed with C-POD attached (image updated from TechWorks Marine mooring diagram)

2.5 Data Analysis

2.5.1 Visual Observations

Visual survey data for land and boat-based surveys (i.e. sighting, effort and weather information) was compiled into a *Microsoft Access* database and *Microsoft Excel*. Maps of study areas and marine mammal sightings were created with ArcMap 10.2.

2.5.1.1 Density and abundance estimation

Distance sampling was used to derive a density estimate and to calculate a corresponding abundance estimate for the study area where possible. The software programme DISTANCE (Version 5, University of St Andrews, Scotland) was used for calculating the detection function, which is the probability of detecting an object a certain distance from the track-line. The detection function was used to calculate the density of animals on the track-line of the vessel. During this survey, we assume that all animals on the track-line were observed, i.e., that g(0) = 1, which is not correct but testing this would require a double platform survey which is not practical at small coastal sites. This assumption is consistent with previous small scale coastal sites in Ireland (see Berrow et al. 2014), to enable comparisons across sites. The DISTANCE software allows the user to select a number of models in order to identify the most appropriate for the data. It also allows truncation of sighting outliers when estimating variance in group size and testing for evasive movement prior to detection.

To calculate density, “day” was used as the sample regime with sightings used as sampling observations. Estimates of abundance and density obtained via the DISTANCE modelling process are presented for each survey day. The overall pooled abundance/density estimate was derived from data from both survey days combined. This was necessary in order to obtain sufficient sightings for a robust estimate using the DISTANCE model (the minimum required is 40—60; Buckland *et al.* 2001). In conducting this pooled analysis, we assumed that there were no significant changes in distribution within each site between sample days or any immigration into or emigration out of the site.

The data were fitted to a number of models available in the DISTANCE software. The Half-Normal model with cosine adjustments was found to best fit according to the Akaike Information Criterion delivered by the model. The recorded data were grouped into equal distance intervals of 0-25m, 25-50m up to 200m for the first survey and 0-30m, 30-60m up to 300m for the second survey and both surveys combined. The DISTANCE model determines the influence of cluster size on variability by using a size-bias regression method with the log(n) of cluster size plotted against the corresponding estimated detection function g(x).

A Chi-squared test associated with the estimation of each detection function is delivered by the DISTANCE model. If found to be statistically significant it indicated that the detection function was a good fit and that the corresponding estimates were robust. The proportions of the variability accounted for by the encounter rates, detection probability and group size (cluster size) are presented with each detection function. Variability associated with the encounter rate reflects the number of sightings on each track-line. The detection probability reflects how far the sightings were from the track-line and cluster size reflects the range of estimated group sizes recorded on each survey.

2.5.2 Static Acoustic Monitoring

All C-POD data were analysed using only high probability clicks. Both dolphin and porpoise detections were extracted as detection positive minutes per day (DPM), but only porpoise detections were analysed statistically. Dolphin detections were present but upon visual validation were found to be false positives. False positives are very short click trains, similar to a dolphin echolocation click train and can occur due to background sounds in the marine environment. As recommended by the manufacturers, a validation overview was carried out on the data, where 10% of all detected trains were visually inspected on cpod.exe to verify they were rightly assigned to harbour porpoise. Of this 10%, 1% of trains were classified as false positives, and therefore analysis of the porpoise detections proceeded with the classification of hourly variables into the following categories; season (spring, summer, autumn and winter), diel cycle (day and night-time), tidal state (ebb, flood, slack high, slack low) and tidal phase (spring, neap). The term PPM represents the number of minutes in a day or an hour that harbour porpoises were acoustically detected. Seasonal categorisations were assigned according to the seasons spring (February, March, April), summer (May, June, July), autumn (August, September, October) and winter (November, December, January). Data files in the format porpoise minutes per hour (PPM/h) were classified into day and night-time categories using local times of sunrise and sunset times, obtained from the U.S. Naval Observatory, who provide the sun rise and sunset data in a readily available format (www.aa.usno.navy.mil/data/docs/RS). Hourly data segments were further categorised into each of the four tidal states, where three hours were assigned to each state (one hour either side of the hour). Files were further split to correspond with tidal phase (spring and neap cycles) using admiralty data (WXTide 32) where two days either side of the highest tidal height was deemed spring, and two days either side of the least difference in tidal height between high and low tide was deemed neap, all other days were classified as transitional.

All data were analysed using the program *R*. *R* is a language and environment for statistical computing and graphics. It is free software, available at http://www.r-project.org/index.html. The software compiles and runs on a wide range of UNIX platforms, Windows and MacOS. *R* provides a wide variety of linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering and graphical techniques (*R* Development Core Team, 2011). *R* is designed around a true computer language, similar to the S language. The effective programming language includes conditionals, loops, user-defined recursive functions and input and output facilities. A Generalized Linear Mixed-effect Model (GLMM) was fitted to the binomial data using the glmer function in the lme4 package developed for *R*. C-POD ID number was included as a random factor to further take into account variability between units. Akaike's information criterion (AIC) and a histogram of fitted residuals were used as diagnostic tools for model selection. Wald chi-squared tests were computed for each variable and predicted proportions of Porpoise Positive Hours (PPH) were extracted across all levels and displayed as box plots using the HH package developed for *R*.

RESULTS

3.1 Land-based observations

Land-based monitoring was carried out monthly from 18 March 2015 until 11 March 2017. Just under 144 hours of monitoring was conducted over 23 independent surveys. Half day surveys were carried out from March to 07 September 2015 when Loughshinny was also surveyed in the same day. Full days surveys off Howth Head commenced on 19 September 2015.

3.1.1 Environmental Conditions

Environmental conditions were favourable during nearly all of the land-based surveys. Swell of less than 1m was recorded on 100% of survey days. Sea-state 0 was recorded for 23% of total survey effort, sea-state 1 for 54%, sea-state 2 for 21% and sea-state 3 for 1% (Figure 9). Visibility of 1-5km was recorded for 3% of total survey effort, 6-10km for 21%, 11-15km for 7%, 16-20km for 36% and greater than 20km for 32% (Figure 10).

Figure 9. Beaufort Sea-state (%) recorded during land-based surveys from Howth Head

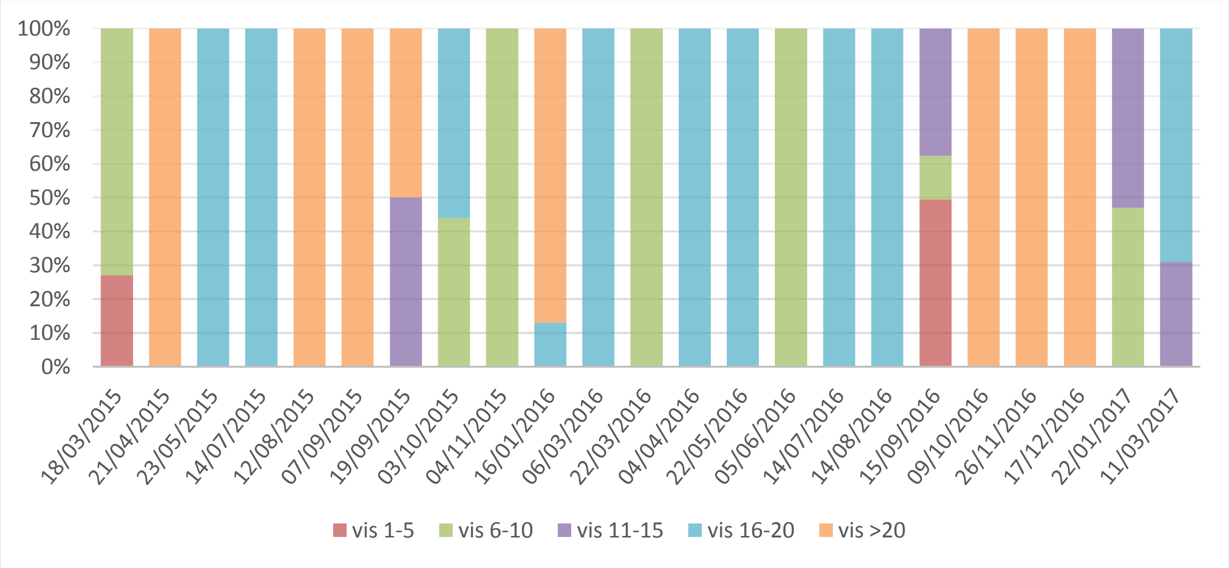


Figure 10. Percentage visibility (km) recorded during land-based surveys from Howth Head

3.1.2 Scan sampling marine mammal sightings

Marine mammals were sighted on 100% of survey days with harbour porpoise present on 83% and seals present on 100% of days. A total of two marine mammal species were recorded during the survey period; harbour porpoise and grey seal.

3.1.2.1 Harbour Porpoise

One hundred and sixty-seven (167) sightings of harbour porpoise were recorded totalling 293 animals (Table 1). A total of 237 adults, 41 juveniles and 15 calves were recorded and sightings had an average group size of two animals. Calves were only recorded between September and November 2015 and in August 2016.

Table 1. Summary of harbour porpoise sightings recorded during Howth Head land-based observations. Grey shaded rows show half-day surveys.

Date	No. sightings	No. animals	Adults	Juveniles	Calves	Range of group size
18/03/2015	0	0	-	-	-	-
21/04/2015	2	3	3	-	-	1-2
23/05/2015	0	0	-	-	-	-
14/07/2015	0	0	-	-	-	-
12/08/2015	1	4	3	1	-	-
07/09/2015	6	18	11	2	5	2-4
19/09/2015	15	28	22	1	5	1-5
03/10/2015	3	6	4	1	1	1-3
04/11/2015	11	19	14	3	2	1-5
16/01/2016	11	29	23	6	-	1-12
06/03/2016	2	2	2	-	-	1
22/03/2016	6	7	6	1	-	1-2
04/04/2016	0	0	-	-	-	-
22/05/2016	4	5	5	-	-	1-2
05/06/2016	1	2	2	-	-	-
14/07/2016	7	13	13	-	-	1-3
14/08/2016	43	66	59	5	2	1-3
15/09/2016	8	14	12	2	-	1-3
09/10/2016	31	60	43	17	-	1-4
26/11/2016	1	1	1	-	-	-
17/12/2016	5	5	5	-	-	1
22/01/2017	4	5	3	2	-	1-2
11/03/2017	6	6	6	-	-	1
TOTAL	**167**	**293**	**237**	**41**	**15**	

Sighting rate was calculated as the number of sightings and number of animals per hour of effort in order to compare the half day and full day surveys. Harbour porpoise sighting rate was consistently higher during late summer and autumn, between August and January 2015 and August and October 2016 (Figure 11). Group size also increased during this period (Table 1).

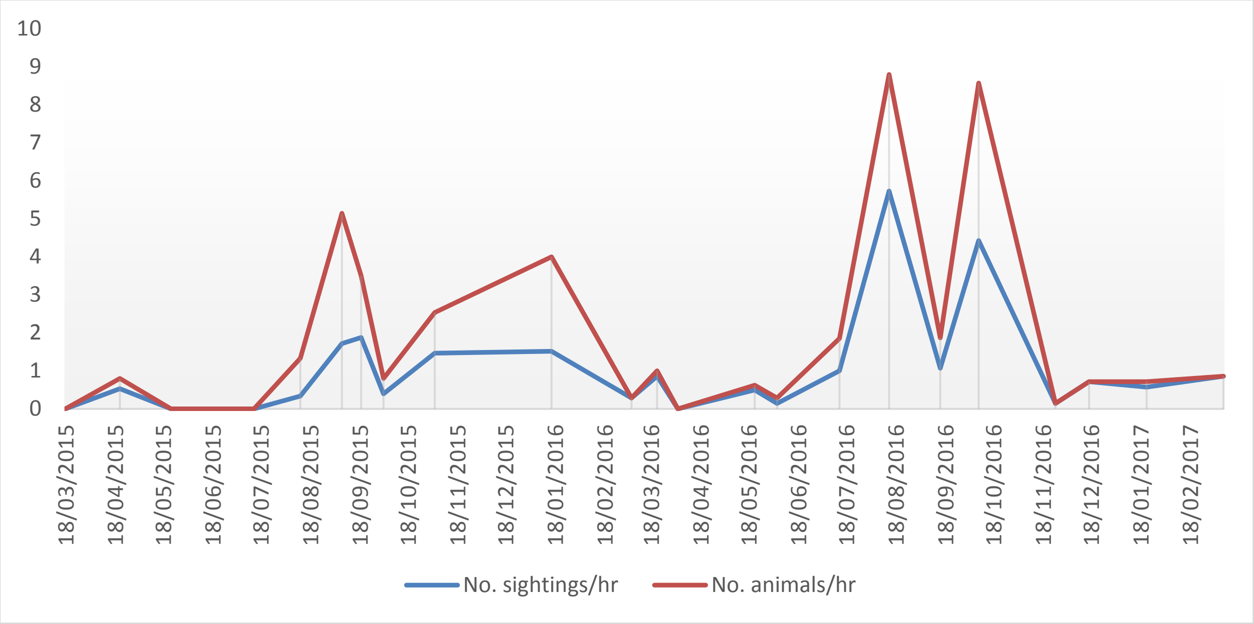


Figure 11. Harbour porpoise sighting rate for Howth Head land-based surveys

The greatest number of the harbour porpoise sightings were recorded to the northeast of the observation site, where animals were often recorded swimming in a tidal current close to the cliffs (Figure 12).

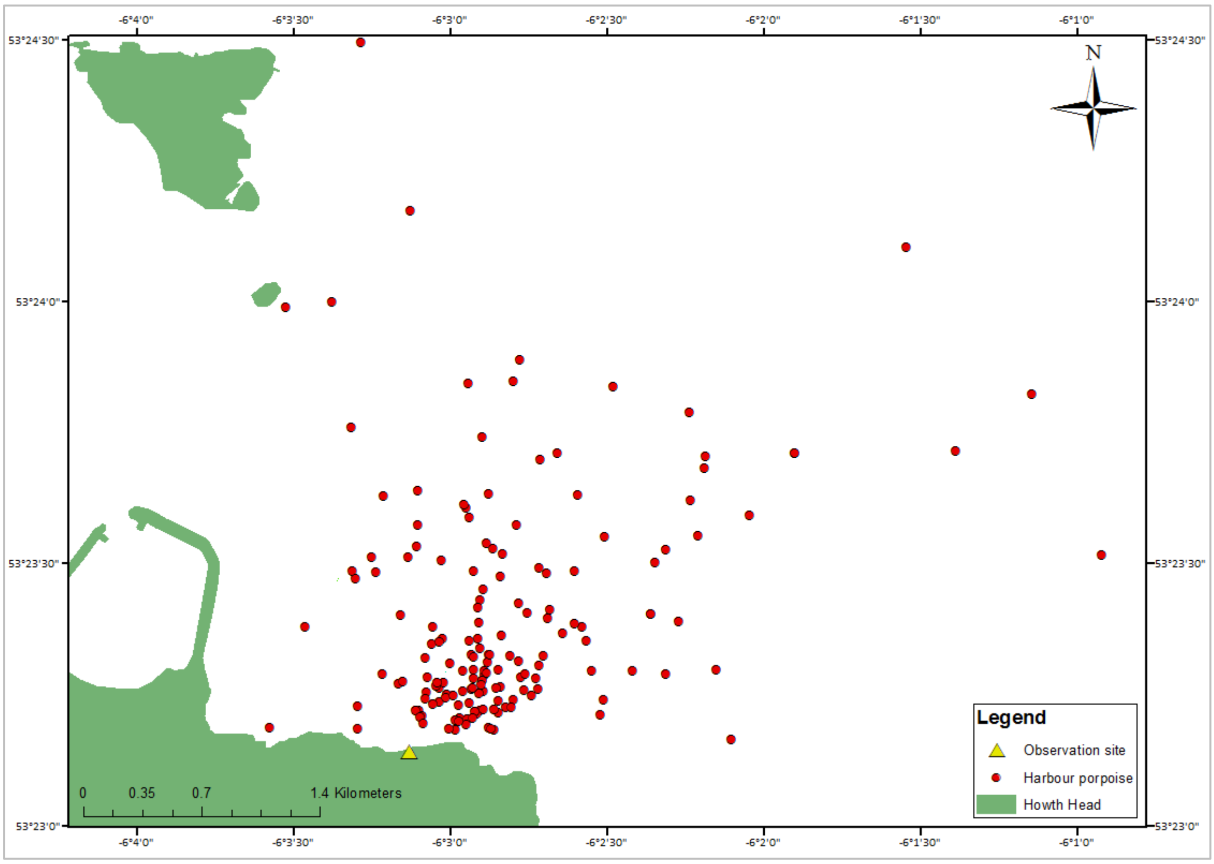


Figure 12. Distribution of harbour porpoise sightings off Howth Head

3.1.2.2 Grey seals

Two hundred and sixty (260) sightings of grey seals were recorded totalling 325 animals. A total of 323 adults and two juveniles were recorded and sightings had an average group size of one animal.

Sighting rate for grey seals was more consistent over the survey period with less consistent peaks. Rate was greatest in April 2015 although high numbers were also recorded in September 2015, January 2016 and October 2016. Group size also increased during this time (Figure 13).

Grey seal distribution was more westerly than harbour porpoise and individuals were often recorded feeding within close proximity to the northern cliffs of Howth Head (Figure 14).

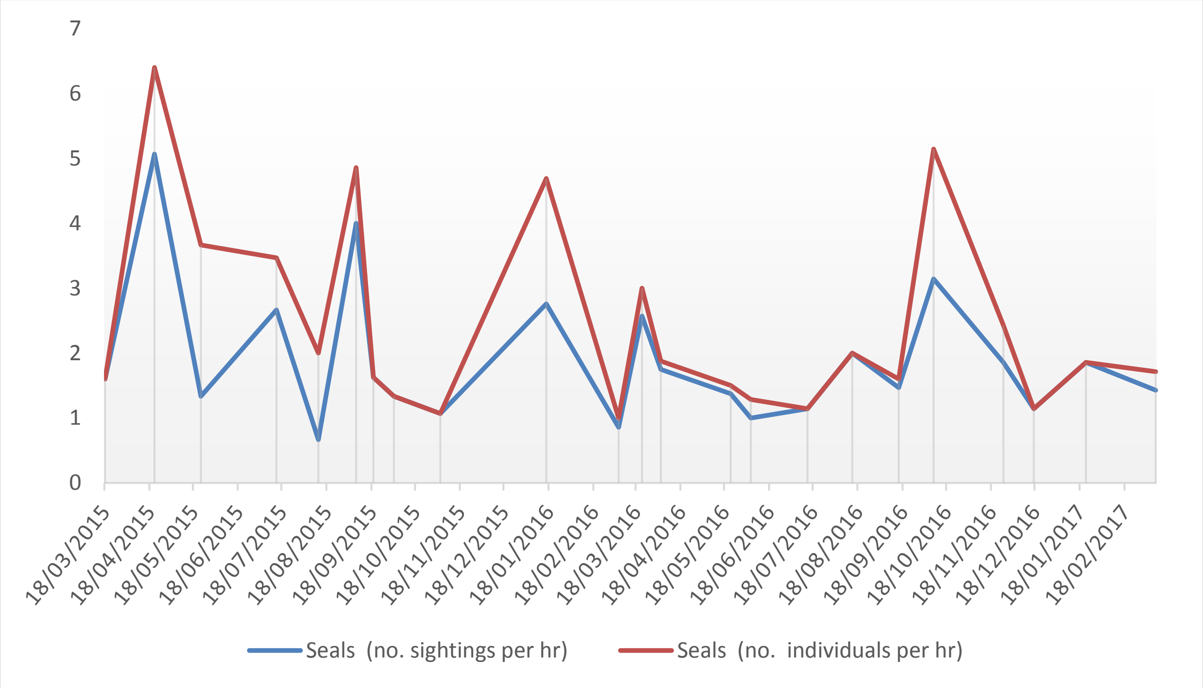


Figure 13. Grey seal sighting rate for Howth Head land-based surveys

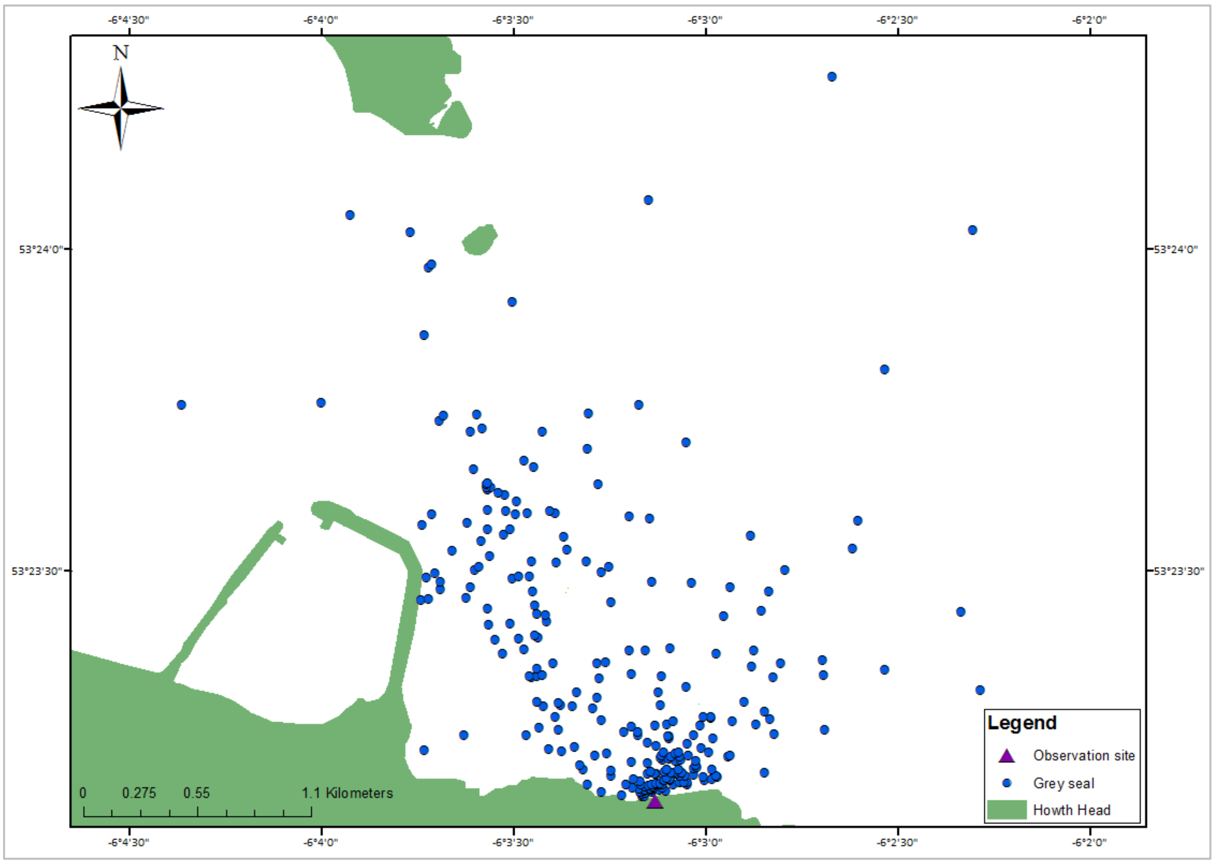


Figure 14. Distribution of grey seal sightings off Howth Head

3.1.2.3 *Focal Follow Observations*

When possible, harbour porpoise were tracked during each surfacing event to gain an understanding of their behaviour. Four focal follows were obtained over four days in September 2015, March 2016 and January and March 2017. In September 2015, a group of harbour porpoise comprising of two adults and one calf was tracked for 20 minutes. Single adult harbour porpoise were tracked for 59 minutes in March 2016, 24 minutes in January 2017 and 53 minutes in March 2017. With the exception of March 2016, all focal follows tracked harbour porpoise in a visible tidal current on the northwest coast of Howth Head (Figure 15).

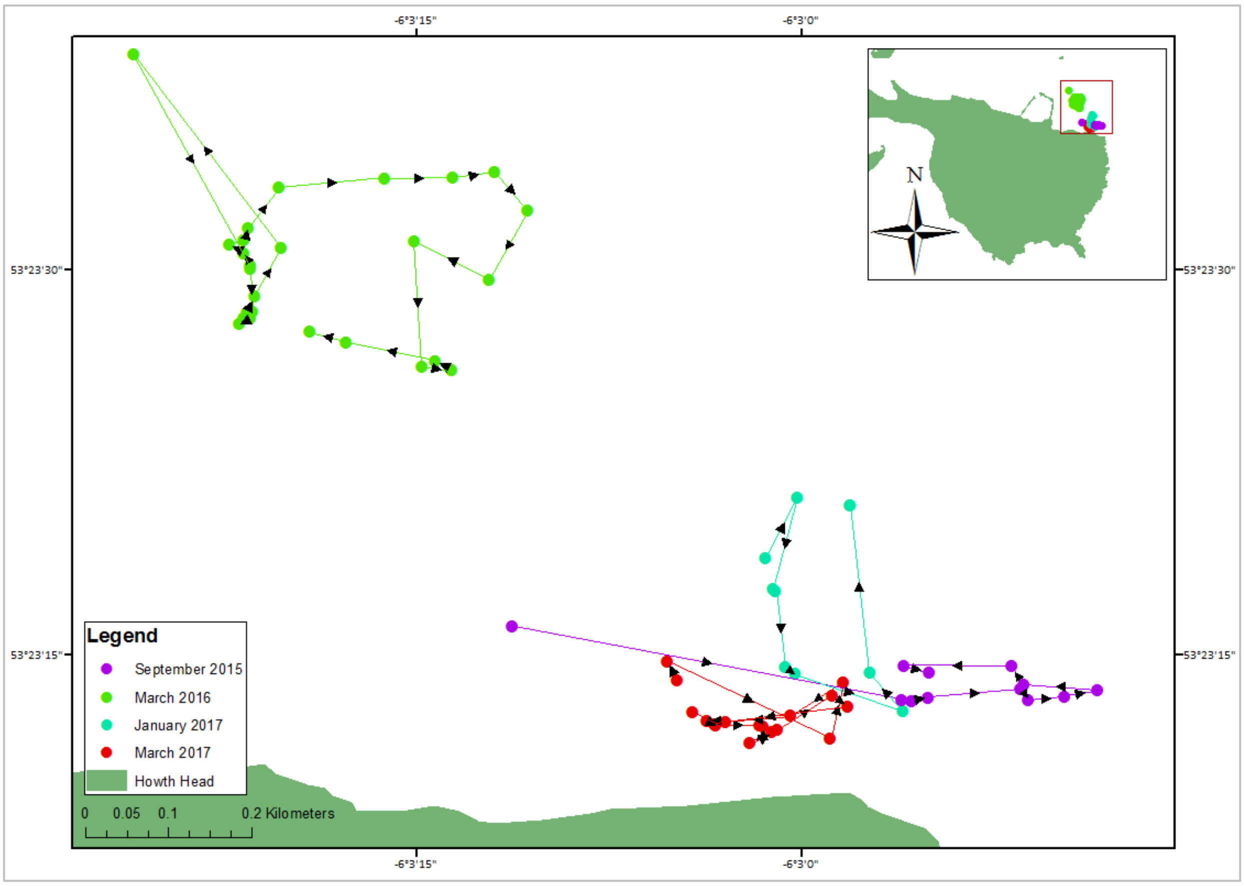


Figure 15. Focal follow tracking of harbour porpoise from the Howth Head site during 2015, 2016 and 2017

3.2 Boat-based surveys

Eleven boat-based marine mammal surveys were conducted onboard MV *Beluga* from April 2015 to January 2017 (Table 2). Track-lines were staggered to provide good coverage of the site and to ensure all habitats were surveyed (see Figure 3).

3.2.1 Environment

Environmental conditions were generally favourable throughout the boat-based surveys. Swell of less than 1m was recorded for 100% of survey effort. Visibility was greater >6km with the exception of the November 2015 where visibility was reduced to >3km due to sea fog. Sea-state of >2 was recorded for 8% during April 2015, 36% during the June 2015 survey and 46% during the December 2016 where sea-state was greater than forecast (Figure 16).

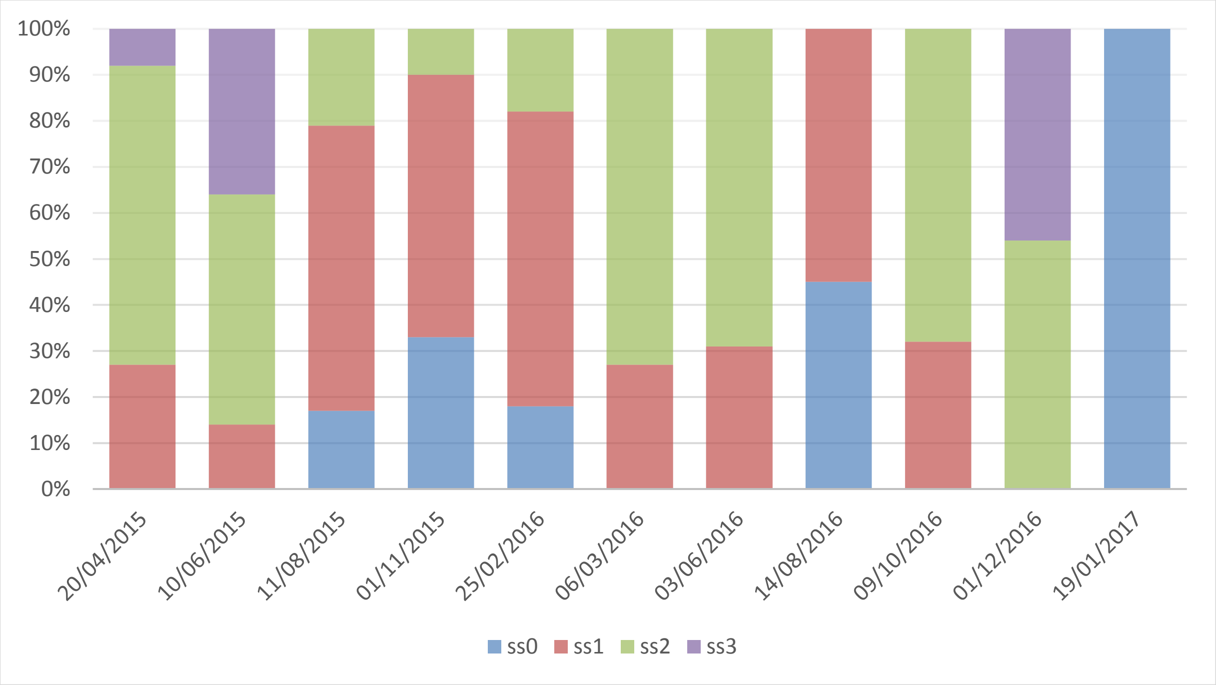


Figure 16. Beaufort Sea-state (%) recorded during boat-based surveys

3.2.2 Boat-based Marine Mammal Sightings

Marine mammals were recorded on 100% of boat-based surveys (Table 2, Figures 17-27). Species recorded comprised of harbour porpoise, grey seal, harbour seal and minke whale.

Table 2. Summary of marine mammal sightings and predominant sea-state from boat-based surveys

Date	No. harbour porpoise sightings	No. seal sightings	No. harbour porpoise individuals	No. seal individuals	No. other marine mammals	Predominant sea-state (0-2)
20/04/2015	11	2	15	2	0	2
10/06/2015	3	1	3	1	1 Minke whale	2-3
11/08/2015	20	2	37	2	0	1
01/11/2015	30	8	35	8	0	1
25/02/2016	16	4	17	4	0	1
06/03/2016	8	2	9	2	0	2
03/06/2016	2	1	2	1	0	2
14/08/2016	39	0	58	0	1 Minke whale	1
09/10/2016	12	2	16	2	0	2
01/12/2016	3	1	3	1	0	2
19/01/2017	23	2	31	2	0	0
Total	**167**	**25**	**226**	**25**	**2**	

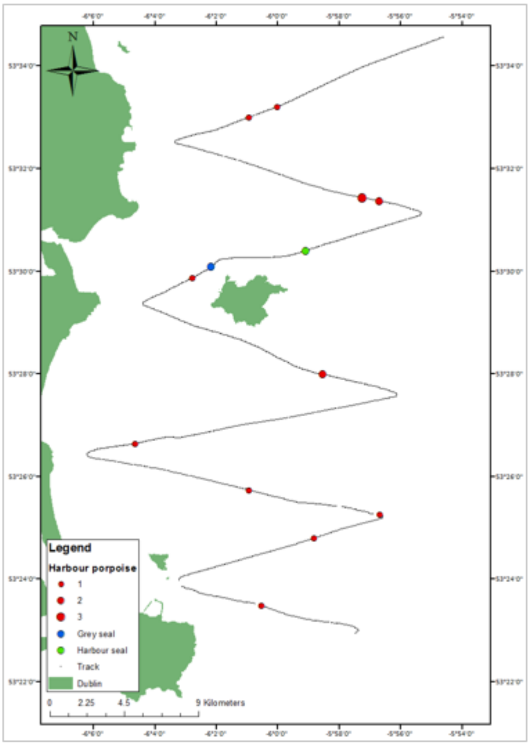


Figure 17. Trackline and sightings recorded during boat survey 1 (April 2015)

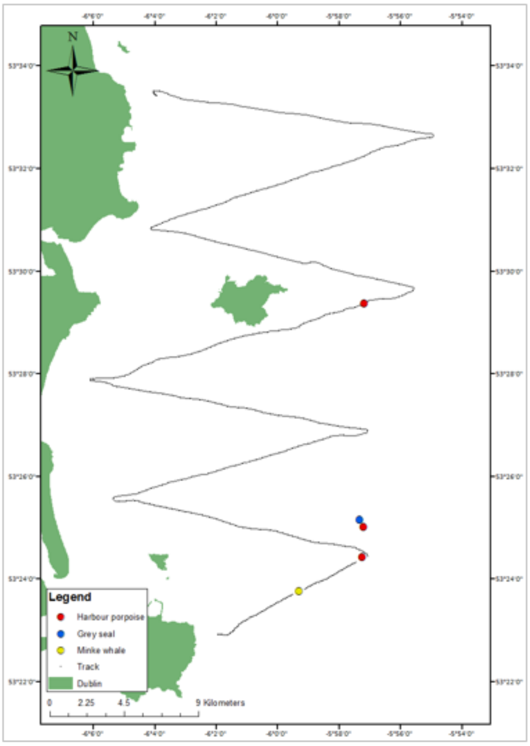


Figure 18. Trackline and sightings recorded during boat survey 2 (June 2015)

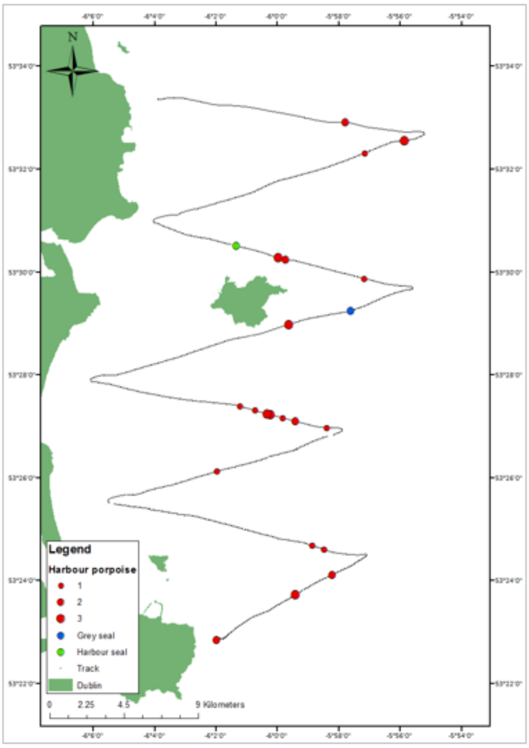


Figure 19. Trackline and sightings recorded during boat survey 3 (August 2015)

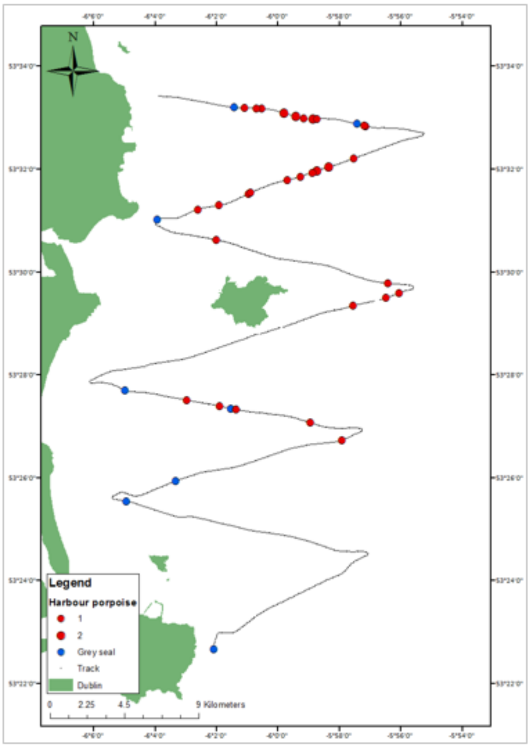


Figure 20. Trackline and sightings recorded during boat survey 4 (November 2015)

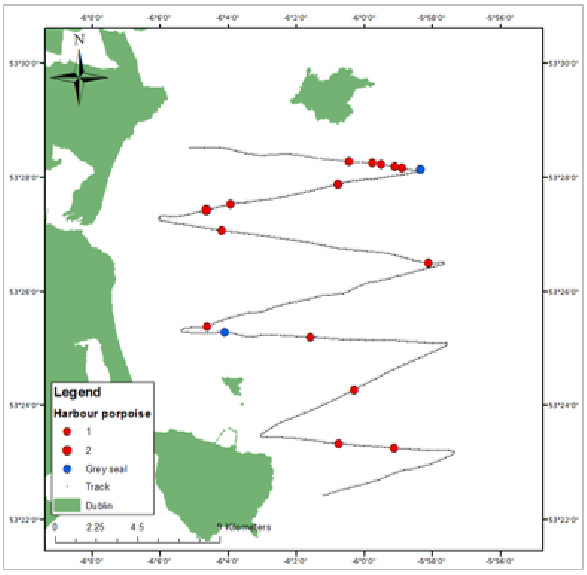


Figure 21. Trackline and sightings recorded during boat survey 5 (February 2016)

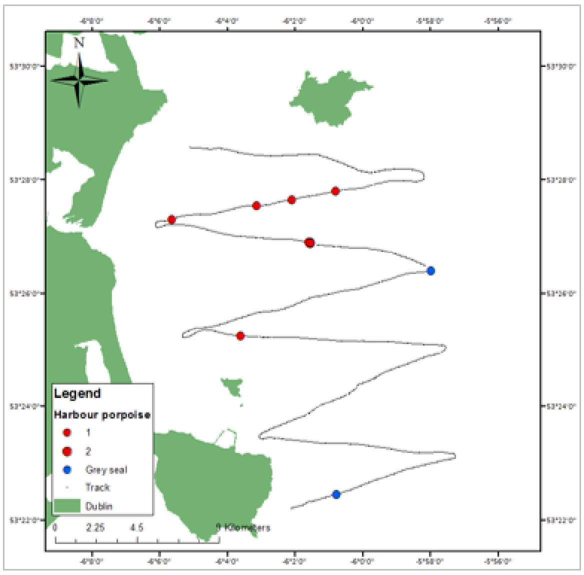


Figure 22. Trackline and sightings recorded during boat survey 6 (March 2016)

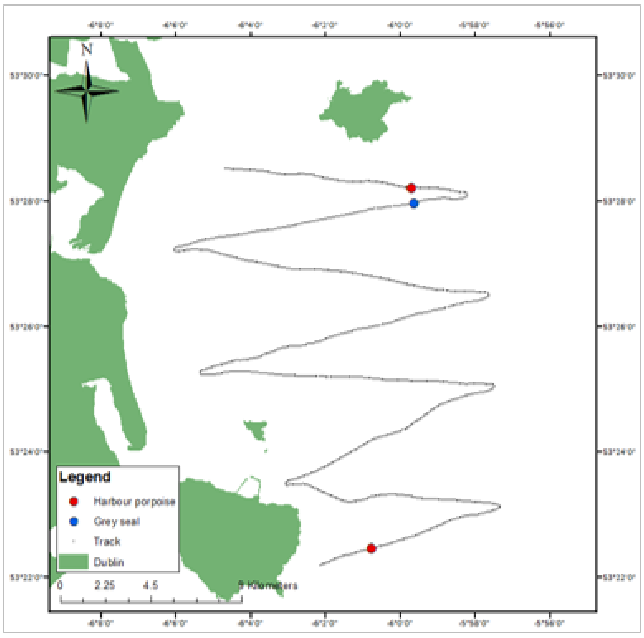


Figure 23. Trackline and sightings recorded during boat survey 7 (June 2016)

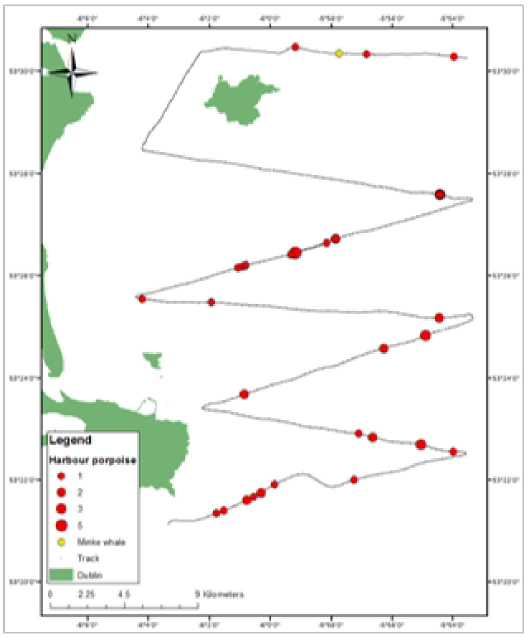
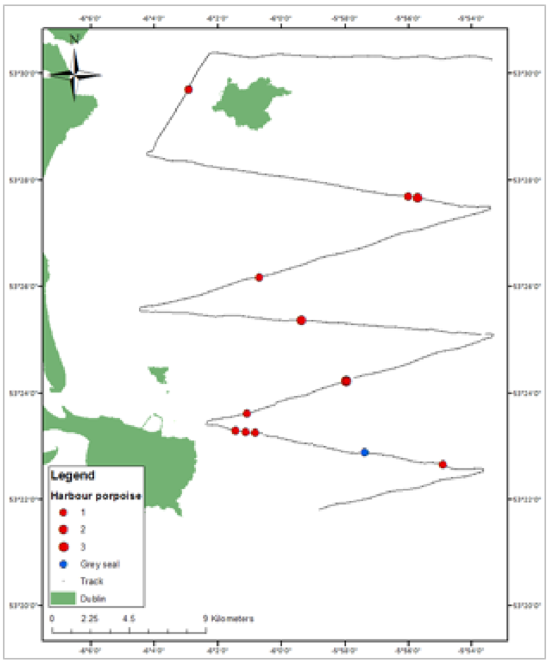


Figure 24. Trackline and sightings recorded during boat survey 8 (August 2016)



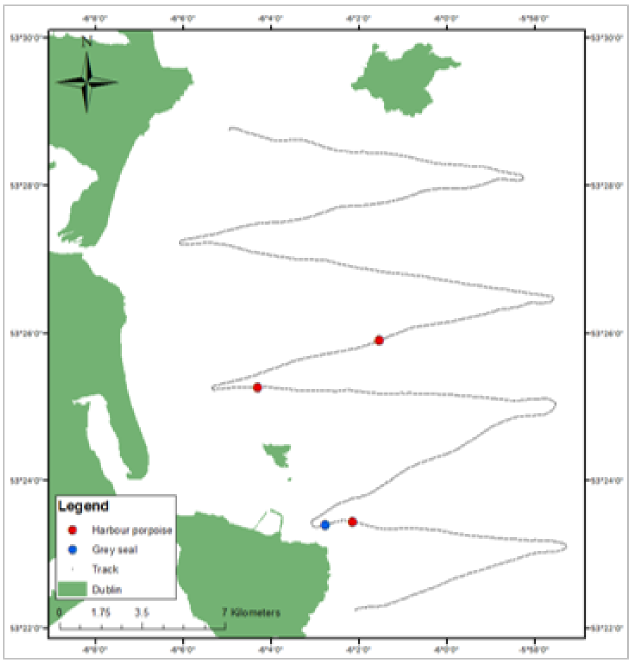


Figure 25. Trackline and sightings recorded during boat survey 9 (October 2016)

Figure 26. Trackline and sightings recorded during boat survey 10 (December 2016)

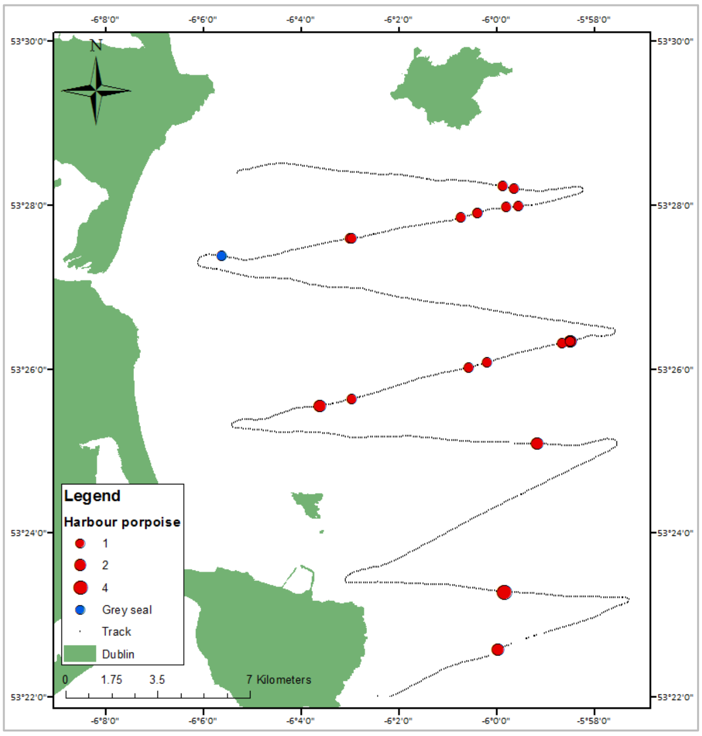


Figure 27. Trackline and sightings recorded during boat survey11 (January 2017)

3.2.2.1 Seal species and minke whale

Seals were recorded on 91% of survey days with the highest numbers of individuals recorded during November 2015 (Table 3, Figure 28). Grey seal sightings were distributed evenly across the study area and all sightings were of single adult individuals. Only two harbour seals were sighted, one during the April and one in August 2015 surveys, both of which were single adults. Single minke whales were recorded during two surveys, one in June 2015 and one in August 2016 (Table 3, Figure 29).

Table 3. Summary of seal sightings recorded during boat-based surveys

Date	No. seal sightings	No. seal individuals	Other marine mammals
20/04/2015	2	2	0
10/06/2015	1	1	1 Minke whale
11/08/2015	2	2	0
01/11/2015	8	8	0
25/02/2016	4	4	0
06/03/2016	2	2	0
03/06/2016	1	1	0
14/08/2016	0	0	1 Minke whale
09/10/2016	2	2	0
01/12/2016	1	1	0
19/01/2017	2	2	0

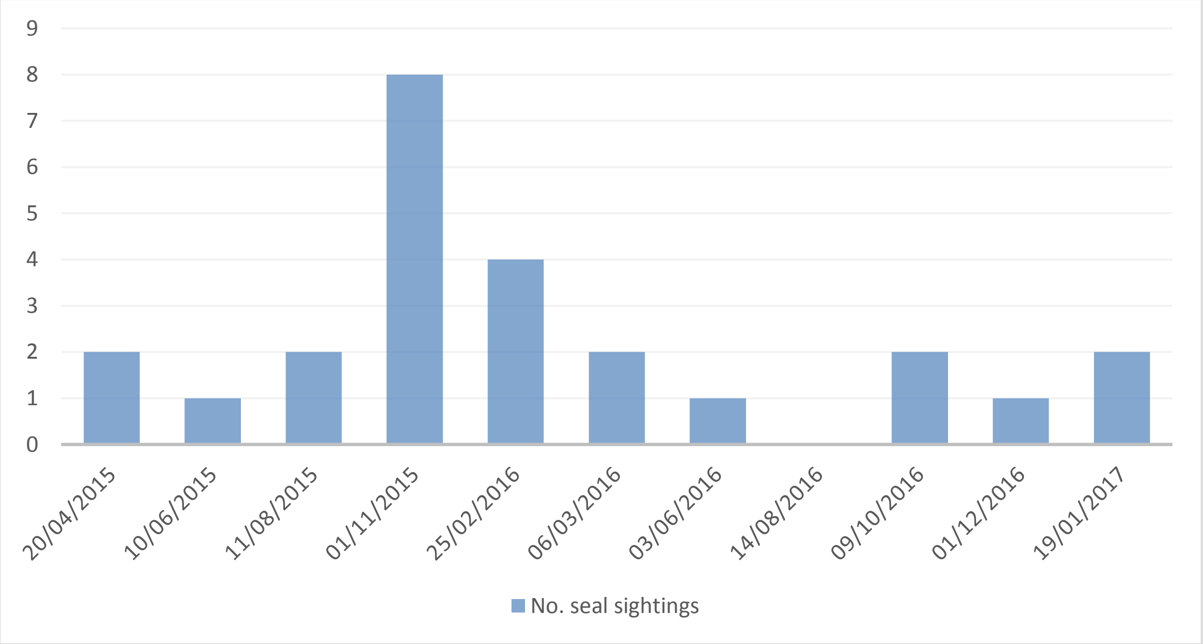


Figure 28. Number of seal sightings recorded during boat-based surveys

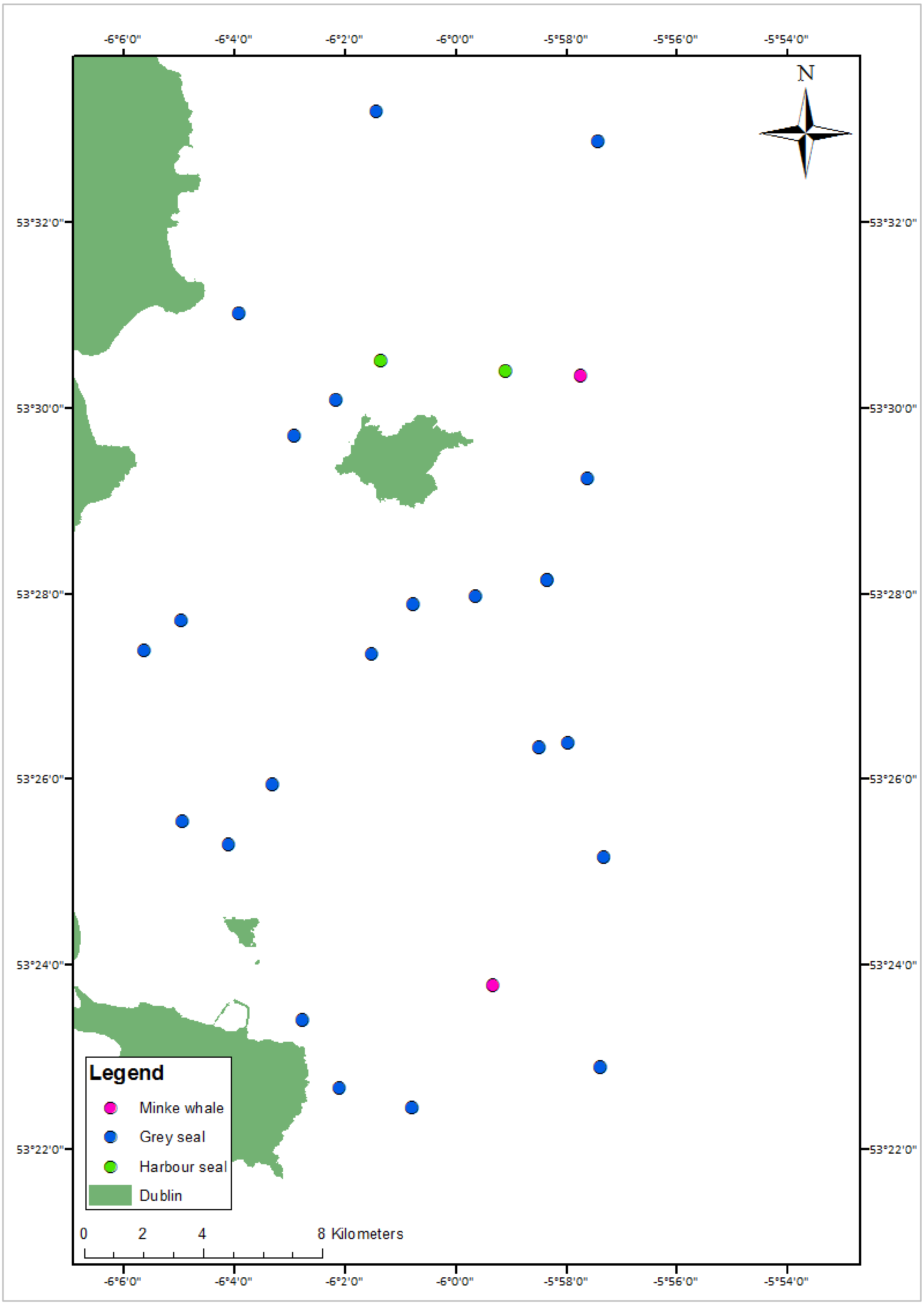


Figure 29. Geographic distribution of seal sightings and minke whales recorded during boat-based surveys

3.2.2.2 Harbour porpoise

Harbour porpoise were recorded on 100% of survey days with the greatest number of sightings recorded in November 2015 and August 2016 (Table 4, Figure 30). Group sizes also increased between August and November in 2015 and in August 2016. The lowest number of sightings were recorded in June 2015, June 2016 and December 2016 however sea-state was higher during these surveys which would increase the likelihood of missed sightings, therefore these results must be treated with caution. Calves were only recorded in August 2015, November 2015 and August 2016. Harbour porpoise sightings were regularly distributed across the study area (Figure 31).

Table 4. Summary of harbour porpoise sightings recorded during boat-based surveys

Date	No. HP sightings	No. HP individuals	Adults	Juveniles	Calves	Range in group size
20/04/2015	11	15	15	-	-	1-3
10/06/2015	3	3	3	-	-	-
11/08/2015	20	37	32	4	1	1-3
01/11/2015	30	35	32	2	1	1-2
25/02/2016	16	17	17	-	-	1-2
06/03/2016	8	9	8	1	-	1-2
03/06/2016	2	2	2	-	-	-
14/08/2016	39	58	47	6	5	1-5
09/10/2016	12	16	15	1	-	1-3
01/12/2016	3	3	3	-	-	-
19/01/2017	23	31	28	3	-	1-4
			202	**17**	**7**	**Average: 1.35**

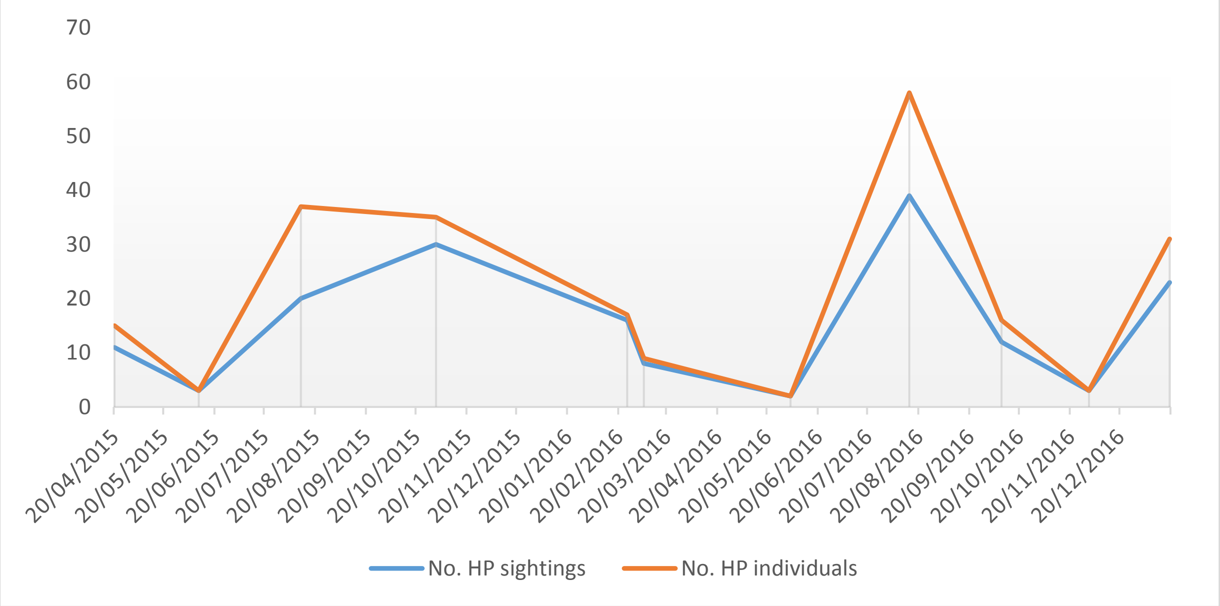


Figure 30. Number of harbour porpoise sightings and individuals recorded during boat-based surveys

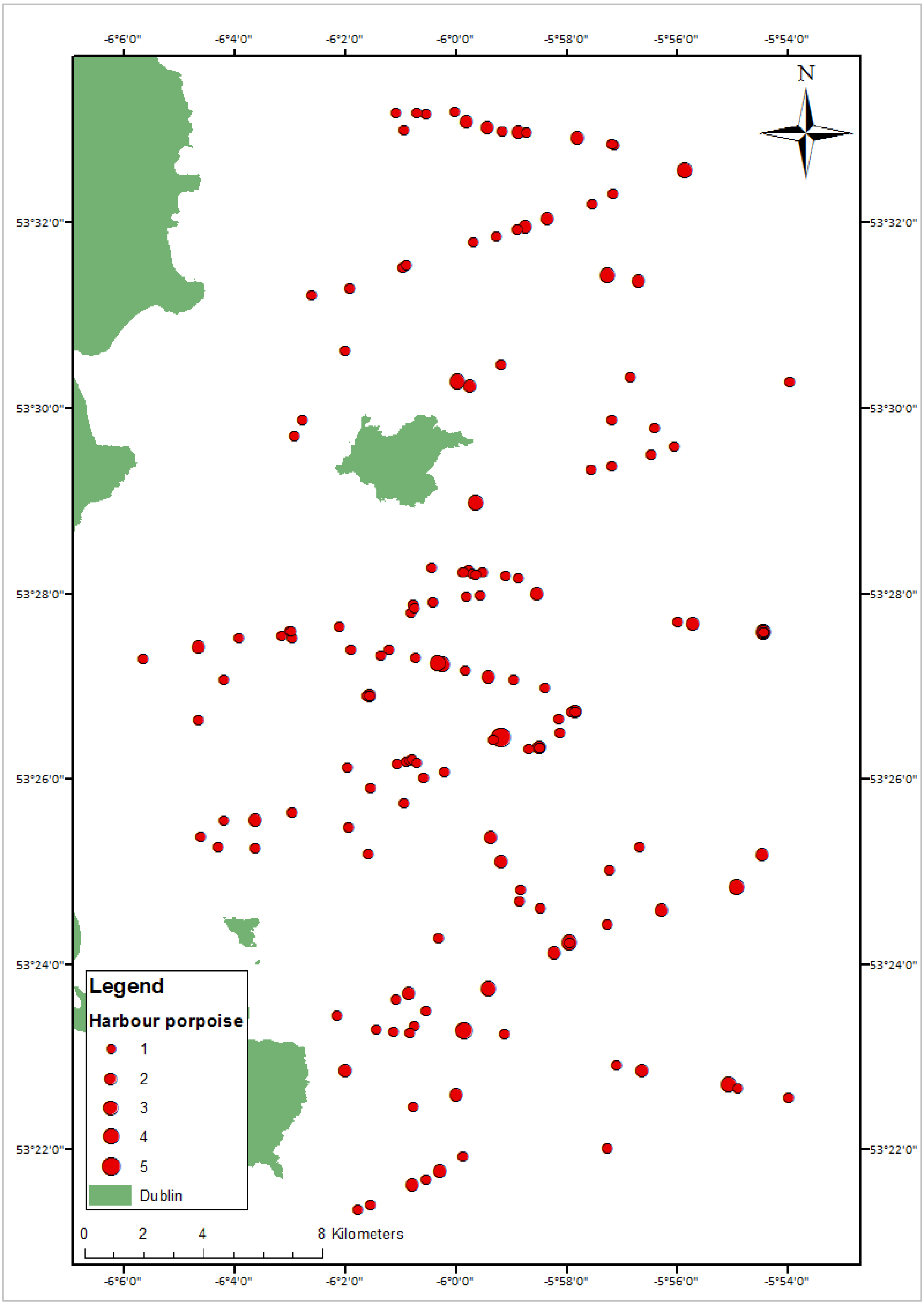


Figure 31. Geographic distribution of harbour porpoise recorded during boat-based surveys

3.2.2.2.1 Density and abundance estimation

Density estimates for harbour porpoises calculated for seven of the eleven survey days and not for surveys two (June 2015), six (March 2016), seven (June 2016) and ten (December 2016) as the number of sightings were less than 10 and too few to derive a reliable density estimate. The detection functions for all surveys combined could not be calculated as the area surveyed was reduced during the winter period and after Loughshinny was removed from survey obligations.

Evasive reactions of porpoises from the survey vessel were most evident on all surveys but especially on surveys 1, 5, 8 and 9 with a peak in sightings some 30-100m from the track-line (Figure 32), most likely resulting in an underestimate of animal density. Variation in cluster size was greater during the surveys 1 and 9 which contributed a greater proportion of the variability. Mean group (cluster) size was greater on surveys 3 (August 2015) and 8 (August 2016) compared to the other surveys, suggesting a peak occurred in late summer which is consistent with land-based observations. Adults will have calved before this period and calves were recorded during both the August 2015 and August 2016 surveys. Calves are unlikely to have weaned which may contribute to this elevated group size.

Density and abundance estimates for harbour porpoise for the Greater Dublin Drainage Marine Mammal Surveys are shown in Table 6. The density estimates increased during summer and early winter (August-November) in 2015 and during August 2016. Densities were lowest in April 2015 and February 2016. The total number of sightings used in the April 2015 (11), February 2016 (16) and October 2016 (12) surveys were low and results should be treated with caution. The track-line surveyed in February was around 25% less than in the previous surveys to account for shorter day length. Also the area surveyed was less than in previous surveys as Loughshinny had been dropped as an area of interest at the end of summer 2015. Areas of high densities of harbour porpoise to the north of the study site were therefore not surveyed which will reduce the reported density estimate. These changes to survey design should be taken into account however the trend to increased densities during late summer and early winter coincided with peak sighting rate from land-based watches.

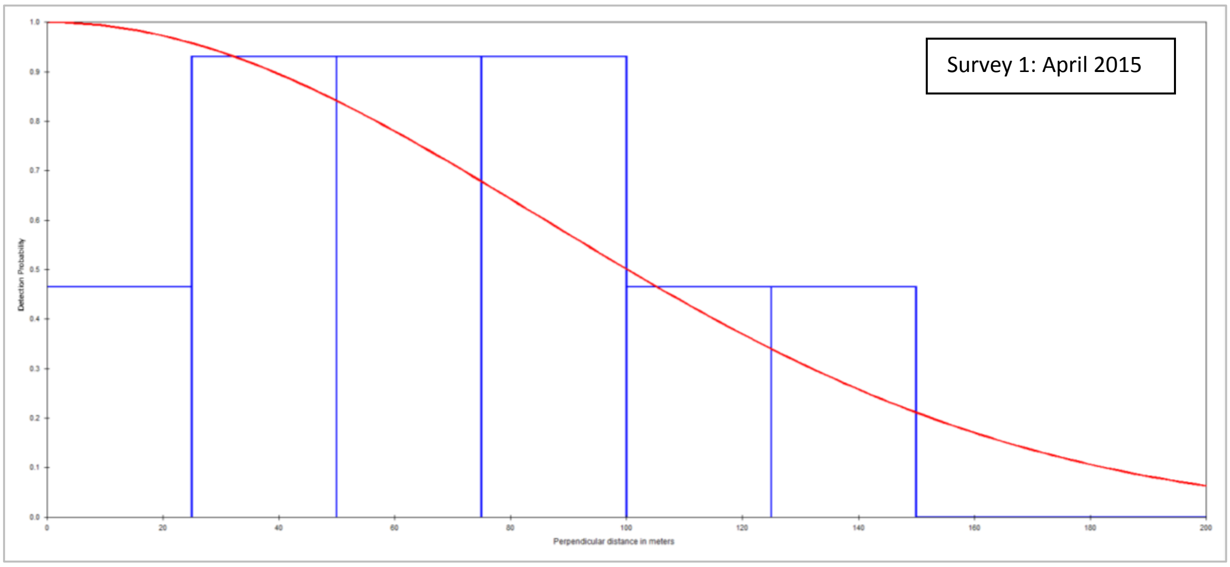
Table 5. Model data used in the harbour porpoise abundance and density estimation process for the Greater Dublin Drainage project (Note: A half-normal model with cosine series adjustments and sightings data truncated at 200m for surveys 1, 8 and 9 and 300m for surveys 3, 4, 5 and 11).

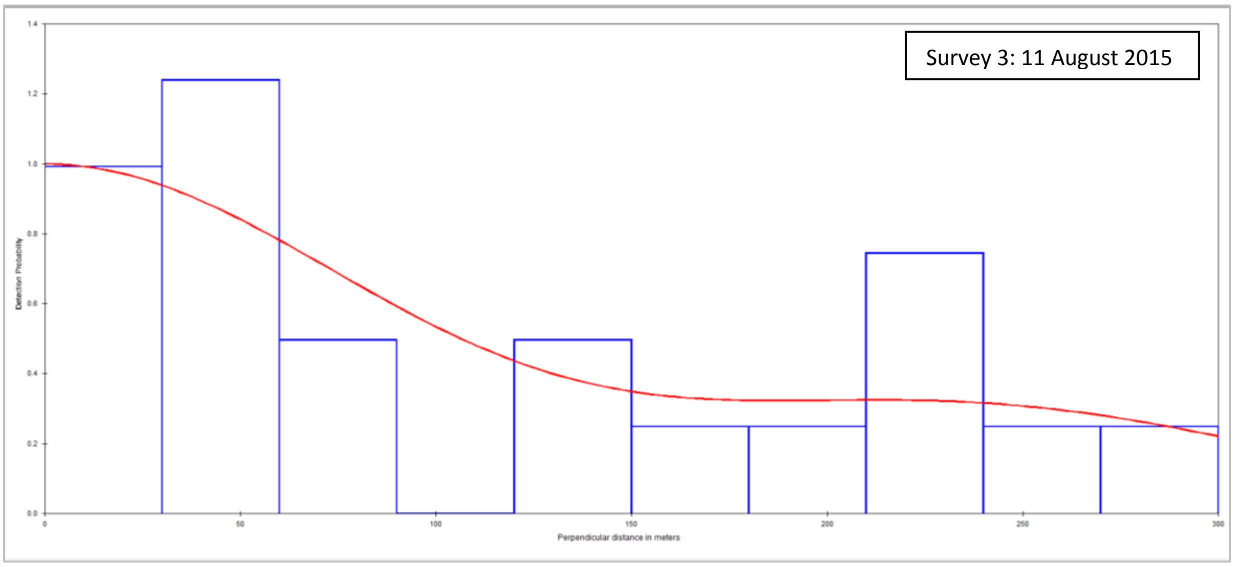
Sample Day	Track length (km)	Area surveyed (km^2)	Number of sightings	Chi^2 P value	Effective Strip Width (m)	Variability (D)	
						Detection	Cluster
1	78	197	11	0.924	104.65	67.6	32.4
3	75	189	20	0.602	148.78	84.1	15.9
4	75	189	30	0.542	141.8	89.0	11.0
5	60	85	16	0.193	190.42	100	00.0
8	89	201	39	0.093	105.1	77.9	22.1
9	89	201	12	0.464	97.35	73.1	26.9
11	89	201	23	0.930	206.9	82.5	17.5

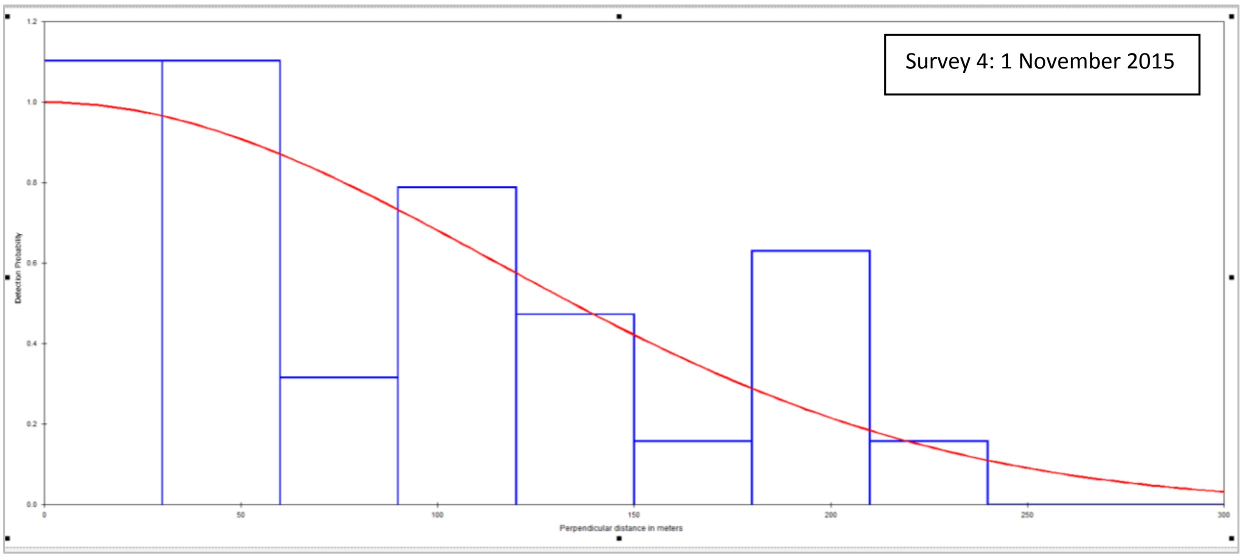
Table 6. Estimated density, abundance (N) and group sizes of harbour porpoise recorded for the Greater Dublin Drainage project.

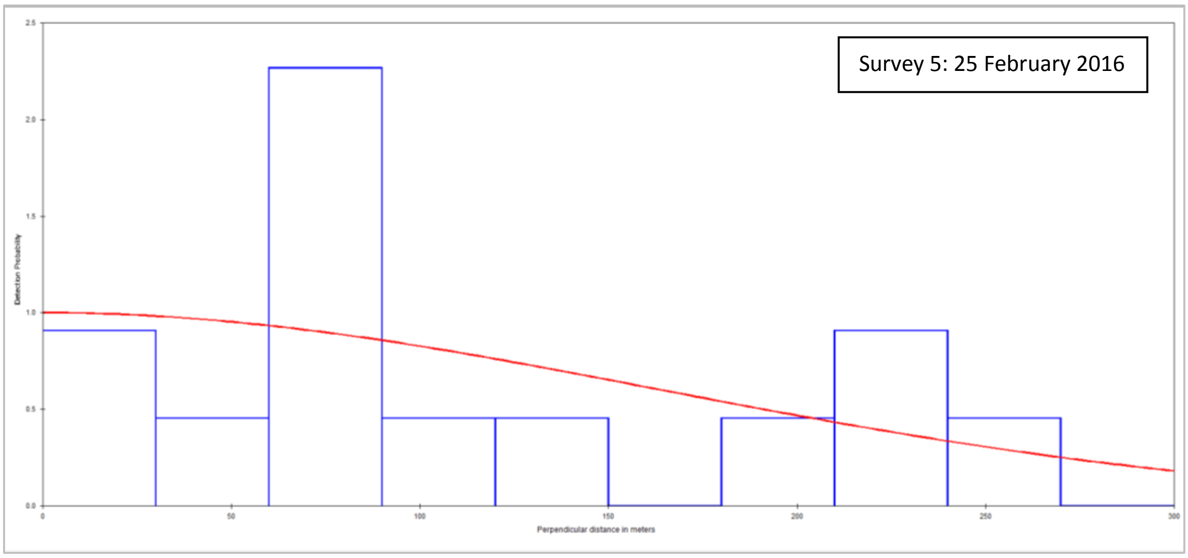
Sample Day	Date	N (95% CI)	SE	CV	Density (per km2)	Mean group size (95% CI)
1	Apr-15	154 (77-306)	54	0.33	0.78	1.44 (1.00-2.12)
3	Aug-15	361 (192-681)	114	0.32	1.91	1.85 (1.48-2.30)
4	Nov-15	332 (245-449)	50	0.36	1.76	1.17 (1.12-1.31)
5[1]	Feb-16	52 (31-86)	12	0.23	0.61	1.00
8	Aug-16	460 (339-625)	70	0.15	2.29	1.53 (1.25-1.85)
9	Oct-16	197 (111-349)	54	0.28	0.97	1.37 (1.00-1.89)
11	Jan-17	179 (117-275)	38	0.21	0.89	1.35 (1.07-1.69)

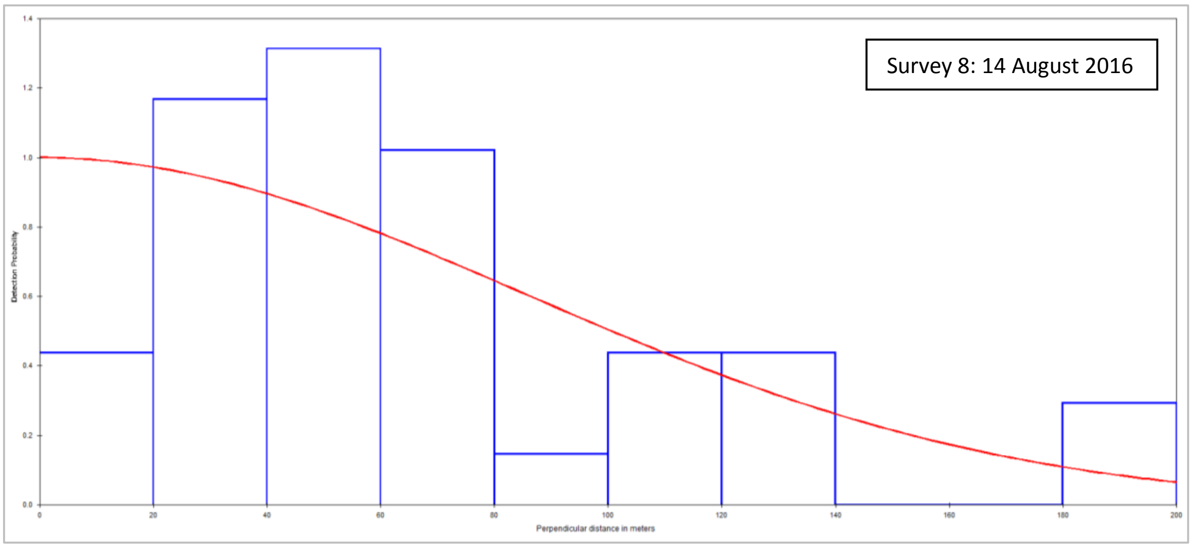
[1] – smaller area surveyed

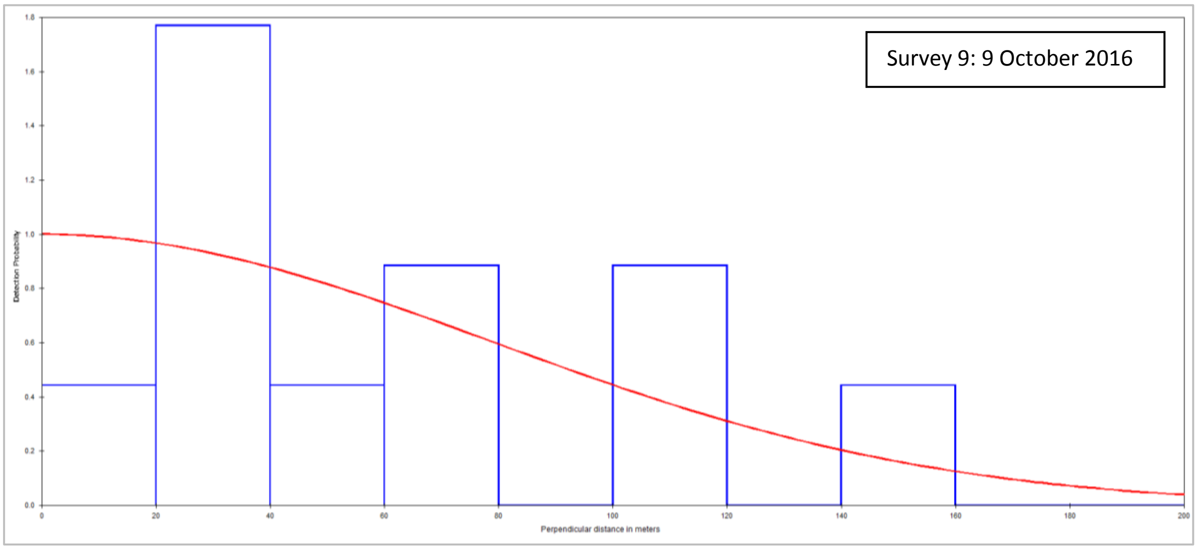

Survey 1: April 2015
Detection Probability
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
20
40
60
80
100
120
140
160
180
200
Perpendicular distance in meters


Survey 3: 11 August 2015
Detection Probability
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
200
250
300
Perpendicular distance in meters


Survey 4: 1 November 2015
Detection Probability
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
200
250
300
Perpendicular distance in meters


Survey 5: 25 February 2016
Detection Probability
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
250
300
Perpendicular distance in meters


Survey 8: 14 August 2016
Detection Probability
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
140
160
180
200
Perpendicular distance in meters


Survey 9: 9 October 2016
Detection Probability
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
140
160
180
200
Perpendicular distance in meters

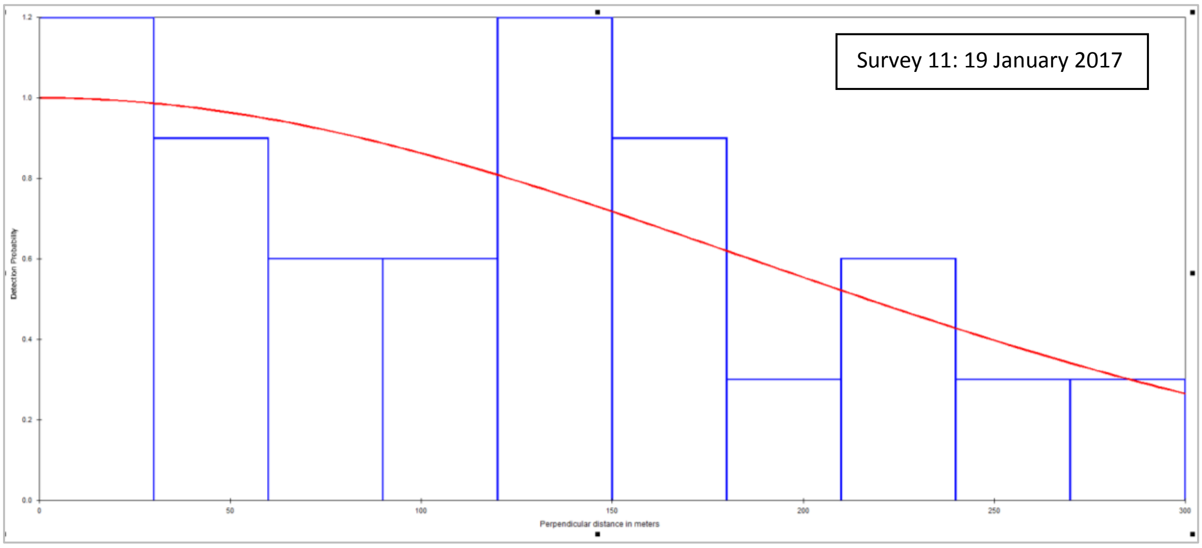


Figure 32. Detection functions for density estimates for boat-based surveys with sufficient number of sightings to analyse in DISTANCE.

3.3 Static Acoustic Monitoring

3.3.1 C-POD Calibrations

All units used over the duration of the present study were calibrated (Figure 33-Figure 38). From these trials, there were some differences in sensitivities between units but that individual unit performance was within the acceptable error margin of ±20% DPM per hour (Figure 35-Figure 38) and therefore no correction factor was applied to the data to make it comparable (O'Brien et al. 2013). During analysis of the long-term dataset, differences in sensitivities between units is accounted for by treating C-POD number as a random factor when running the GLMM and additionally C-PODs were deployed randomly between sites over the duration of the study.

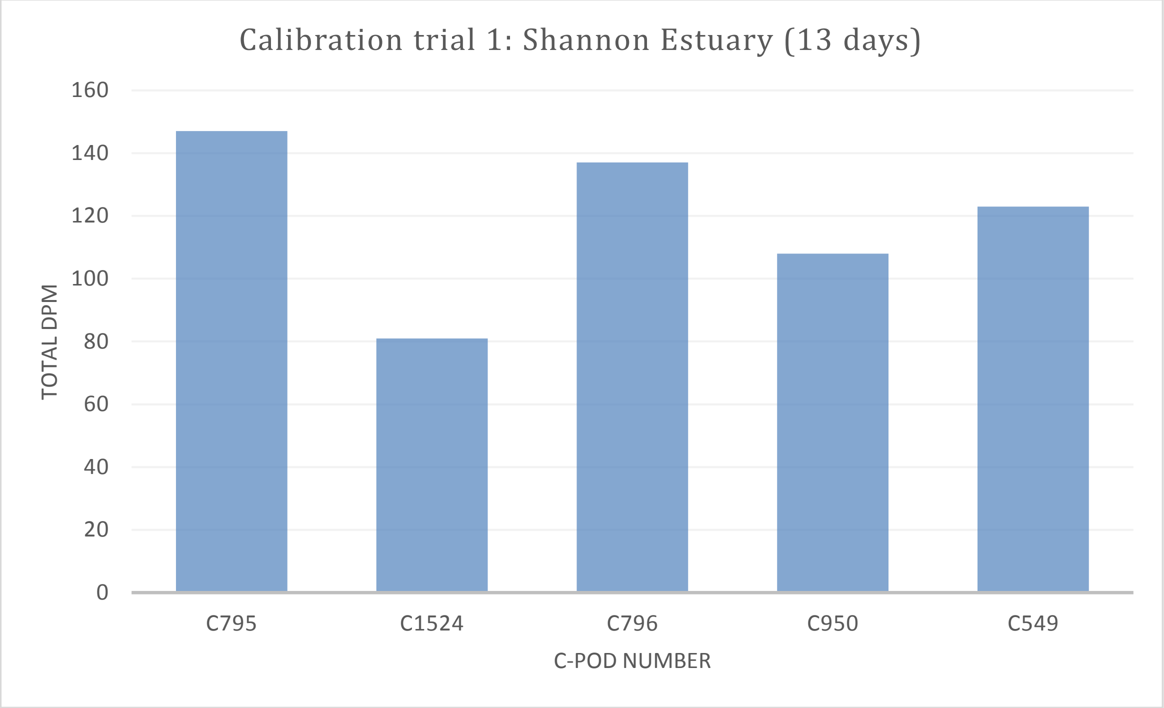


Figure 33. Detection Positive Minutes from all C-PODs deployed during calibration trial 1 in the Shannon Estuary.

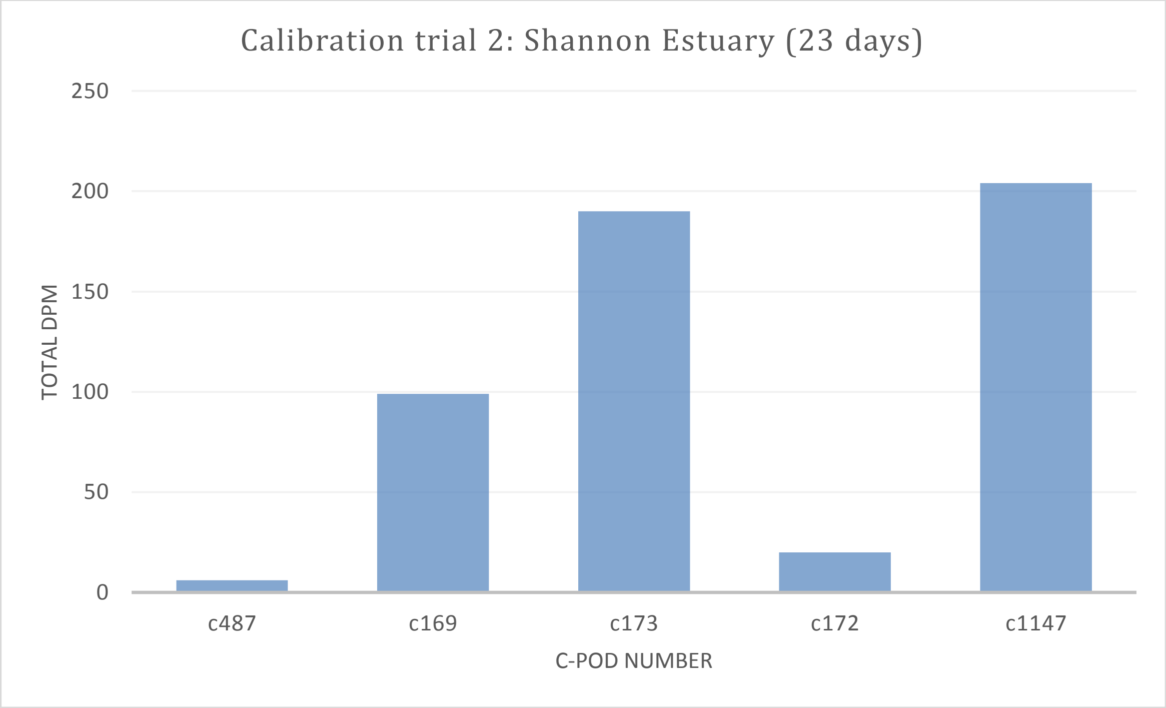


Figure 34. Detection Positive Minutes from all C-PODs deployed during calibration trial 2 in the Shannon Estuary.

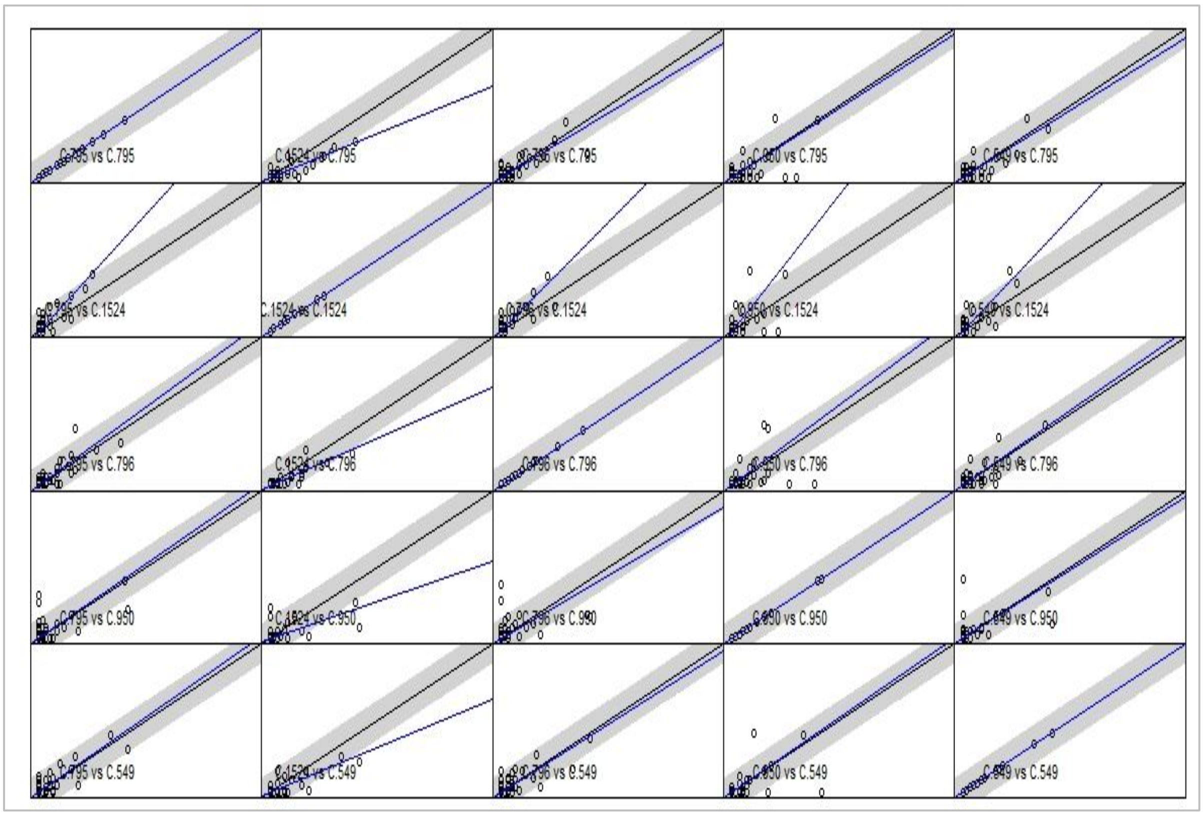


Figure 35. Orthogonal regression plot of C-POD comparisons in calibration trial, in blue, with a null model where each unit performs exactly the same, in black and an acceptable error margin of ±20%, in grey from Calibration 1, January 2015.

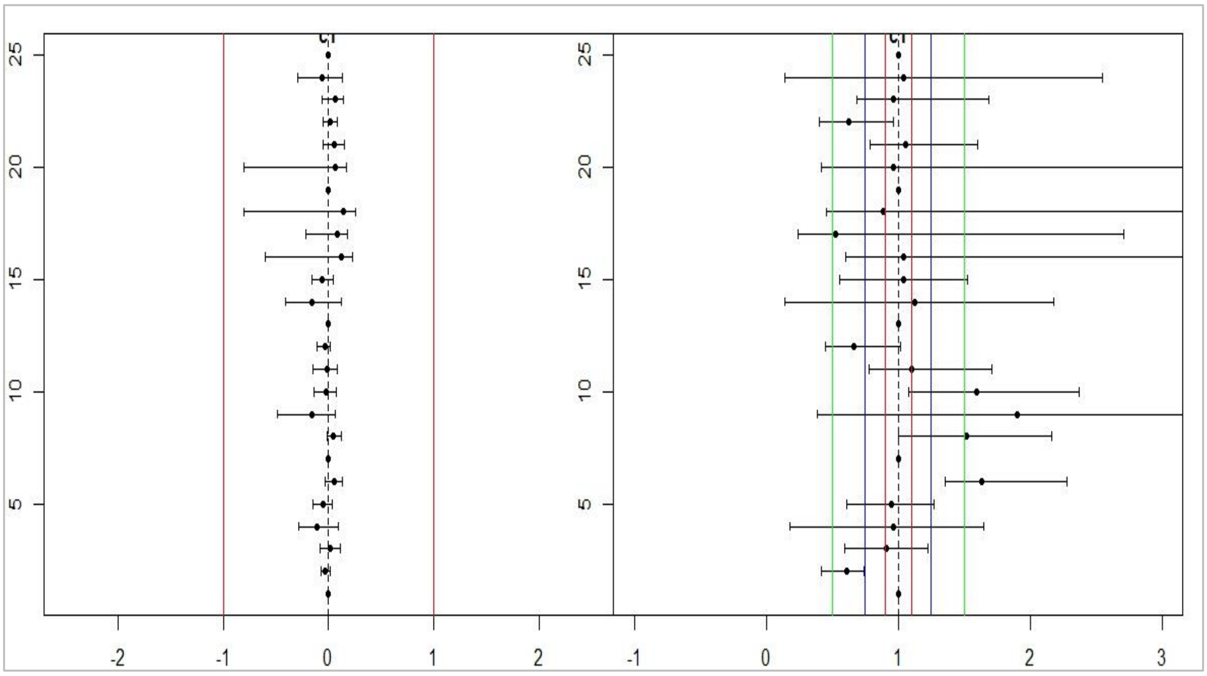


Figure 36. Centipede plot of the intercept and slope values (±std), of the orthogonal regression plots, for each pod performance comparison in calibration trail 1 at Money Point, January 2015. Deviation from the red dotted lines, 0 on the intercept plot and 1 on the gradient plot, indicates deviation from the null model assuming no variation. Plot indicates that a greater extent of variation is found within the gradient values.

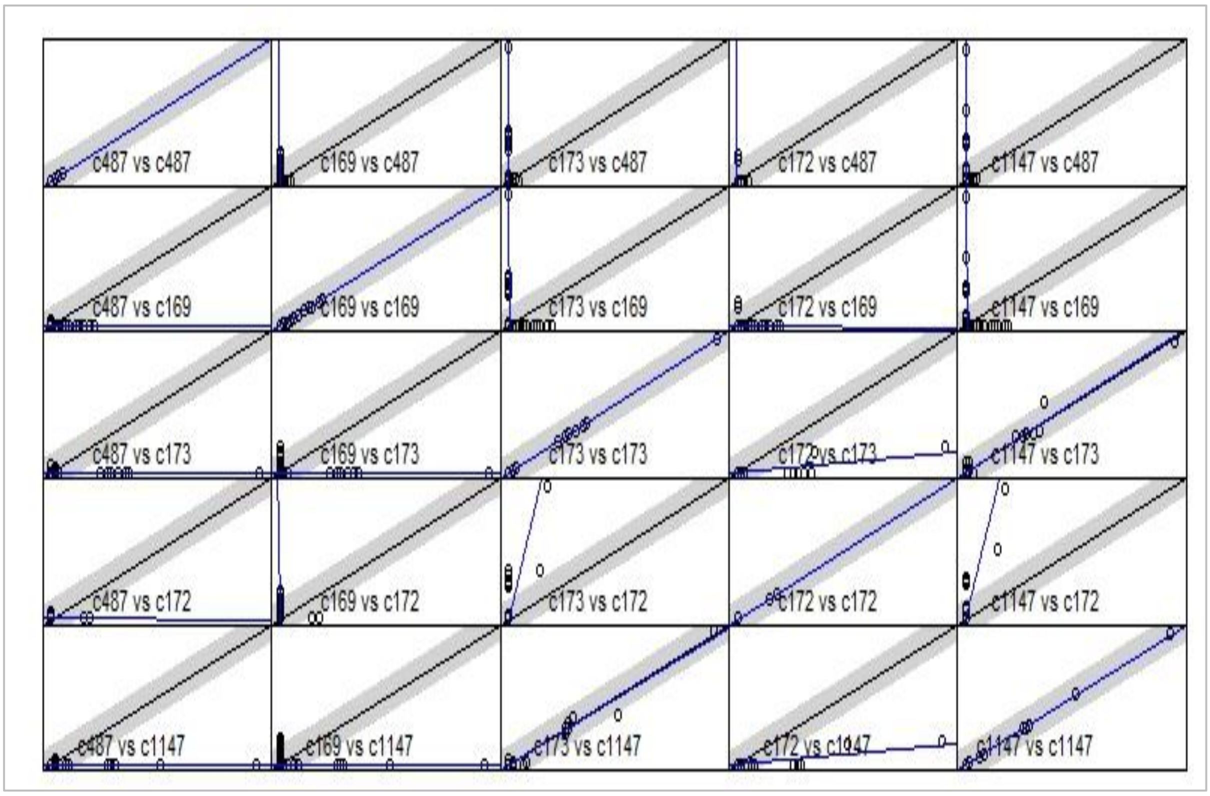


Figure 37. Orthogonal regression plot of C-POD comparisons in calibration trial, in blue, with a null model where each unit performs exactly the same, in black and an acceptable error margin of ±20%, in grey from Calibration 2, February 2015.

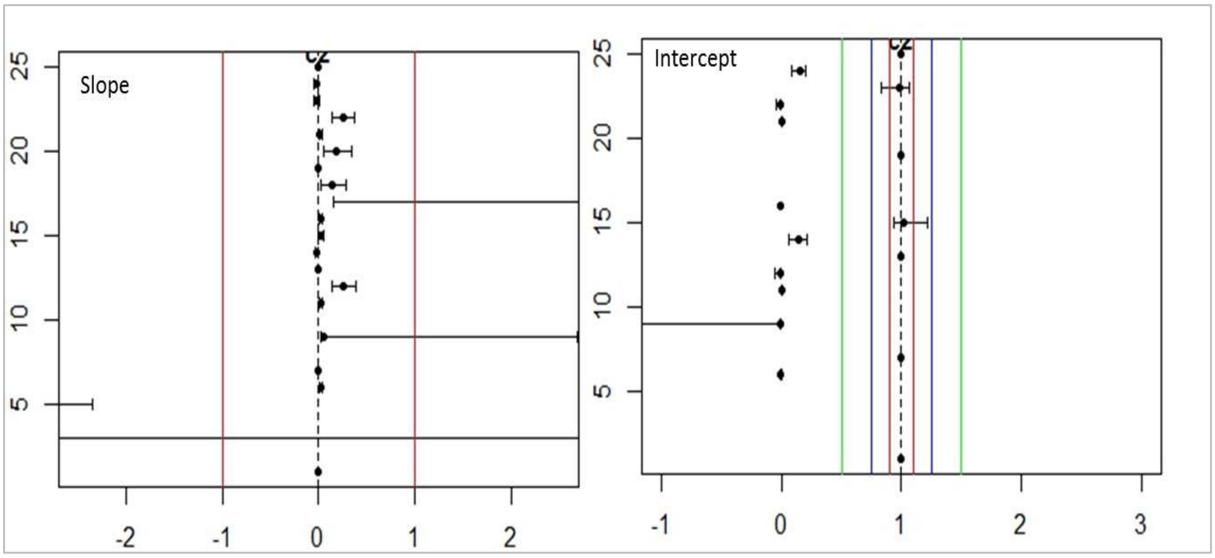


Figure 38. Centipede plot of the intercept and slope values (±std), of the orthogonal regression plots, for each pod performance comparison in calibration trail 1 at Money Point, January 2015. Deviation from the red dotted lines, 0 on the intercept plot and 1 on the gradient plot, indicates deviation from the null model assuming no variation. Plot indicates that a greater extent of variation is found within the gradient values.

3.3.2 Overview of SAM results

SAM using C-PODs was carried out at Portmarnock at three sites simultaneously for a duration of 750 days (between March 2015 and March 2017). The number of monitoring days at each site varied due to a number of reasons but mainly interference with moorings and gear missing upon retrieval (Table 7). This did not impact significantly on the dataset as monitoring over such a long-term period ensured enough replication was achieved across years and a range of factors which are thought to influence presence. Detections were recorded 96-99% of days on average at each site (Table 7). The number of Porpoise Positive Minutes (PPM) ranged from 3690 to 25089 per year, between sites, with mean DPM/day ranging between 41.3 to 94.3 (Table 7; Figure 39). Very few dolphin detections were recorded and most of those were determined to be false positives and therefore were not used for analyses. A monitoring index was calculated as the mean number of detection positive minutes per hour for porpoises (Table 7). This index can be compared across locations, or with results from previous studies in Ireland and was used to compare the present dataset with that recorded in 2015 from Loughshinny, Co. Dublin (approx. 14 km north of the Portmarnock site).

Table 7. Summary of all deployments across 3 GDD sites from 2015 to 2017 (N=750 days).

Location	Year	No. of days monitored	No. of data days	Total PPM	% PPDs	Mean DPM/Day	Mean DPM/hr	%DPM
GDD1	2015	294	294	24728	98	84.1	3.5	5.8
	2016	366	187	3680	94	20.6	0.81	1.4
	2017	90	75	1443	95	19.2	0.80	1.3
Total		**750**	**556 (74%)**	**29,851**	**x̅=96%**	**41.3**	**1.7**	**2.8**
GDD2	2015	294	211	11396	97	54.0	2.3	3.8
	2016	366	258	25089	99	97.2	4.1	6.7
	2017	90	75	9894	99	131.9	5.5	9.2
Total		**750**	**544 (72%)**	**46,379**	**x̅=98%**	**94.3**	**4.0**	**6.6**
GDD3	2015	294	228	14486	100	63.5	2.6	4.4
	2016	366	227	12820	99	56.5	2.4	3.9
	2017	90	75	3960	97	52.8	2.2	3.7
Total		**750**	**530 (71%)**	**31,266**	**x̅=99%**	**57.6**	**2.4**	**3.0**

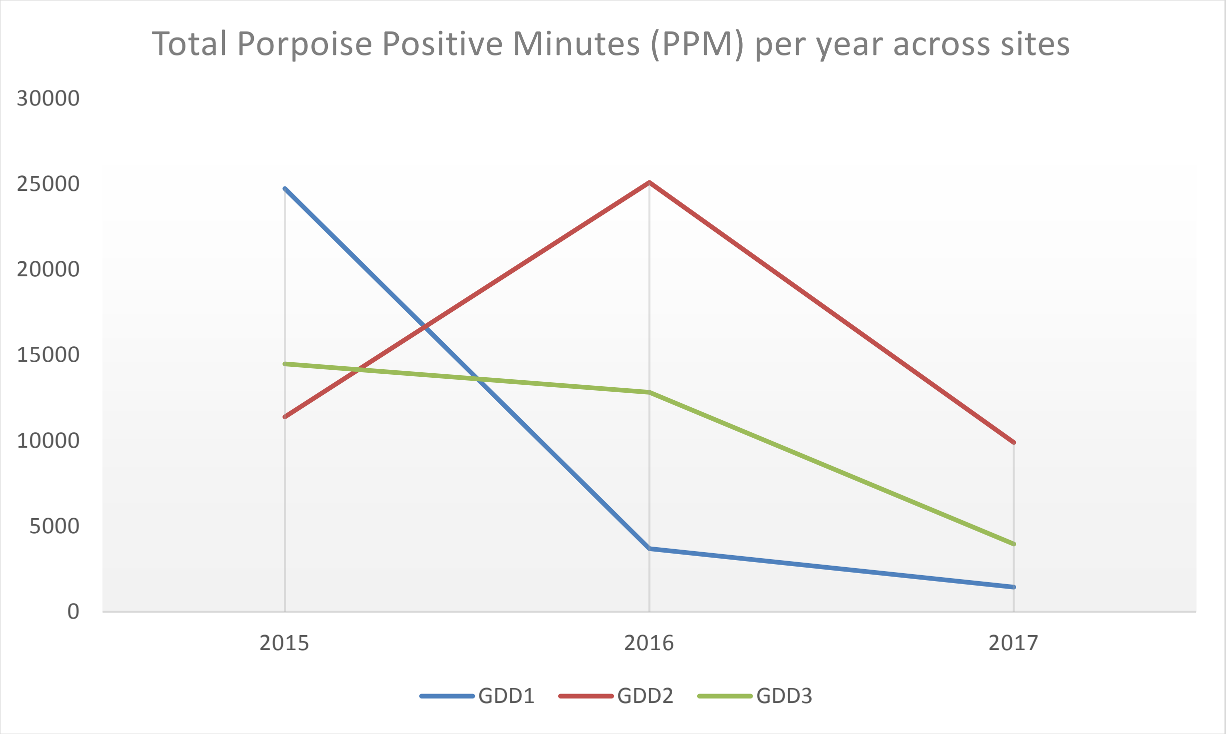


Figure 39. Porpoise Positive Minutes per day (PPMs) recorded each year across sites. The duration of sampling differed between years; days monitored in 2015 (294), days monitored in 2016 (366) and days monitored in 2017 (90).

3.3.2.1 Generalized linear mixed-effect model (GLMM) analyses

As this was a long-term study with monitoring taking place across three years and at three sites, analyses using GLMM were used to assess differences between years and then at the completion of the monitoring, data from all three years from each site were compiled and assessed as one long dataset, allowing for a detailed assessment of fine scale use of the area.

3.3.2.2 GDD 1

GDD1 was the closest site to shore, approx. 2.5 km, and was the shallowest location at a depth of 5.1m. Results across years showed that each of the four factors (season, diel, tidal cycle and tidal phase) were significant during 2015, while in 2016 only season and diel were found to be significant. When all data were compiled, all factors were found to be significant (Table 8).

Table 8. Results from GLMM's per year and all data combined from GDD1.

Location	Year	Variable	X^2	df	P-value
GDD1	2015	Season	212.2	4	0.000
		Diel	212.2	4	0.000
		T.P	192.3	3	0.000
		T.C	212.2	4	0.000
GDD1	2016	Season	140.1	4	0.000
		Diel	140.1	4	0.000
		T.P	53.7	3	0.1
		T.C	42.0	4	0.1
GDD1	2017	Season	167.5	4	0.000
		Diel	167.5	4	0.000
		T.P	128.7	3	0.000
		T.C	168.6	4	0.000
GDD	all years combined	Season	277.9	4	0.000
		Diel	204.2	4	0.000
		T.P	144.3	3	0.000
		T.C	204.2	4	0.000

Data are presented as box plots, which help to visualise the results. In 2015, there were significantly more detections at GDD1 during the autumn, winter and summer months when compared with spring (χ2= 212, p<0.000). Significantly more detections were recorded during the hours of darkness and the intermittent hours between dawn and dusk (χ2= 212.2, p<0.000), as well as during the tidal phase spring (χ2= 192.3, p<0.000) and tidal cycle low (χ2= 212.2, p<0.000), Figure 40)).

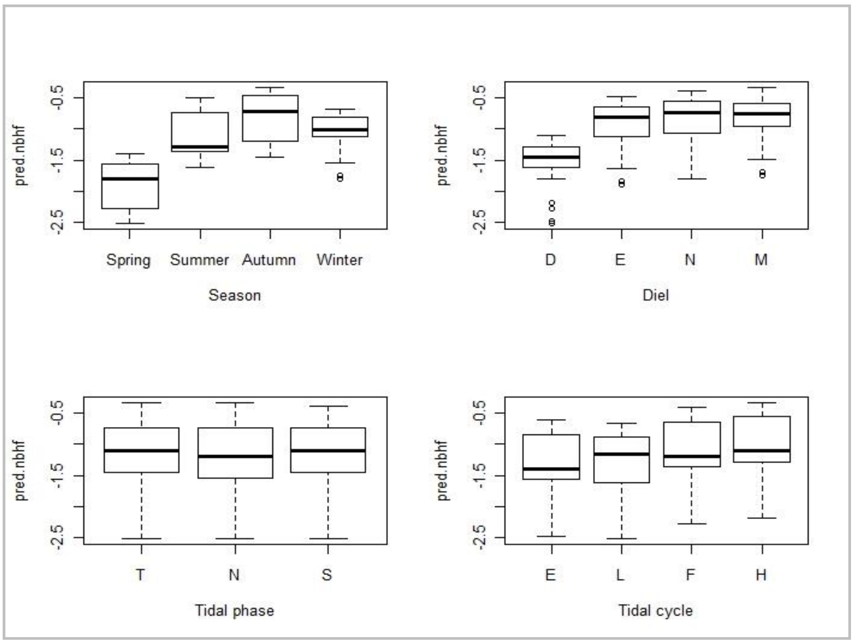


Figure 40. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD1 (Co. Dublin) Mar 2015-Dec 2015 across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

In 2016, season was found to be a significant factor again but detections in spring was found to be significantly higher compared with 2015, where most detections were during the spring months (χ^2= 140.1, p<0.000). Similarly to 2015, more detections were recorded during the hours of darkness and the intermittent hours between dawn and dusk (χ^2= 140.1, p<0.000), but tidal phase (χ^2= 53.7, p=1.3) and tidal cycle (χ^2= 42.0, p=1.7) were not significant (Figure 41).

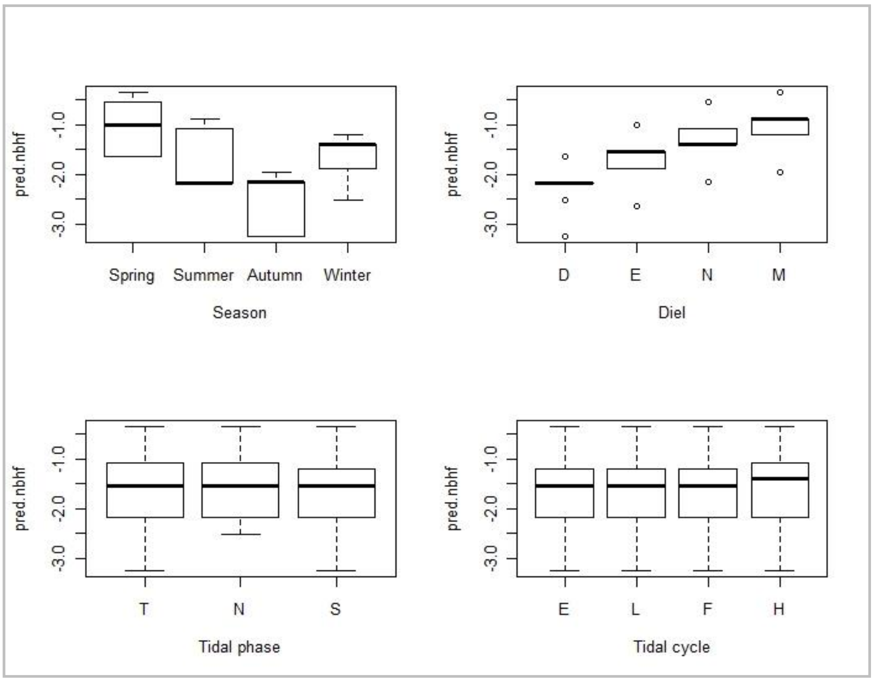


Figure 41. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD1 (Co. Dublin) Jan - Dec 2016 across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

Monitoring only took place in 2017 between January and March but the data were still processed as before with just two seasons, winter and spring. All factors were found to be significant (Table 8, Figure 42).

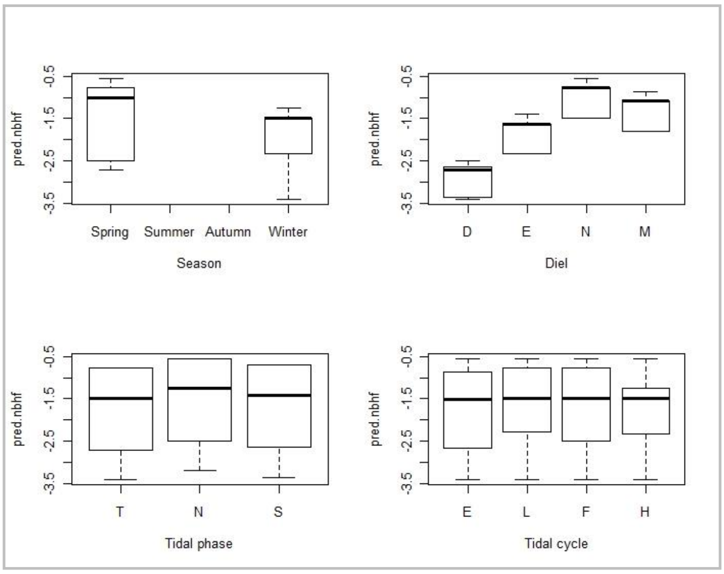


Figure 42. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD1 (Co. Dublin) Jan - Mar 2017 across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

The last analyses on data from GDD1 was to combine all dataset collected across the 556 days, which showed that three of the four factors were significant. Significantly more detections occurred in Autumn (χ^2= 279.9, p<0.000), with most detections during the night and in morning hours (χ^2= 204.2, p<0.000), while significantly more detections were recorded at slack high tide (χ^2= 168.6, p<0.000), which is plausible given this site, is very shallow (Figure 43).

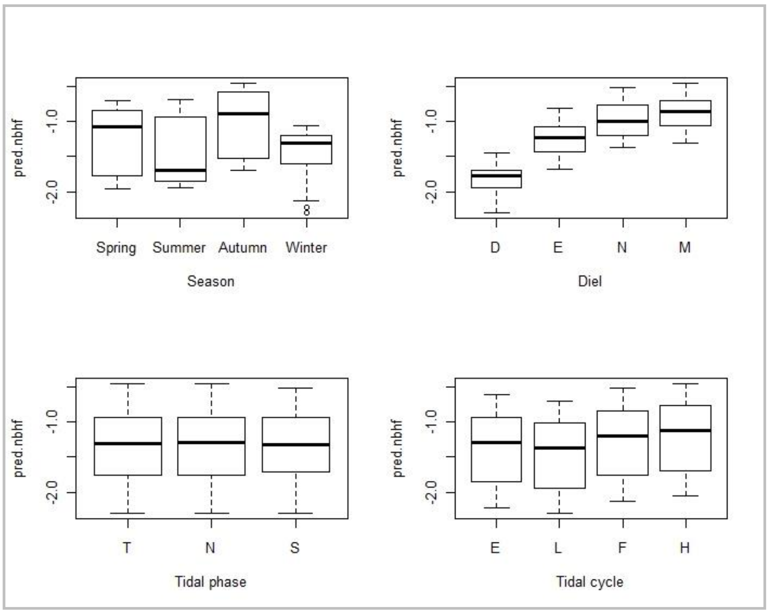


Figure 43. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD1 (Co. Dublin), all days, Mar 2016 - Mar 2017 (556 days) across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

3.3.2.3 GDD 2

GDD2 was the middle site, approximately 1km from GDD1 and 1.5km from GDD3 and at a depth of approximately 14m. Results (Table 9) show a lot of variability between years and across factors, but when all years were combined it was evident that all factors except tidal phase were significant.

Table 9. Results from GLMM's per year and all data combined from GDD2.

Location	Year	Variable	X^2	df	P-value
GDD2	2015	Season	371.5	4	0.000
		Diel	371.5	4	0.000
		T.P	38.3	3	0.2
		T.C	458.4	4	0.000
GDD2	2016	Season	80.4	4	0.000
		Diel	80.4	4	0.000
		T.P	21.1	3	0.1
		T.C	29.2	4	0.000
GDD2	2017	Season	164.4	4	0.000
		Diel	164.4	4	0.000
		T.P	53.7	3	0.1
		T.C	170.6	4	0.000
GDD2	all years combined	Season	105.5	4	0.000
		Diel	760.5	4	0.000
		T.P	144.3	3	0.3
		T.C	59.9	4	0.000

Box plots below help visualise the results from GDD2 demonstrating there were significantly more detections during the winter, autumn and summer months when compared with spring ($\chi2= 212$, $p<0.000$) in 2015, following similar trends to GDD1 but in the following year (2016). Significantly more detections were recorded during the hours of darkness and the intermittent hours between dawn and dusk ($\chi2= 212.2$, $p<0.000$). Tidal cycle had significantly more detections during the flood tide, while no significant trends were found for tidal phase (Figure 44).

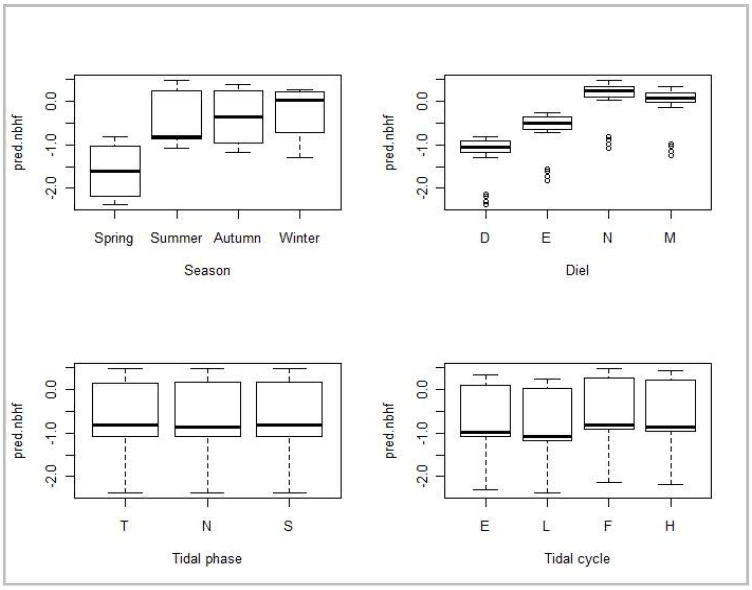


Figure 44. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD2 (Co. Dublin) Mar – Dec 2015 across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

At GDD2, results for 2016 showed season to be a significant factor, similar to results from GDD1 from 2015, with detections in spring significantly higher (χ^2= 140.1, p<0.000). Similarly to 2015 across sites, more detections were recorded during the hours of darkness and the intermittent hours between dawn and dusk (χ^2= 140.1, p<0.000), and during high tide (χ^2= 29.2, p<0.000), with tidal phase having no significant effect (χ^2= 21.1, p=7.0; Figure 45).

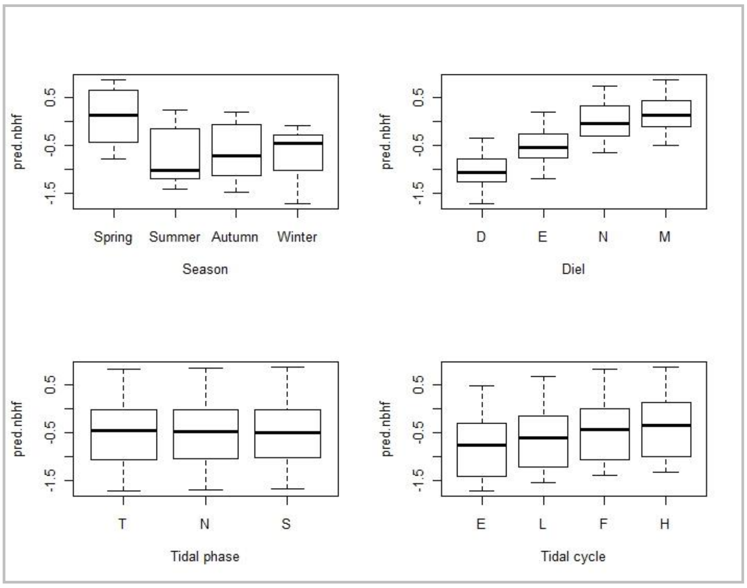


Figure 45. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD2 (Co. Dublin) Jan – Dec 2016 across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

At GDD2 in 2017, results showed all factors to be significant except tidal phase (Table 9; Figure 46).

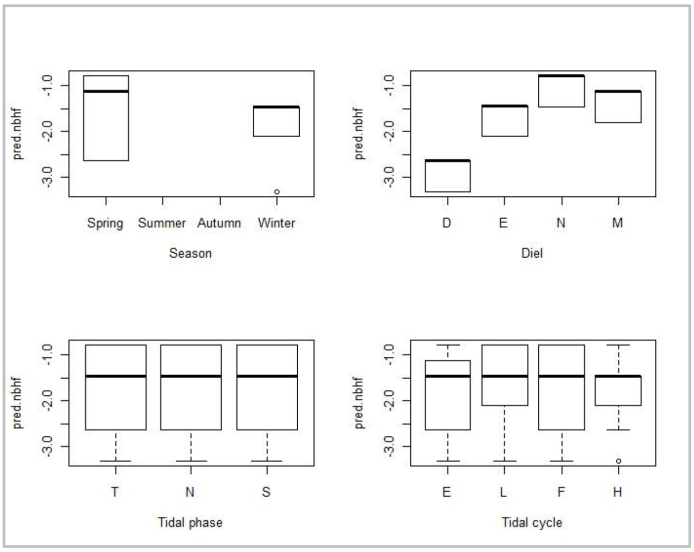


Figure 46. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD2 (Co. Dublin) Jan – Mar 2017 across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

As for GDD1, all data from GDD2 were combined across years for the 544 days monitored and results showed that three of the four factors were significant. In this instance, significantly more detections occurred during winter (χ2= 279.9, p<0.000), with most detections during the night and morning hours (χ2= 204.2, p<0.000), while significantly more detections were recorded at slack high tide (χ2= 168.6, p<0.000), which is plausible given this site, is very shallow (Figure 47).

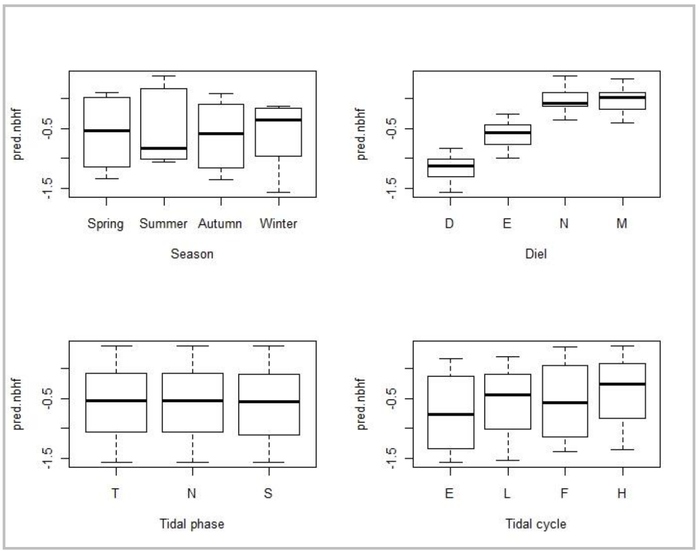


Figure 47. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD2 (Co. Dublin), March 2015 – Mar 2017 (544 days) across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

3.3.2.4 GDD 3

GDD3 was the furthest site offshore, 1.5km from GDD2, and 2.5km from GDD1 (5km from land) and in a depth of approximately 24m. Similarly, for GDD3, the same analytical approach was followed and results showed all factors to be significant in 2015, 2016 and 2017. It was clear that there was a lot of variability between years and across factors (Table 10), but when all years were combined it was evident that all factors except tidal cycle were significant at GDD3.

Table 10. Results from GLMM's per year and all data combined from GDD3.

Location	Year	Variable	X^2	df	P-value
GDD3	2015	Season	30.5	4	0.000
		Diel	30.5	4	0.000
		T.P	30.4	3	0.000
		T.C	16.4	4	0.000
GDD3	2016	Season	119.4	4	0.000
		Diel	119.4	4	0.000
		T.P	43.9	3	1.0
		T.C	29.9	4	0.000
GDD3	2017	Season	279.0	4	0.000
		Diel	340.0	4	0.000
		T.P	26.3	3	1.3
		T.C	38.3	4	0.000
GDD3	all years combined	Season	105.5	4	0.000
		Diel	760.5	4	0.000
		T.P	144.3	3	0.000
		T.C	59.9	4	3.0

For GDD3 2015, results showed significantly more detections occurred across spring, summer and autumn when compared with winter. Although no significant difference was apparent in the box plot, the Walds test showed significance existed (χ^2= 30.5, p<0.000). Tidal phase and tidal cycle were also significant although again not apparent from the diagram (Table 10, Figure 48).

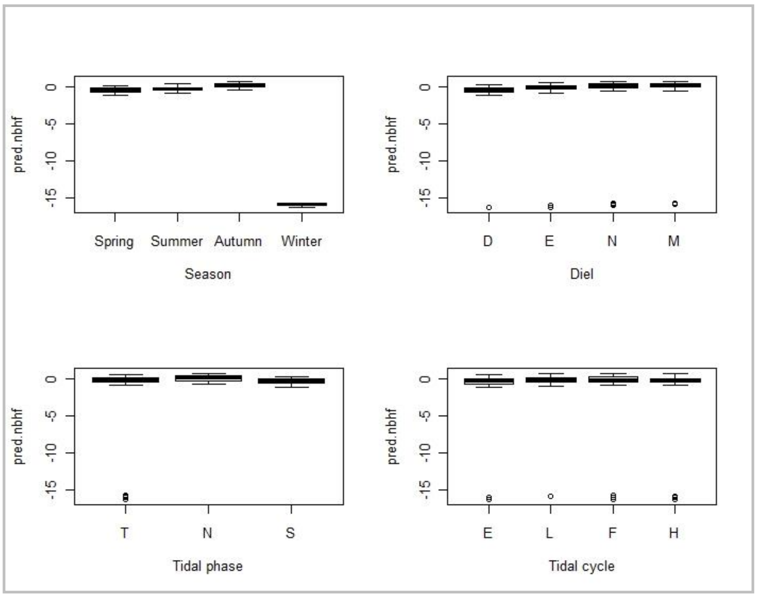


Figure 48. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD3 (Co. Dublin) Mar– Dec 2015 across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

GDD3 for 2016 showed similar results to GDD1 and 2 where season showed significantly more detections during the spring and winter months (χ2= 119.4, p<0.000), and across diel cycle night and morning (χ2= 119.4, p<0.000). Significantly, more detections were recorded during the neap phase of the tide (χ2= 43.9, p<0.000), and during slack periods of the tidal cycle (χ2= 29.9, p<0.000; Figure 49).

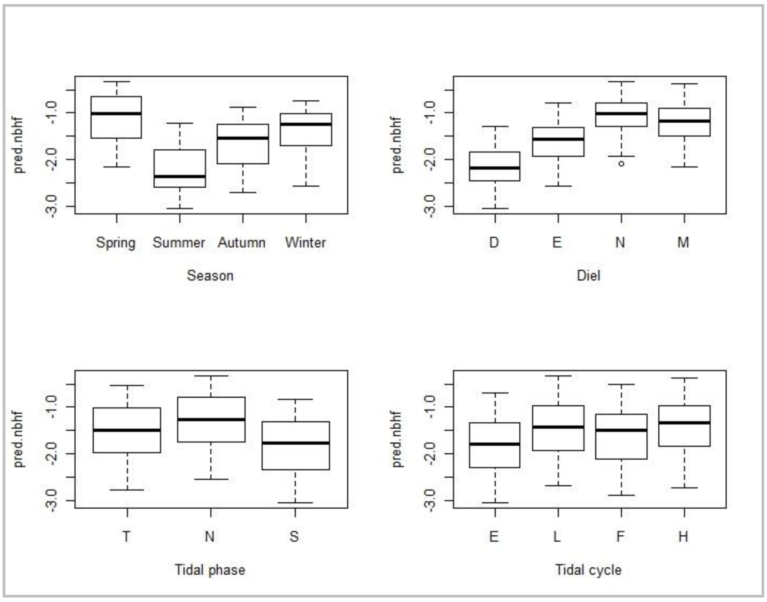


Figure 49. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD3 (Co. Dublin) Jan– Dec 2016 across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

At GDD3 in 2017, results showed all factors to be significant except tidal phase (Table 10; Figure 50), and mirroring the results of GDD3 2016.

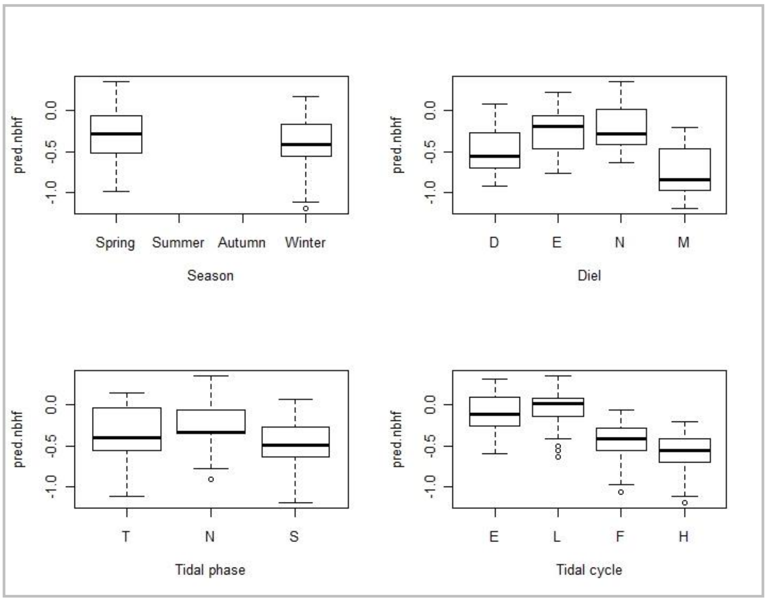


Figure 50. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD3 (Co. Dublin) Jan – Mar 2017 across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

All GDD3 data across years were combined for the 530 days monitored at the site and results showed that all four factors were significant. In this instance significantly more detections occurred in Autumn (χ2= 279.1, p<0.000), with most detections during the night and morning hours (χ2= 340, p<0.000), while significantly more detections were recorded the neap tidal phase (χ2= 65.5, p<0.000) at slack high tide (χ2= 38.3, p<0.000; Figure 51).

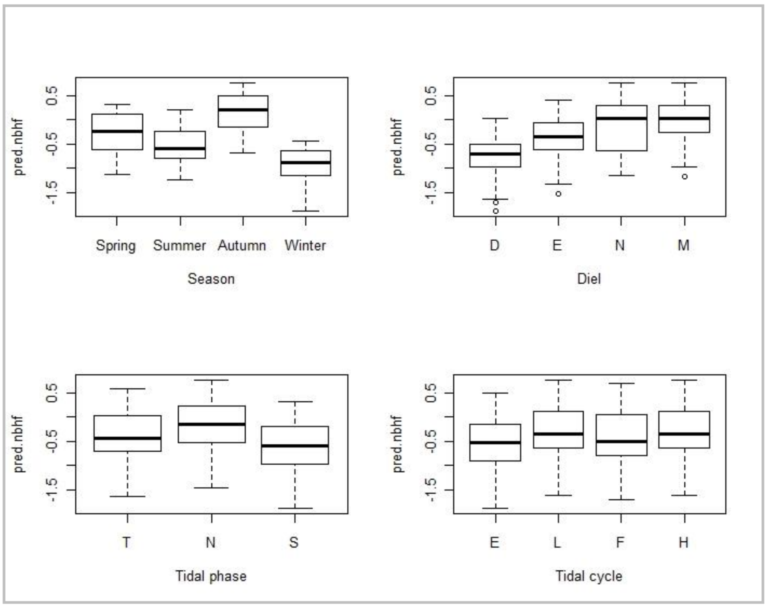


Figure 51. Predicted proportion of detection positive hours, in the narrow band high frequency channel at GDD3 (Co. Dublin) all months, March 2015 to March 2017 across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

In summary, results across all days monitored at each of the sites showed harbour porpoise to be present on average 98% of days monitored. The highest presence was detected across the autumn and winter months, during the hours of darkness (incl. dawn and dusk), during high tide and at GDD3 during the neap cycle of the tidal phase (Table 11). The site with the highest overall detections was GDD2.

Table 11. Significant results from the long-term dataset at each site (*no significance).

Significant factors	**GDD1**	**GDD2**	**GDD3**
Season	Autumn	Winter	Autumn
Diel	Night	Night	Night
Tidal phase	*	*	Neap
Tidal cycle	High	High	High

DISCUSSION

A combination of visual and acoustic, land and boat-based methodologies has provided a very detailed, high resolution assessment of the marine mammal community and its use of the site in line with best international practice. Visual surveys provided information on species identification, distribution and abundance and behaviour while acoustic data provided high resolution information on the use of the site by harbour porpoise including diel, tidal and temporal patterns.

4.1 Visual surveys

Marine mammals were recorded on 100% of survey days demonstrating the importance of the area for this important group of high nature conservation animals. Species recorded comprised of harbour porpoise, grey seal, harbour seal and minke whale.

Harbour porpoise were recorded on 83% of land-based surveys and 100% of boat-based surveys. Abundance was lowest from May to July, 2015 and from April to June, 2016. Harbour porpoise in Irish waters move offshore during spring and early summer, which is believed to associated with calving (Wall et al. 2013) and trends during the present study were consistent with this. Harbour porpoise abundance increased between August and January 2015 and between August and October 2016. Group size also increased during this period which coincided with a peak in sightings of young animals. In the North Atlantic, harbour porpoise calves are born in mid to late summer (Rogan & Berrow, 1996, Lockyer, 2003; Learmonth et al. 2014) and reliant on their mothers for 8-10 months (Learmonth et al. 2014). Female harbour porpoise may time calving so that high energetic demands such as lactation coincides with the availability of seasonally abundant local prey (Learmonth et al. 2014). In Irish waters, harbour porpoise feed primarily on fish with *Trisopterus* and gadoid species being important (Rogan & Berrow 1996, IWDG 2009, Hernandez-Milian 2014). The peak in abundance of harbour porpoise may therefore be attributed to the inshore movement of porpoise to feed on locally abundant prey. The increase in group size recorded during this time is most likely due to the presence of nursing calves.

The area has also been shown to be important for grey seals with individuals recorded on 100% of land-based surveys and 91% of boat surveys. Sightings were highest in April 2015 which coincided with the end of the male moulting season and January 2016 which coincided with the end of the female moult (Kiely et al. 2000). High numbers were also recorded in September 2015, November 2015 and October 2016 which spans the grey seal breeding and pupping season (Ó Cadhla, 2007). Sightings largely consisted of single adults although two juveniles were recorded in September 2015 beside Ireland's Eye. Seals tended to occupy more westerly waters than the harbour porpoise and were often seen following fishing boats, feeding and hauling out on Ireland's Eye at low tide.

Few other marine mammal species were recorded. Although Lambay Island SAC is designated for both grey seal and harbour seal, only two individual harbour seals were recorded during this study, one each in April and August 2015. Two sightings of single minke whales were recorded during two boat-surveys, one in June 2015 and one in August 2016. These records are similar to a previous study where minke whales were recorded from late April to early August off north Co. Dublin (Wall et al. 2013).

4.1.1 Density and abundance for harbour porpoise

For seven of the eleven surveys carried out, the number of sightings were sufficient to derive density and abundance estimates for harbour porpoise. Within the area surveyed, the density of harbour porpoise varied from 0.61 to 2.29 harbour porpoise per km^2, with a mean density of 1.32, which was similar to previous surveys in the area (Table 12). Densities were lowest in April 2015 and February 2016, peaking in August 2015, November 2015 and August 2016, with lower but still relatively high densities in October 2016 and January 2017.

Harbour porpoise densities were previously derived for two sites off Co Dublin in 2008 and for the Rockabill to Dalkey Island SAC in 2013 and 2016. The area surveyed off North County Dublin was similar to the area surveyed in the present study. Density estimates from North County Dublin in 2008 varied considerably but the highest density of porpoises recorded at any site in Ireland so far was recorded at 6.93 porpoises per km^2 in August 2008. However estimates during other surveys during 2008 were much lower, which resulted in an overall density estimate of 2.03 harbour porpoise per km^2.

Table 12. Density, abundance and group size estimates for harbour porpoise in North County Dublin

Location	Year	Area (km²)	Mean group size	Density (per km²)	Abundance ± SE (95% CI)	CV	Reference
Greater Dublin Drainage	2015-17	201	1.39	1.32	248	-	This report
Rockabill to Dalkey Island SAC	2016	273	1.62	1.55	424±45 (335-536)	0.10	O'Brien and Berrow (2016)
Rockabill to Dalkey Island SAC	2013	273	1.47	1.44	391±25 (344-445)	0.06	Berrow and O'Brien (2013)
North County Dublin	2008	104	1.41	2.03	211±47 (137-327)	0.23	Berrow *et al.* (2008a)
Dublin Bay	2008	116	1.19	1.19	138±33 (86-221)	0.24	Berrow *et al.* (2008a)

If we use the average of the overall density estimates from 2008 for the two sites it equates to 1.61 which is higher but similar to the present survey. A previous wider-scale line-transect survey in the north Irish Sea, to the east and north of the current SAC, derived a density estimate of 1.59±0.22 porpoises per km^2 (Berrow et al. 2011). This was also of a similar magnitude to that calculated from the present survey.

Density estimates within the Rockabill to Dalkey Island SAC were greater in 2016 than presented here but only by 10-15% which suggests the present study area is very favourable for porpoise with densities similar to those within an SAC. Indeed, there was remarkable consistency in density estimates across all surveys carried out in North County Dublin since 2013 which were consistently elevated compared to sites surveyed elsewhere in Ireland (Berrow et al. 2014).

Thus this survey has, despite quite considerable variability in density estimates, provided a mean density very similar to previous studies. This density is high and emphasizes the importance of this site for this species as these are some of the highest densities of harbour porpoise recorded to date in Ireland.

4.2 Static Acoustic Monitoring

Cetaceans live in an acoustic world and increasingly attempts have been made to develop acoustic monitoring techniques rather than relying on visual methods, where efficacy is dependent on light, weather conditions and sea-state, especially for species such as the elusive harbour porpoise. Their reliance on vocalisations for navigation and communication is essential and therefore acoustic monitoring is a very valuable tool for determining presence and assessing fine-scale habitat use. The main advantage of acoustic monitoring is that it can provide information on species that spend up 95% of the time underwater and thus can be difficult to observe (Read & Westgate 1995). Patterns of cetacean presence have been described over seasonal scales (Canning et al. 2008, Bolt et al. 2009; Simon et al. 2010, Gilles et al. 2011, O'Brien et al. 2013), diel cycles (Cox & Read 2004, Carlström 2005, Todd et al. 2009, O'Brien et al. 2013) and tidal patterns (Marubini et al. 2009, O'Brien et al. 2013). In order to evaluate the importance of an area, it is fundamental that the presence of small odontocetes is fully understood and this requires monitoring over varying time scales. Although SAM can provide a much more complex account of cetacean activity at a site in comparison to visual monitoring, it cannot present accurate estimates of abundance for which visual surveys are required.

The aim of the present study was to produce a detailed assessment of the use of the site by marine mammals and to provide baseline data. Cetacean occurrence in the general area was achieved through visual surveys but detailed information on the use of the proposed route of the discharge pipe off Portmarnock sites was achieved through static acoustic monitoring. The data collected at Portmarnock was compared with the smaller dataset collected off Loughshinny, which was treated as a control site and with other regional sites.

The acoustic data demonstrated that the all three sites monitored along the proposed route of the outfall pipe off Portmarnock are used consistently by harbour porpoises on a daily basis. However, presence was greater during autumn and winter, during hours of darkness and at slack high tides. When the data from Portmarnock are compared to Loughshinny data collected in 2015 (Meade et al. 2015) results were similar with autumn having the highest detections, however, only six months were monitored. Tidal cycle was not significant at Loughshinny in contrast to Portmarnock, where more detections were recorded during spring tidal phase. Monitoring index at Loughshinny was high at 9.8%, while at Portmarnock values ranged between 2.8 and 6.6 across sites, suggesting Loughshinny is the most important site monitored for harbour porpoise during the GDD project.

Trends in the presence of harbour porpoise with diel cycle on the east coast of Ireland have been found to differ geographically, but they are consistently more active at night. The reasons for increased nocturnal activity are uncertain but could be linked to an increase in prey abundance or activity in the absence of light, as suggested by Todd et al. (2009).

The results from Portmarnock and Loughshinny are compared to other sites around Ireland (Table 13). Some of the highest DPM's recorded to date were from Loughshinny, especially given deployments were only for six months. Some of the early studies used T-PODs, which are an earlier version of the C-POD. Previous work by O'Brien et al. (2013) showed that C-PODs recorded on average, seven times more data than T-PODs during simultaneous deployments in Galway Bay. However, it is clear that deployments from the east coast have a greater number of detections per deployment from any other monitored site in the country. Previous deployment off Howth Head recorded 12.2 DPM/hr, in comparison to the present study with an average across sites of 2.7. However, the Howth deployment was over a short duration using a T-POD. The Portmarnock dataset is similar to that at Spiddal in Galway Bay with a similar number of deployment days. Galway Bay is not a designated SAC while the Portmarnock area lies within the boundaries of the Rockabill to Dalkey SAC. When the present data is compared with other deployments around Ireland, such as the Blasket Islands SAC, the number of detections from Co. Dublin were still much greater.

Table 13. Monitoring results from SAM across Ireland (green line denotes data collection using T-PODs so some caution necessary when interpreting results.

County	Site	Total days	DPD %	Total PPM	%DPM	Mean DPM/day	Mean DPM/hr	Reference
Dublin	GDD1	556	96	29,851	2.8	41.3	1.7	*Present study*
Dublin	GDD2	544	98	46,379	6.6	94.3	4.0	*Present study*
Dublin	GDD3	540	99	31,266	3.0	57.6	2.4	*Present study*
Dublin	Loughshinny	189	100	26,281	9.6	137	5.8	Meade *et al.,* 2015
Galway	Spiddal	572	541	27,902	3.4	48.8	2.0	O'Brien *et al.,* 2013
Kerry	Inishtooskert	264	236	3930	1.04	14.9	0.6	O'Brien *et al.,* 2013
Kerry	Wild Bank	289	221	2097	0.51	7.3	0.3	O'Brien *et al.,* 2013
Kerry	The Gob	52	49	3015	4.1	58.0	2.4	O'Brien *et al.,* 2013
Dublin	Howth	47	100	13718	10.1	291.9	12.2	Berrow *et al.* (2008a)
Cork	Castlepoint	63	100	1379	2.0	21.9	0.9	Berrow *et al.* (2008a)
Cork	Sherkin	23	44	707	1.0	30.7	1.3	Berrow *et al.* (2008a)
Cork	Galley Head	63	30	1614	2.4	25.6	1.1	Berrow *et al.* (2008a)

It is clear from both the visual and acoustic surveys that North County Dublin is an important area for marine mammals, especially harbour porpoise. Marine mammals were present during 100% of visual surveys although abundance did vary throughout the year. The site is also important for grey seals which were recorded throughout the year. Grey seals can be sensitive to disturbance particularly during the breeding season (Kiely et al. 2000), which occurs from August to December (O'Cadhla, 2007). The proposed outfall site is 8km to Lambay Island SAC which is the most important site for grey seals on the east coast of Ireland (Kiely et al. 2000).

Harbour porpoise numbers increased in late summer during both 2015 and 2016 which coincided with the presence of calves and may be due to seasonally abundant food sources such as sprat, herring and *Trisopterus* and gadoid species. Reduced numbers were recorded during late spring/early summer which may be associated with an offshore movement of this species before calving. The density estimate of harbour porpoise was high and emphasizes the importance of this site for this species as these are some of the highest densities recorded in Ireland to date. Acoustic monitoring provided an insight into the habitat use of the site across time and diel and tidal cycles, which could not be recorded from visual surveys. Harbour porpoise were present almost daily at the Portmarnock site, with their presence influenced by seasonal, diel and tidal factors.

4.3 Recommendations

Harbour porpoises and grey seals, both of which are listed under Annex II of the Habitats Directive, are entitled to strict protection including their habitat, and extreme care must be taken to ensure the proposed development does not degrade this habitat or cause undue disturbance. These results will serve to inform protocols of best practice if work goes ahead and thus ensure the presence of marine mammals in the area is not negatively impacted upon.

Mitigation measures should take into account the acoustic disturbance of marine mammals at the site and any associated noise input or long-term potential disturbance should be reviewed to minimise displacement and to prevent habitat exclusion or hearing impacts such TTS or PTS. Mitigation measures should be in accordance with the NPWS document "*Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters*" to ensure impacts through habitat exclusion or noise impacts are minimised. In order to assess if any displacement of harbour porpoise occurs, we recommend acoustic monitoring is carried out at a control site such as the Loughshinny site during and after installation works, with additional monitoring close to the actual outfall point post construction.

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REFERENCES

Akamatsu, T., Wang, D., Wang, K., Li, S. and Dong, S., 2010. Scanning sonar of rolling porpoises during prey capture dives. *Journal of Experimental Biology*, *213* (1), pp.146-152.

Berrow, S.D. and O'Brien, J., 2013. Harbour porpoise surveys in Rockabill to Dalkey Island SAC, 2013. Report to the National Parks and Wildlife Service. Irish Whale and Dolphin Group, pp. 37.

Berrow, S.D., Hickey, R., O'Brien, J. O'Connor, I. and McGrath, D., 2008a. Harbour Porpoise Survey 2008. Report to the National Parks and Wildlife Service. Irish Whale and Dolphin Group, pp. 31.

Berrow, S.D., Hickey, R., O'Connor, I. and McGrath, D., 2008b. Small Cetacean Site Investigations Survey 2008. Report to the National Parks and Wildlife Service. Irish Whale and Dolphin Group, pp. 25.

Berrow, S.D., Hickey, R., O'Connor, I. and McGrath, D., 2014. Density estimates of harbour porpoises *phocoena phocoena* at eight coastal sites in Ireland. In *Biology and Environment: Proceedings of the Royal Irish Academy*, *114* (1), pp. 19-34.

Berrow, S.D., O'Brien, J., O'Connor, I. and McGrath, D., 2009. Abundance estimate and acoustic monitoring of harbour porpoise *Phocoena phocoena* in the Blasket Islands candidate Special Area of Conservation. *Biology and Environment, Proceeding of the Royal Irish Academy*, pp. 35-46.

Berrow, S.D., Whooley, P., O'Connell, M. and Wall, D., 2010. Irish Cetacean Review (2000-2009). Irish Whale and Dolphin Group, pp. 60.

Bolt, H.E., Harvey, P.V., Mandleberg, L. and Foote, A., 2009. Occurrence of killer whales in Scottish inshore waters: temporal and spatial patterns relative to the distribution of declining harbour seal populations. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *19* (6), pp. 671-675.

Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L. and Thomas, L., 2001. An Introduction to Distance Sampling: Estimating abundance of biological populations. *Oxford University Press*, Oxford, UK.

Canning, S.J., Santos, M.B., Reid, R.J., Evans, P.G., Sabin, R.C., Bailey, N. and Pierce, G.J., 2008. Seasonal distribution of white-beaked dolphins (*Lagenorhynchus albirostris*) in UK waters with new information on diet and habitat use. *Journal of the Marine Biological Association of the UK*, *88* (06), pp. 1159-1166.

Carlström, J., 2005. Diel variation in echolocation behavior of wild harbor porpoises. *Marine Mammal Science*, *21* (1), pp. 1-12.

Clarke, R., 1982. An index of sighting conditions for surveys of whales and dolphins. *Report of the International Whaling Commission*, *32*, pp. 559-561.

Cox, T.M., Read, A.J., Solow, A. and Tregenza, N., 2001. Will harbour porpoises (*Phocoena phocoena*) habituate to pingers?. *Journal of Cetacean Research and Management*, *3* (1), pp. 81-86.

David, L., 2002. Disturbance to Mediterranean cetaceans caused by vessel traffic. Report prepared for the ACCOBAMS Secretariat, Monaco, pp. 21.

Dawson, S., Wade, P., Slooten, E. and Barlow, J., 2008. Design and field methods for sighting surveys of cetaceans in coastal and riverine habitats. *Mammal Review*, *38* (1), pp. 19-49.

Evans, P.G. and Hammond, P.S., 2004. Monitoring cetaceans in European waters. *Mammal review*, *34* (1-2), pp. 131-156.

Gilles, A., Adler, S., Kaschner, K., Scheidat, M. and Siebert, U., 2011. Modelling harbour porpoise seasonal density as a function of the German Bight environment: implications for management. *Endangered species research*, *14* (2), pp. 157-169.

Hernandez-Milian, G. 2014. Trophic role of small cetaceans and seals in Irish waters. Ph.D. thesis, University College Cork, Cork, Ireland, pp. 402.

Herzing, D.L., 2000. Acoustics and social behavior of wild dolphins: implications for a sound society. In *Hearing by whales and dolphins*, Springer New York, pp. 225-272.

IWDG (2009) Muc Mhara – Ireland's smallest whale. Proceedings of the 2nd Irish Whale and Dolphin Group International Whale Conference (Eds. Berrow, S.D. and Deegan, B.) 19th -21st September 2008, Killiney, Co. Dublin.

Kiely, O., Lidgard, D.C., McKibben, M., Baines, M.E. & Connolly, N., 2000. Grey Seals: Status and Monitoring in the Irish & Celtic Seas. Maritime Ireland/Wales INTERREG report No. 3. Marine Institute, 80 Harcourt St., Dublin.

Koschinski, S., Diederichs, A. and Amundin, M., 2008. Click train patterns of free-ranging harbour porpoises acquired using T-PODs may be useful as indicators of their behaviour. *J. Cetacean Res. Manage*, *10* (2), pp. 147-155.

Learmonth, J.A., Murphy, S., Luque, P.L., Reid, R.J., Patterson, I.A.P., Brownlow, A., Ross, H.M., Barley, J.P., Begona Santos, M. and Pierce, G.J., 2014. Life history of harbor porpoises (*Phocoena phocoena*) in Scottish (UK) waters. *Marine Mammal Science*, *30* (4), pp. 1427-1455.

Leeney, R.H., Carslake, D. and Elwen, S.H., 2011. Using static acoustic monitoring to describe echolocation behaviour of Heaviside's dolphins (*Cephalorhynchus heavisidii*) in Namibia. *Aquatic Mammals*, *37* (2), pp. 151.

Lockyer, C., 2003. Harbour porpoises (*Phocoena phocoena*) in the North Atlantic: Biological parameters. *NAMMCO Scientific Publications*, *5*, pp. 71-89.

Mann, J., 1999. Behavioral sampling methods for cetaceans: a review and critique. *Marine mammal science*, *15* (1), pp. 102-122.

Marubini, F., Gimona, A., Evans, P.G., Wright, P.J. and Pierce, G.J., 2009. Habitat preferences and interannual variability in occurrence of the harbour porpoise *Phocoena phocoena* off northwest Scotland. *Marine Ecology Progress Series*, *381*, pp. 297-310.

Meade, R., O'Brien, J. and Berrow, S., 2016. Greater Dublin Drainage Marine Mammal Monitoring: Loughshinny. Final report to Jacobs Engineering by IWDG Consulting, pp. 36.

Miller, L.A., Pristed, J., Møshl, B. and Surlykke, A., 1995. The click-sounds of narwhals (*Monodon monoceros*) in Inglefield bay, northwest Greenland. *Marine Mammal Science*, *11* (4), pp. 491-502.

Ó Cadhla, O., Keena, T., Strong, D., Duck, C. and Hiby, L., 2013. Monitoring of the breeding population of grey seals in Ireland, 2009 - 2012. *Irish Wildlife Manuals, No. 74*. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Dublin, Ireland, pp. 18.

Ó Cadhla, O., Strong, D., O'Keeffe, C., Coleman, M., Cronin, M., Duck, C., Murray, T., Dower, P., Nairn, R., Murphy, P., Smiddy, P., Saich, C., Lyons, D. & Hiby, A.R., 2008. An assessment of the breeding population of grey seals in the Republic of Ireland, 2005. *Irish Wildlife Manuals No. 34.* National Parks & Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland, pp. 60.

O'Brien, J. and Berrow, S.D., 2015. Harbour porpoise surveys in Roaringwater Bay and Islands SAC, 2015. Report to the National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht. Irish Whale and Dolphin Group. pp. 43.

O'Brien, J. and Berrow, S.D., 2016. Harbour porpoise surveys in Rockabill to Dalkey Island SAC, 2016. Report to the National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs. Irish Whale and Dolphin Group. pp. 23.

O'Brien, J., Beck, S., Wall, D., Pierini, A., and Hansen, S., 2013. Marine Mammals and Megafauna in Irish Waters, behaviour, distribution and habitat use. Work Package 2: Developing Acoustic Monitoring Techniques. PReCAST Final Report – Marine Research Sub-programme 2007-2013, pp 1-205.

Palka, D., 1996. Effects of Beaufort sea state on the sightability of harbor porpoises in the Gulf of Maine. *Report of the International Whaling Commission*, *46*, pp. 575-582.

Read, A.J. and Westgate, A.J., 1997. Monitoring the movements of harbour porpoises (*Phocoena phocoena*) with satellite telemetry. *Marine Biology*, *130* (2), pp. 315-322.

Rogan, E. and Berrow, S.D., 1996. A review of harbour porpoises. *Phocoena phocoena*, in Irish waters. *Report of the International Whaling Commission*, *46*, pp. 595-606.

Ryan, C., Berrow, S.D., Pierini, A., O'Brien, J., O'Connor, I. and McGrath, D., 2010. Inshore Boat-based Surveys for Cetaceans. Report to the National Parks and Wildlife Service. Irish Whale and Dolphin Group, pp. 33.

Simon, M., Nuuttila, H., Reyes-Zamudio, M.M., Ugarte, F., Verfub, U. and Evans, P.G., 2010. Passive acoustic monitoring of bottlenose dolphin and harbour porpoise, in Cardigan Bay, Wales, with implications for habitat use and partitioning. *Journal of the Marine Biological Association of the United Kingdom*, *90* (08), pp. 1539-1545.

Teilmann, J., 2003. Influence of sea state on density estimates of harbour porpoises (*Phocoena phocoena*). *Journal of Cetacean Research and Management*, *5* (1), pp. 85-92.

Todd, V.L.G., Pearse, W.D., Tregenza, N., Lepper, P.A. and Todd, I.B., 2009. Diel echolocation activity of harbour porpoises (*Phocoena phocoena*) around the North Sea offshore gas installations. *ICES Journal of Marine Science 66* (4) pp. 734-745.

Villadsgaard, A., Wahlberg, M. and Tougaard, J., 2007. Echolocation signals of wild harbour porpoises, *Phocoena phocoena*. *Journal of Experimental Biology*, *210* (1), pp. 56-64.

Wahlberg, M., 2002. The acoustic behaviour of diving sperm whales observed with a hydrophone array. *Journal of Experimental Marine Biology and Ecology*, *281* (1), pp. 53-62.

Wall D., Murray C., O'Brien J., Kavanagh L., Wilson C., Ryan C., Glanville B., Williams D., Enlander I., O'Connor I., McGrath D., Whooley P. and Berrow S., 2013. Atlas of the distribution and relative abundance of marine mammals in Irish offshore waters 2005 - 2011. Irish Whale and Dolphin Group, Merchants Quay, Kilrush, Co Clare. ISBN 0-9540552-7-6.

Young, R.F. and Peace, S., 1999. Using simultaneous counts by independent observers to correct for observer variability and missed sightings in a shore-based survey of bottlenose dolphins, Tursiops truncatus. *J. Cetacean Res. Manage*, *1* (3), pp. 279-287.

APPENDIX – Results from the Loughshinny Marine Mammal Surveys

5.1 Land-based Observations

Land-based monitoring commenced on 18 March and finished on 7 September 2015. Twenty hours of monitoring was conducted over six surveys throughout the monitoring period (Table 14).

5.1.1 Environment

The weather was favourable throughout the surveys with no swell, sea state ≤2and visibility of 6-20km. Precipitation was recorded on two days in July and September. On 13 July, rain was recorded for 39% of the survey. Thirty one (31%) of the rain was recorded as light intermittent and eight (8%) was recorded as heavy. On 07 September, light intermittent rain was recorded for 13% of the survey (Table 14).

Table 14. Environmental conditions recorded during the Loughshinny land-based surveys

Date	Sea state (predominant)	Swell (m)	Visibility (km)	Cloud cover (*/8)	Precipitation (%)	Precipitation Intensity
18 March	1	0	6-10	0	0	-
21 April	1	0	16-20	0	0	-
23 May	1	0	16-20	7	0	-
13 July	2	0	16-20	8	46	Light intermittent
12 August	1	0	16-20	2	0	-
7 September	1	0	16-20	8	13	Light intermittent

5.1.2 Marine Mammal Sightings

Marine mammals were sighted on 86% of land-based survey days. Two marine mammal species were recorded; harbour porpoise and grey seal. Harbour porpoise were present on 67% of days with a peak in numbers recorded in September (Figure 52, Figure 53). Two harbour porpoise calves were recorded during the September survey. Seal species were present on 67% of days (Figure 54, Figure 55). All seal sightings were of adult individuals and consisted of 10 grey seals and two unidentified seal species.

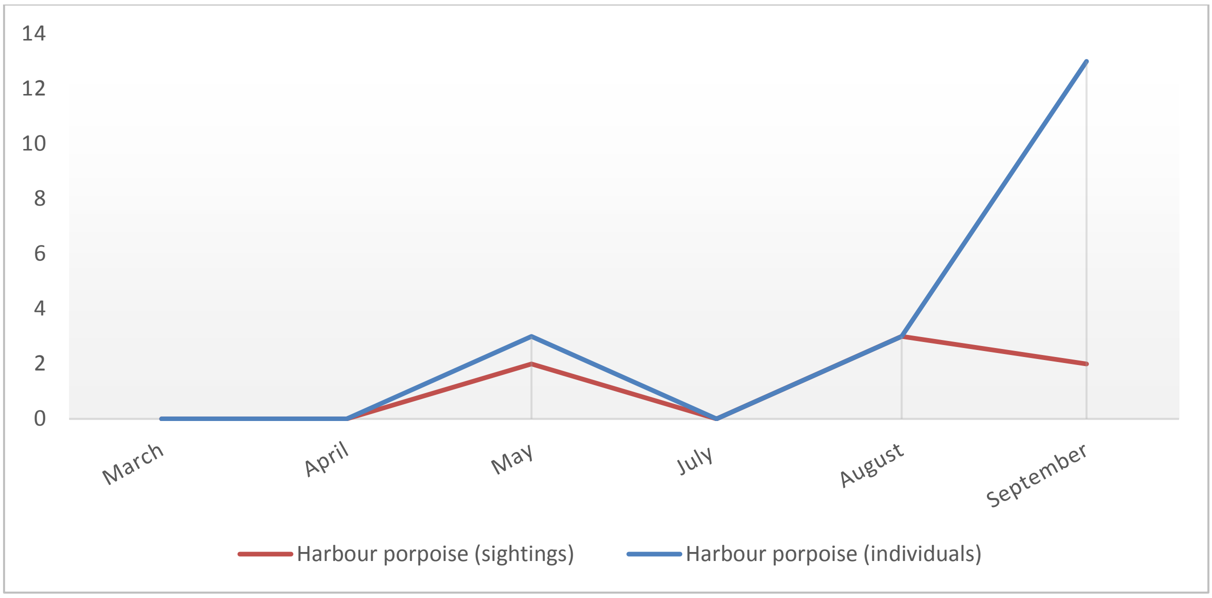

Figure 52. Number of harbour sightings and individuals recorded during Loughshinny land-based surveys

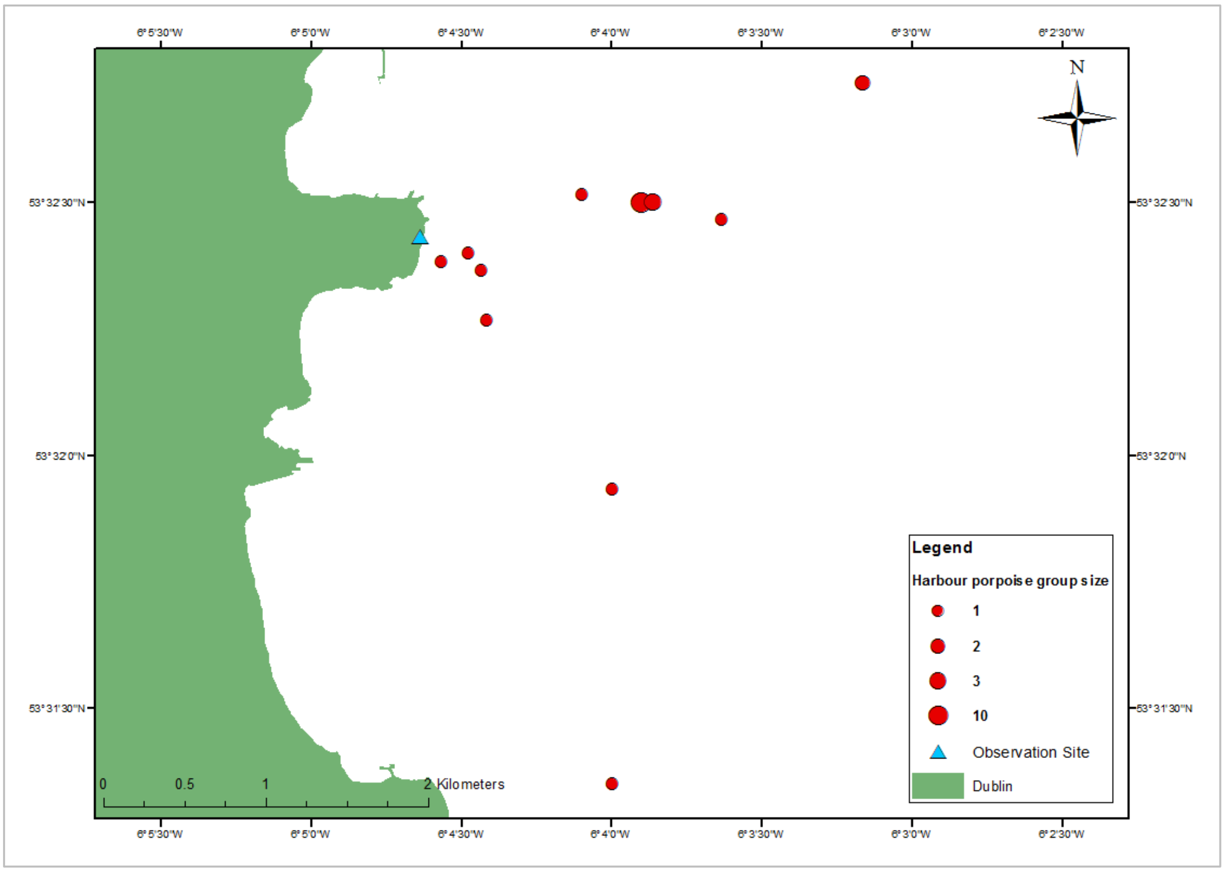

Figure 53. Distribution and group size of harbour porpoise sightings off Loughshinny

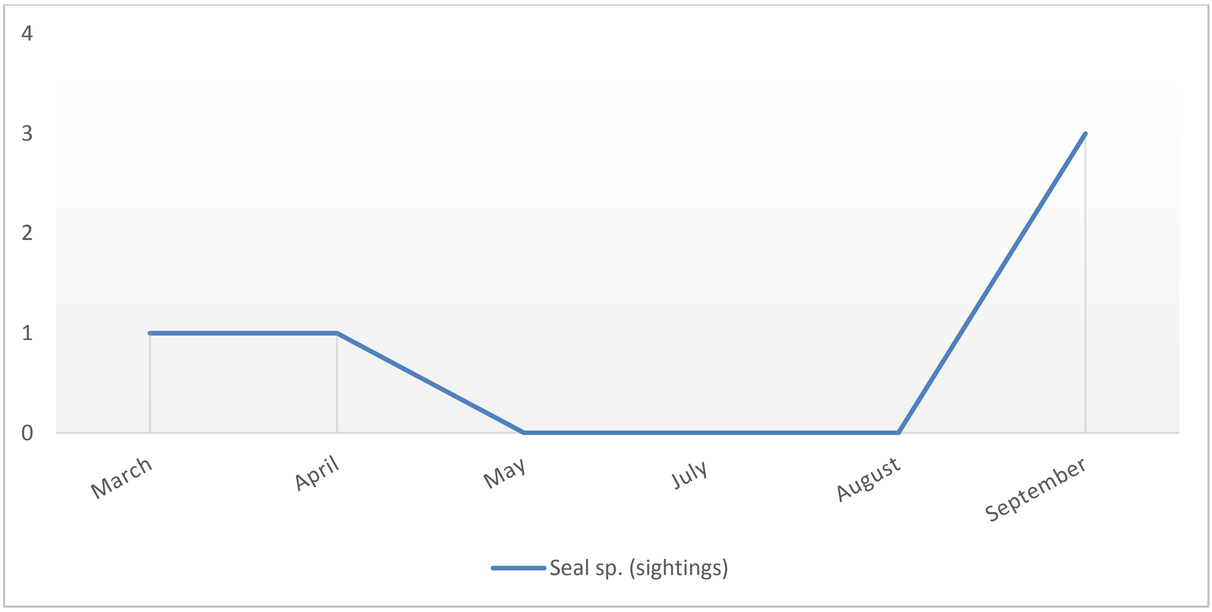

Figure 54. Number of seal sightings recorded during Loughshinny land-based surveys (all single adults)

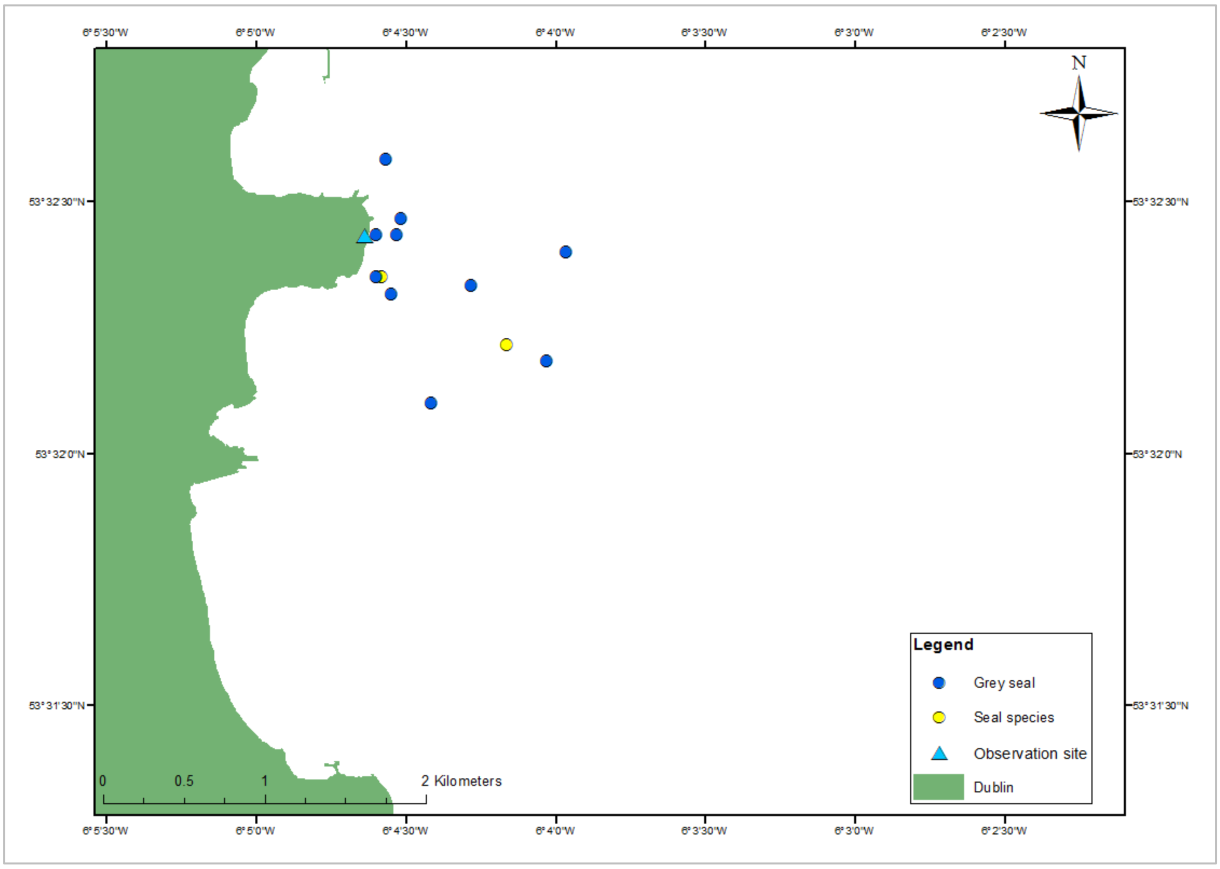

Figure 55. Distribution of seal sightings off Loughshinny

Table 15. Summary of Loughshinny land-based marine mammal surveys showing percentage sea state during survey.

Date	Sea state (% of total survey time)				Number of harbour porpoise sightings	Number of seal sightings	Number of harbour porpoise individuals	Number of seal individuals
	0	1	2	3				
18 March	0	66	33	0	2	5	2	5
21 April	0	100	0	0	0	2	0	2
23 May	40	60	0	0	3	1	4	1
14 July	0	8	92	0	0	0	0	0
12 August	31	69	0	0	3	0	3	0
7 September	7	93	0	0	3	4	14*	4
Total					**11**	**12**	**23**	**12**

*includes 2 calves

5.1.2.1 Focal Follow Observations

Two focal follows were obtained over two days in March and May. During March, a single adult harbour porpoise was tracked with every behaviour recorded for a total of 18 minutes and in May, an individual adult harbour porpoise was followed for 26 minutes (Figure 56).

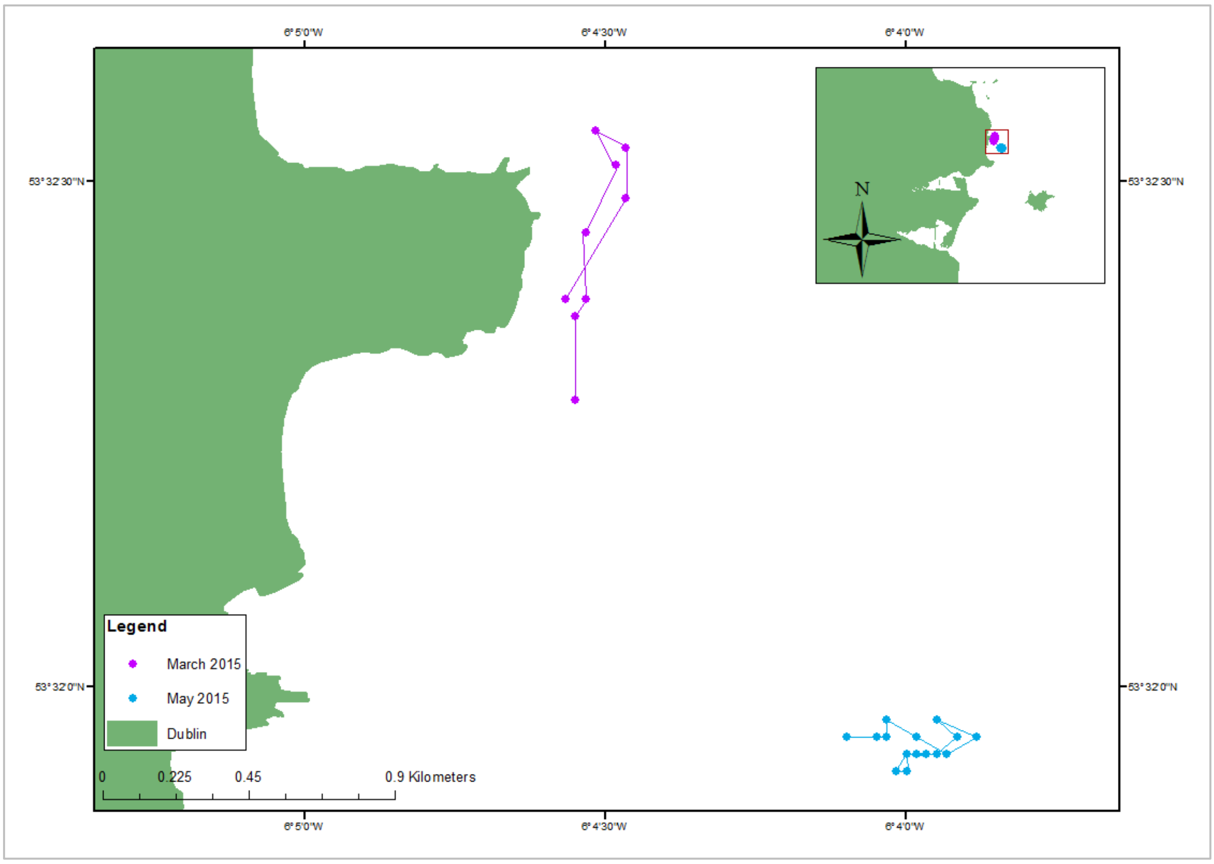

Figure 56. Focal follow tracks of single harbour porpoise during March and May 2015 from Loughshinny land-based site

5.2 Boat-based Surveys

A boat-based survey was attempted on 19 March but fog prevented the vessel from leaving Dun Laoghaire harbour. Three successful surveys were carried out on 20 April, 10 June and 11 August 2015.

5.2.1 Environment

Environmental conditions were generally favourable with the exception of the June survey (Table 16) which although 64% of effort was within the targeted sea state (≤2), was not ideal for detecting harbour porpoises. Weather forecasts for the day consistently reported light winds of 5-7kts from NE for the survey day and minimal swell. We experienced 10 and up to 14kts during the survey with an occasional moderate swell. Even during the survey the forecasts checked (at least three independent forecasts) stated light winds however sea-state was greater than predicted. These local variations have been experienced before during IWDG surveys at this location (e.g. Berrow and O'Brien 2013).

Table 16. Environmental conditions recorded during boat-based marine mammals surveys

Date	Sea state (%)				Predominant swell (m)	Predominant visibility (km)
	0	1	2	3		
20 April	0	27	65	8	1	16-20
10 June	0	14	50	36	0	16-20
11 August	17	63	20	0	0	16-20

5.2.2 Marine Mammal Sightings

Marine mammals were sighted on 100% of survey days (Table 17). Four marine mammal species were recorded during the survey period; harbour porpoise, grey seal, harbour seal and minke whale (Figure 57, Figure 58, Figure 59). All sightings were of adults with the exception of the August survey where four juvenile harbour porpoise and one calf were recorded.

Table 17. Summary of boat-based marine mammal surveys covering Loughshinny in 2015

Date	No. of harbour porpoise sightings	No. of seal sightings	No. of harbour porpoise individuals	No. of seal individuals	No. of other marine mammals
20 April	11	2	15	2	0
10 June	3	1	3	1	1 (minke whale)
11 August	20	2	37	2	0
Total	**34**	**5**	**55**	**5**	

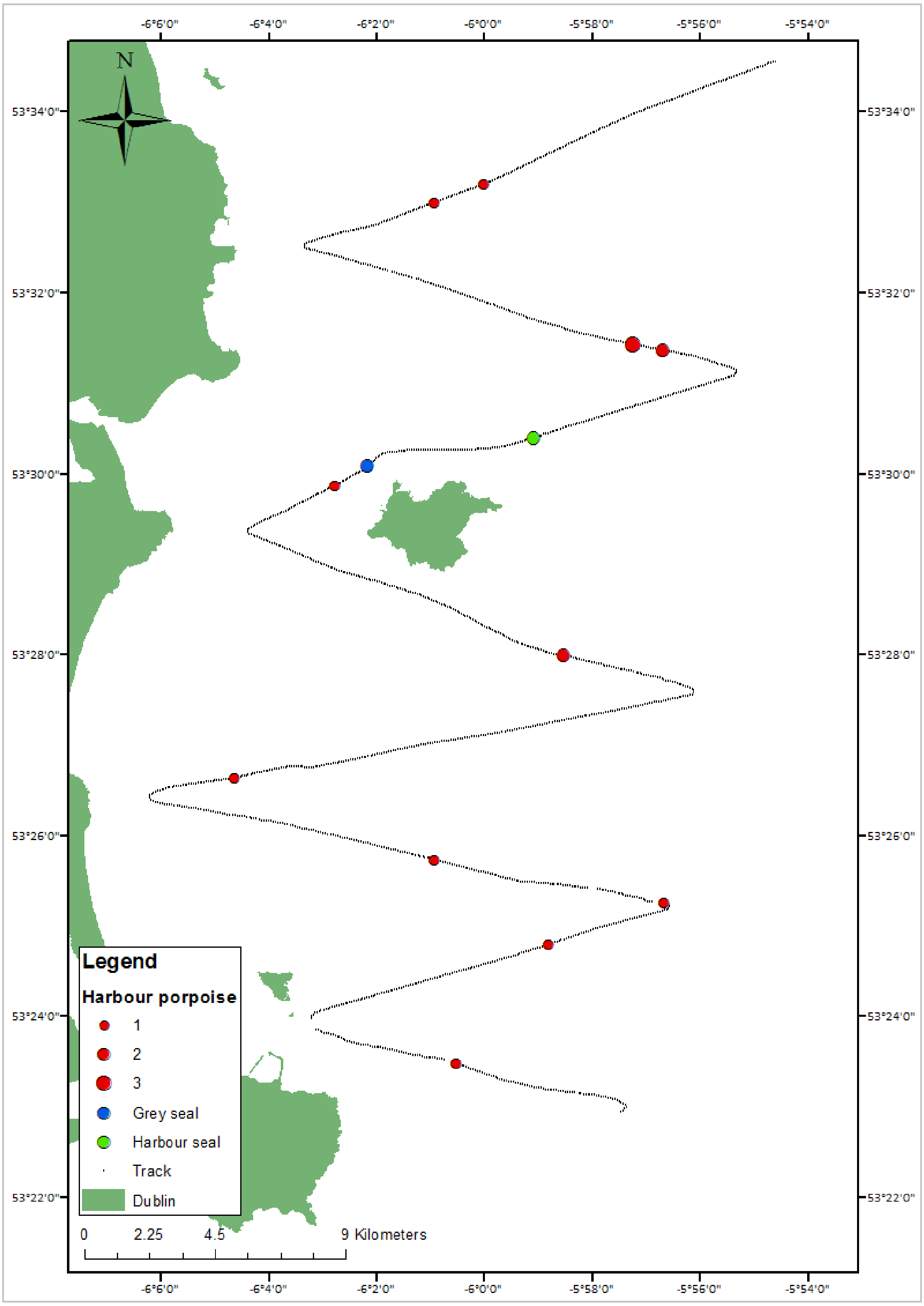

Figure 57. Map of transect line and marine mammal sightings for April 2015 boat-based survey

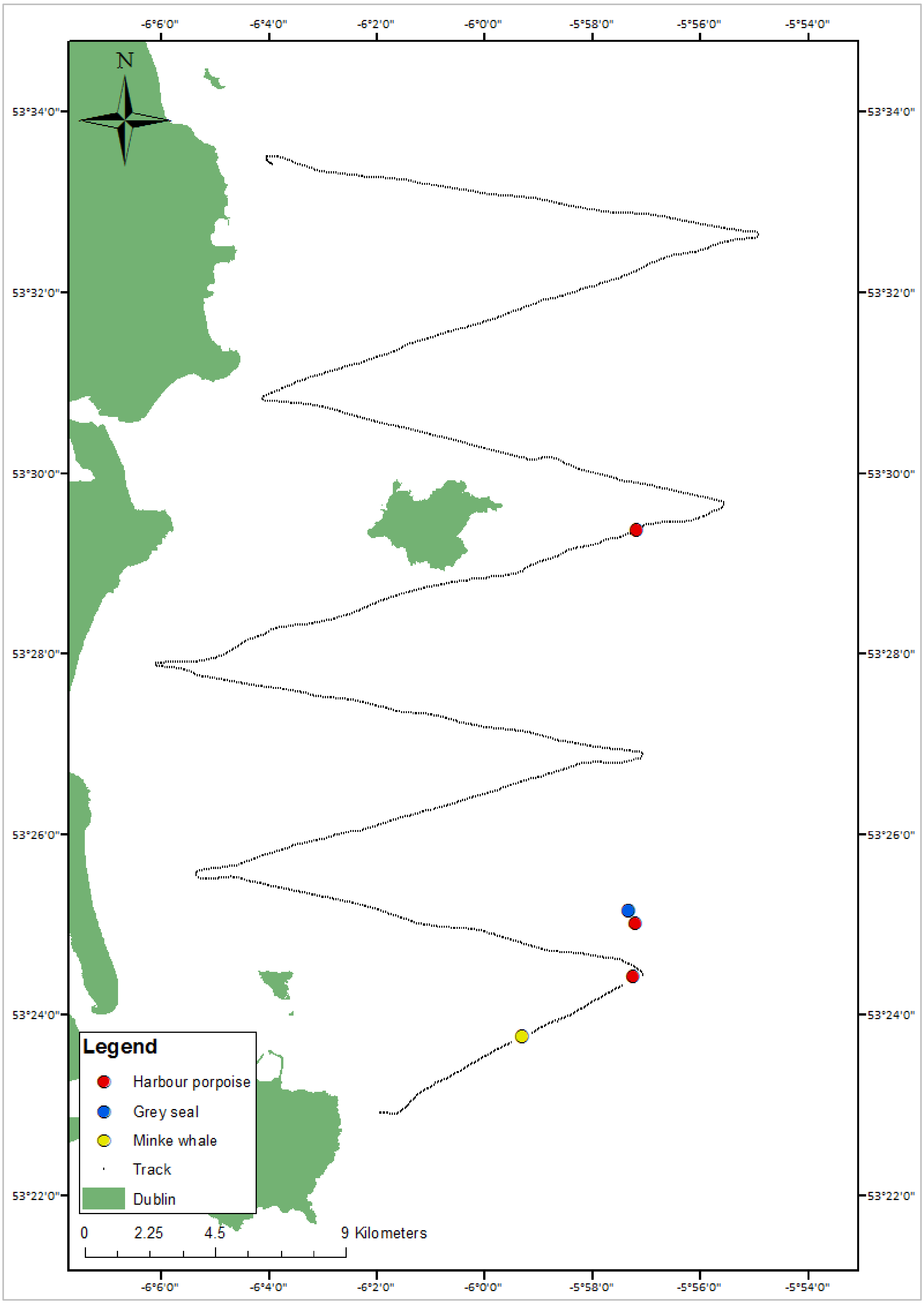

Figure 58. Map of transect line and marine mammal sightings for June 2015 boat-based survey

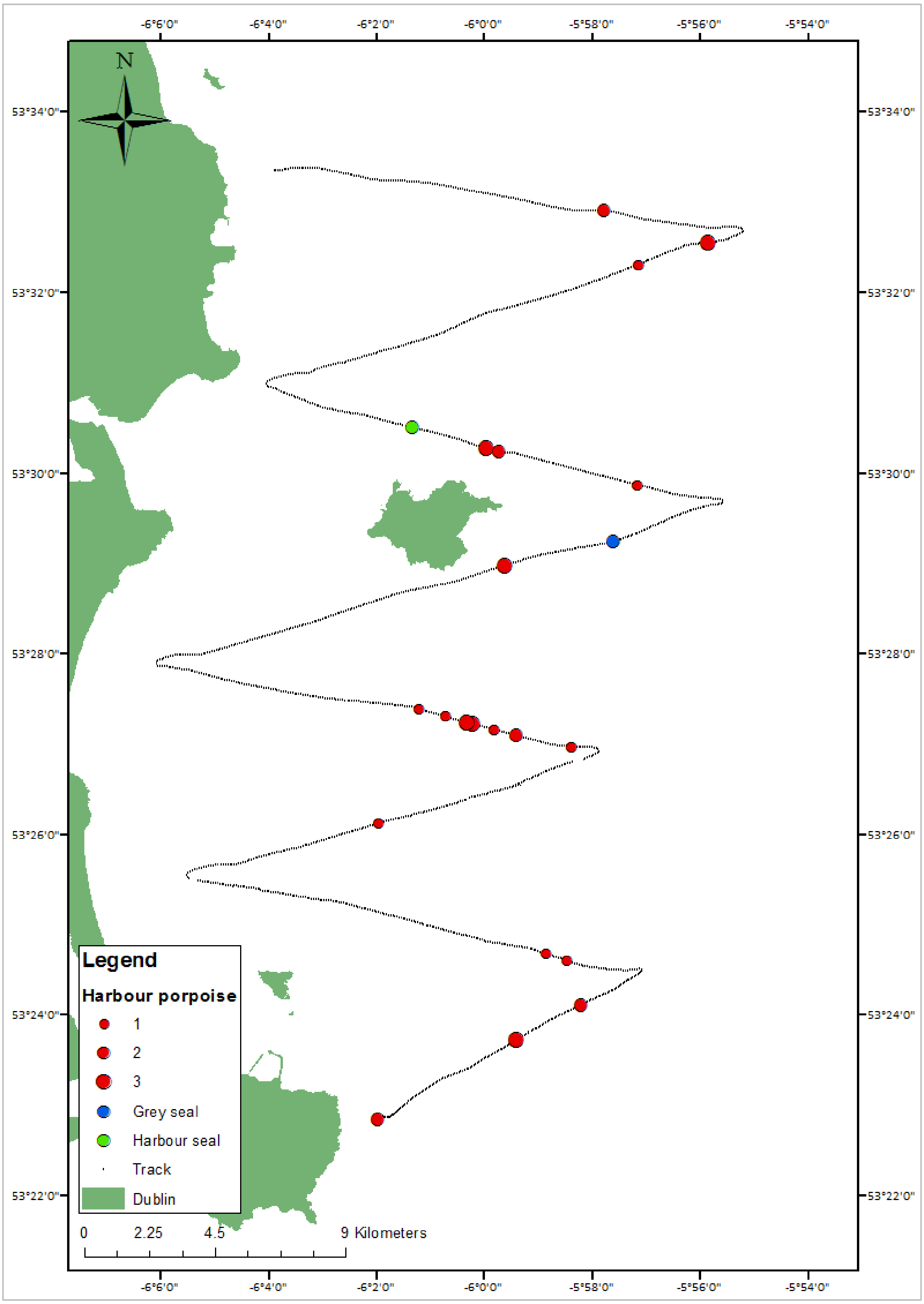

Figure 59. Map of transect line and marine mammal sightings for August 2015 boat-based survey

5.2.2.1 *Density and abundance estimation*

Density estimates for harbour porpoises calculated for two of the three survey days and not for survey two as the number of sightings (n=5) were too few to derive a reliable density estimate. The detection functions for harbour porpoise during all surveys are shown graphically (Figure 60). Using the Chi-squared test for goodness of fit to the DISTANCE model data for the first survey were poor (P=0.92) but for survey 2 better (P=0.62).

Evasive reactions of porpoises from the survey vessel were most evident on survey 1, with a peak in sightings some 50-100m from the track-line (Figure 60), most likely resulting in an underestimate of animal density. Variation in cluster size was greater during the first survey which contributed a greater proportion of the variability.

Mean group (cluster) size was greater on survey 3 (1.85±0.20) compared to survey 1 (1.44±0.27) suggesting a trend of increasing group size with time which was consistent with land-based observations.

Table 18. Model data used in the harbour porpoise abundance and density estimation process for the Greater Dublin Drainage project(Note: A half-normal model with cosine series adjustments and sightings data truncated at 200m for Survey 1 and 300m for Survey 2 and Overall analysis was used).

Sample Day	Chi^2 P value	Effective Strip Width (m)	Number of sightings	Mean Cluster size ± SE	Variability (%)		
					Detection	Encounter	Cluster
1	0.924	104.65	11	1.44±0.27	67.6	-	32.4
3	0.602	148.78	20	1.85±0.20	84.1	-	15.9
Overall	**0.811**	**144.2**	**31**	**1.68±0.15**	**38.3**	**55.0**	**6.7**

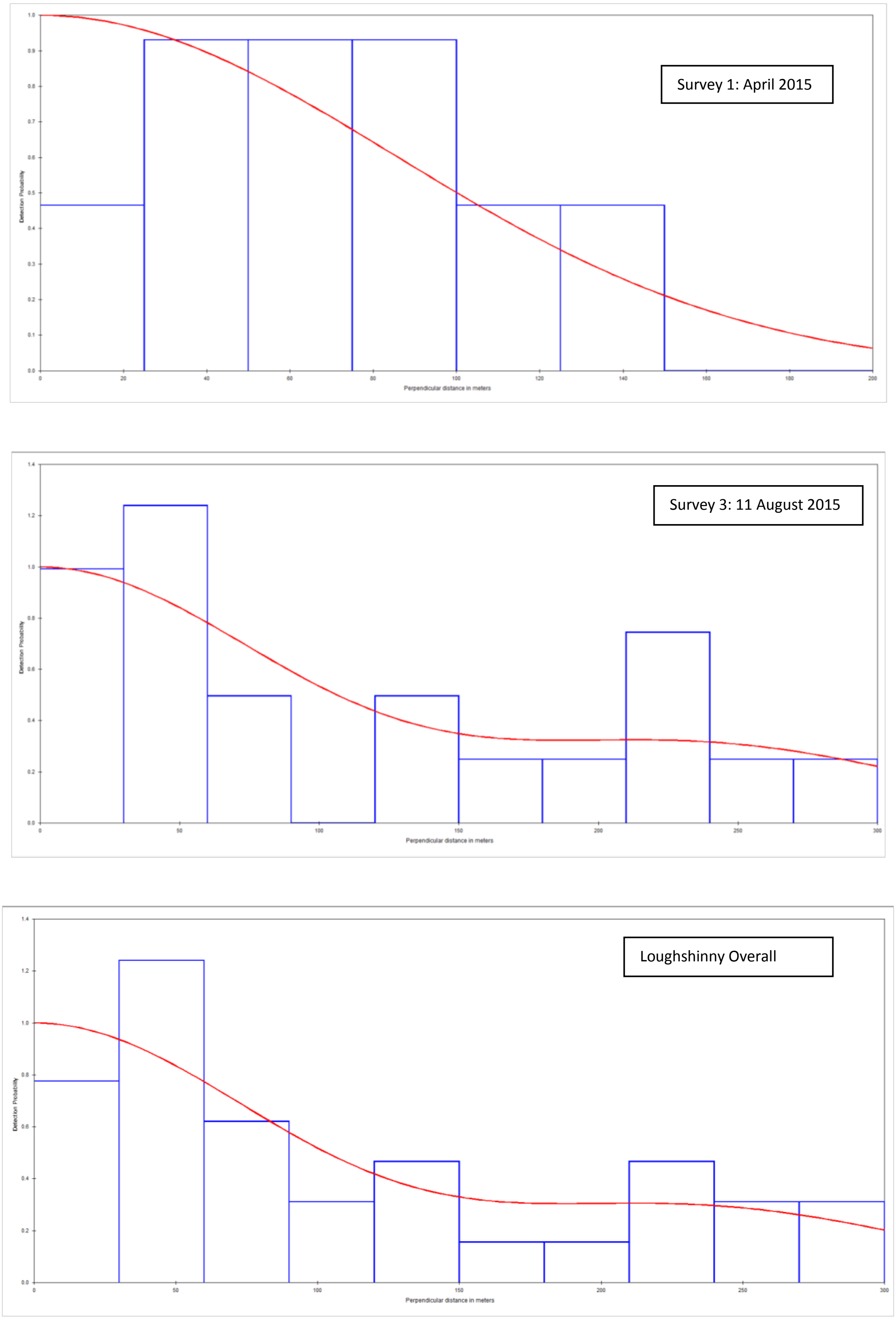

Figure 60. Detection functions plots for harbour porpoise during boat-based surveys

Density and abundance estimates for harbour porpoise in the Rockabill to Dalkey Island SAC are shown in Table 19. The density estimates were quite different between surveys with highest densities on survey 3 correlating with the survey with the greatest number of sightings as the track length and area surveyed were the same. This produced an overall abundance estimate of 256±93 porpoises with 95% Confidence Intervals of between 87-751 porpoises and a CV of 0.37.

Table 19. Estimated density, abundance (N) and group sizes of harbour porpoise recorded for the Greater Dublin Drainage project

Sample Day	N (95% CI)	SE	CV	Density (per km^2)	Mean group size (95% CI)
1	154 (77-306)	54	0.33	0.78	1.44 (1.00-2.12)
3	361 (192-681)	114	0.32	1.91	1.85 (1.48-2.30)
Overall[1]	**256 (87-751)**	**93**	**0.37**	**1.31**	**1.67 (1.39-2.01)**

[1] – includes combined sightings and effort data from both surveys

5.3 Static Acoustic Monitoring

5.3.1 C-POD Calibrations

All units used over the duration of the present study were calibrated as part the long-term GDD monitoring project (Loughshinny and Portmarnock). Results of both trials are presented below (Figure 61-66). From the calibration trials, results showed that there were some discrepancies between units. Further exploration into individual unit performance showed that C-POD performance was within the acceptable error margin of ±20% DPM per hour (Figure 63-Figure 66) and therefore no correction factor was required to be applied to the data to make it comparable (O'Brien *et al*. 2013). During analysis of the long-term dataset, differences in sensitivities between units is accounted for by inserting the C-POD number as a random factor when running the generalized linear mixed-effect models.

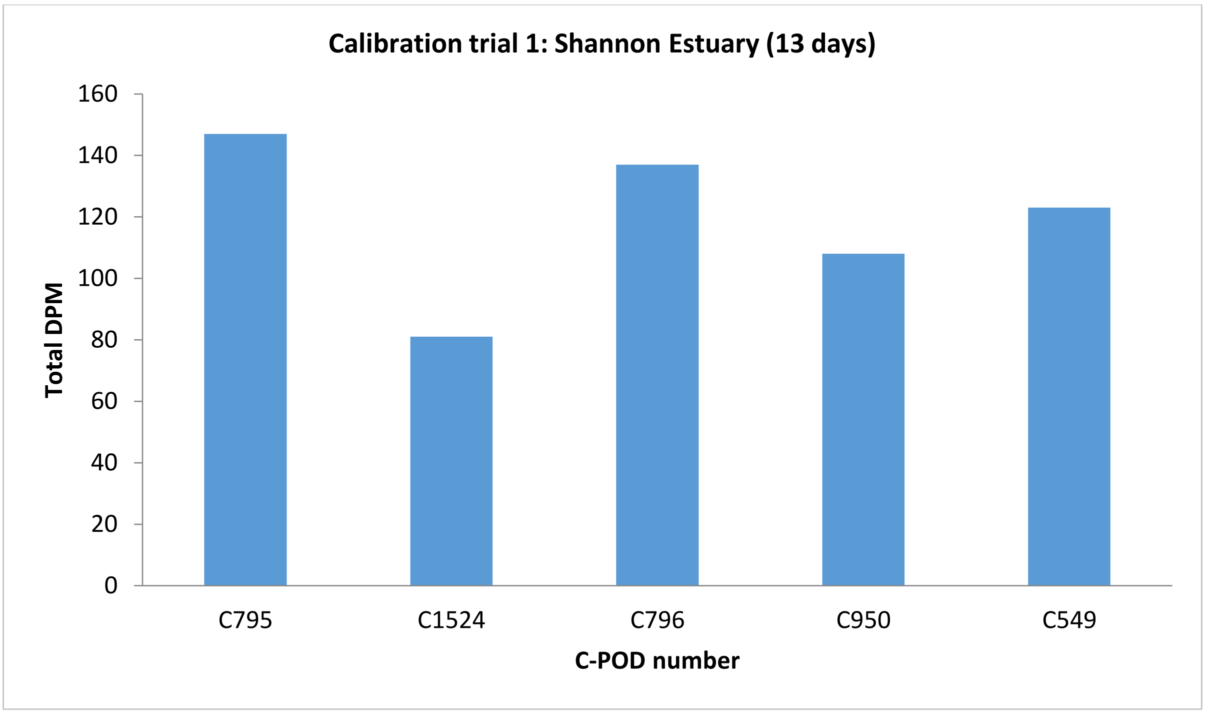

Figure 61. Detection Positive Minutes from all C-PODs deployed during calibration trial 1 in the Shannon Estuary

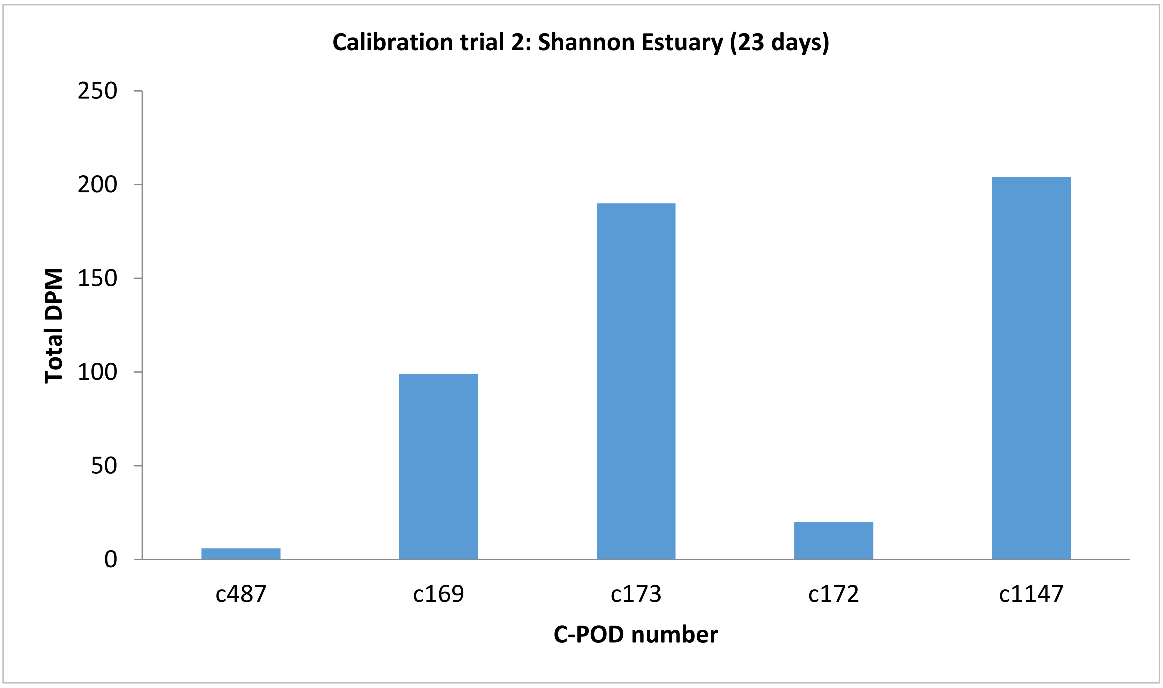

Figure 62. Detection Positive Minutes from all C-PODs deployed during calibration trial 2 in the Shannon Estuary

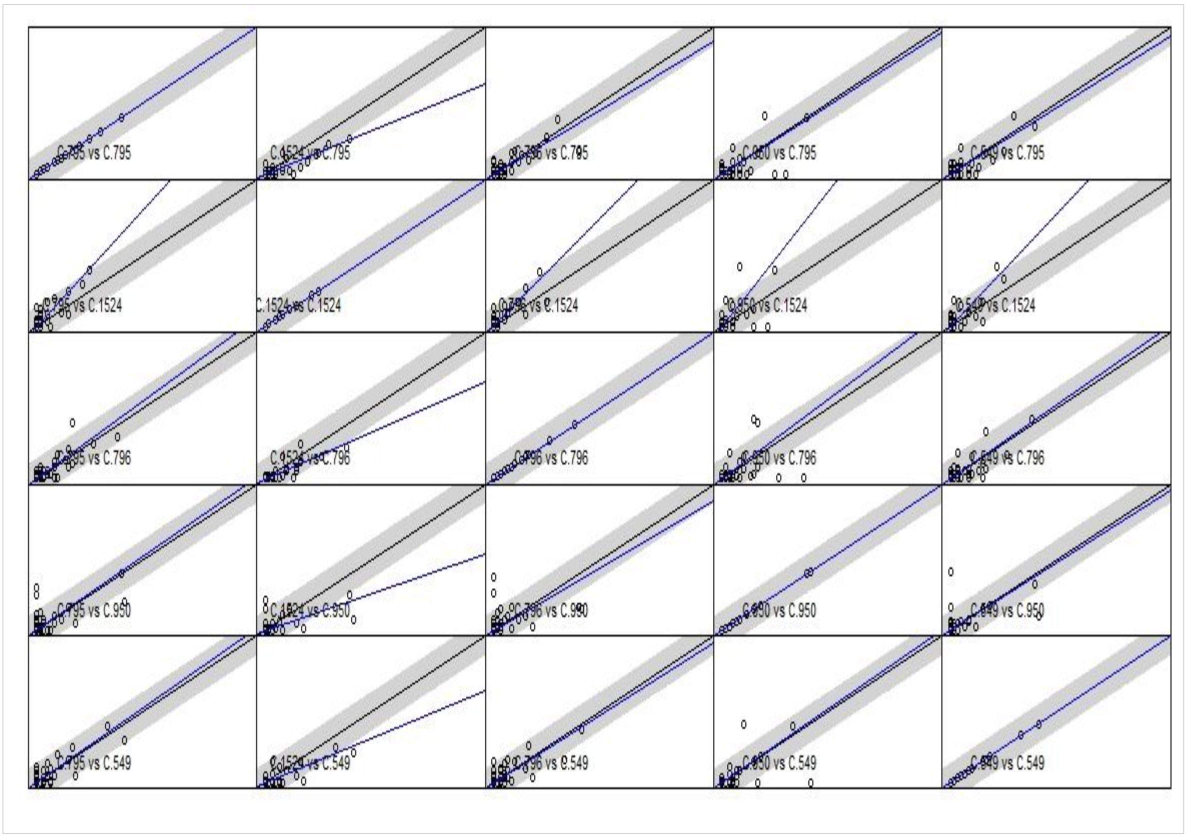

Figure 63. Orthogonal regression plot of C-POD comparisons in calibration trial, in blue, with a null model where each unit performs exactly the same, in black and an acceptable error margin of ±20%, in grey from Calibration 1, January 2015

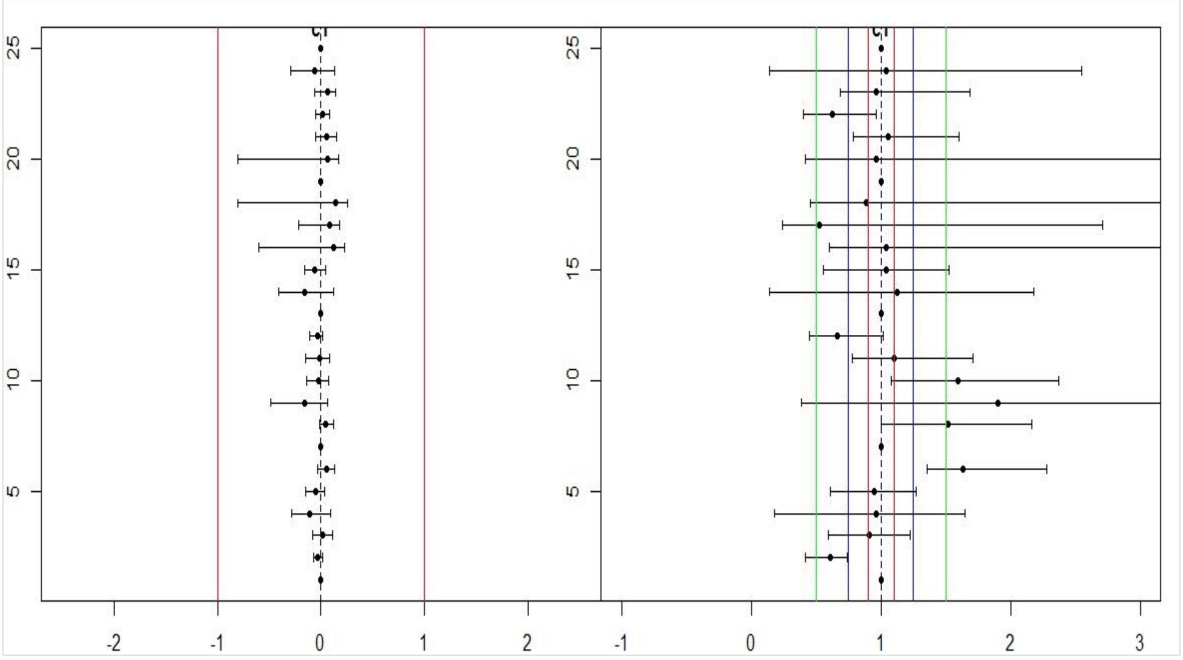

Figure 64. Centipede plot of the intercept and slope values (±std), of the orthogonal regression plots, for each pod performance comparison in calibration trail 1 at Money Point, January 2015. Deviation from the red dotted lines, 0 on the intercept plot and 1 on the gradient plot, indicates deviation from the null model assuming no variation. Plot indicates that a greater extent of variation is found within the gradient values

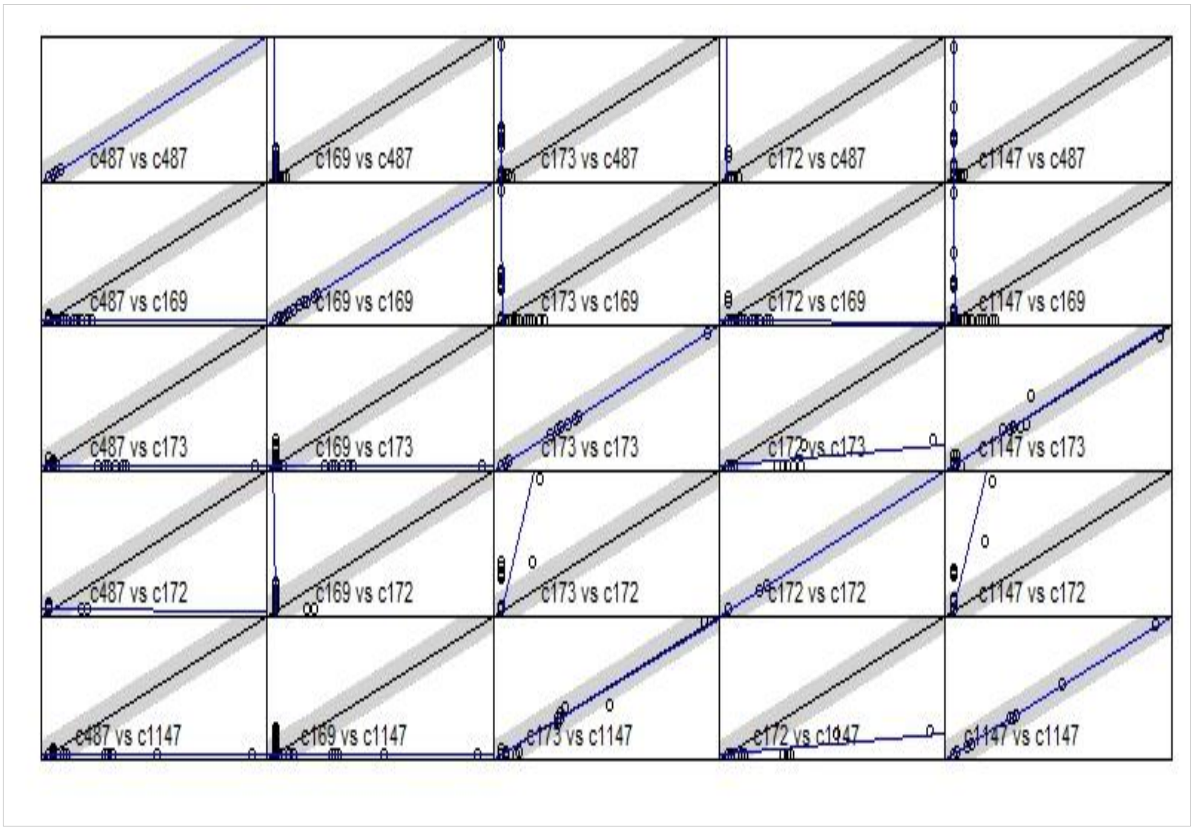

Figure 65. Orthogonal regression plot of C-POD comparisons in calibration trial, in blue, with a null model where each unit performs exactly the same, in black and an acceptable error margin of ±20%, in grey from Calibration 2, February 2015

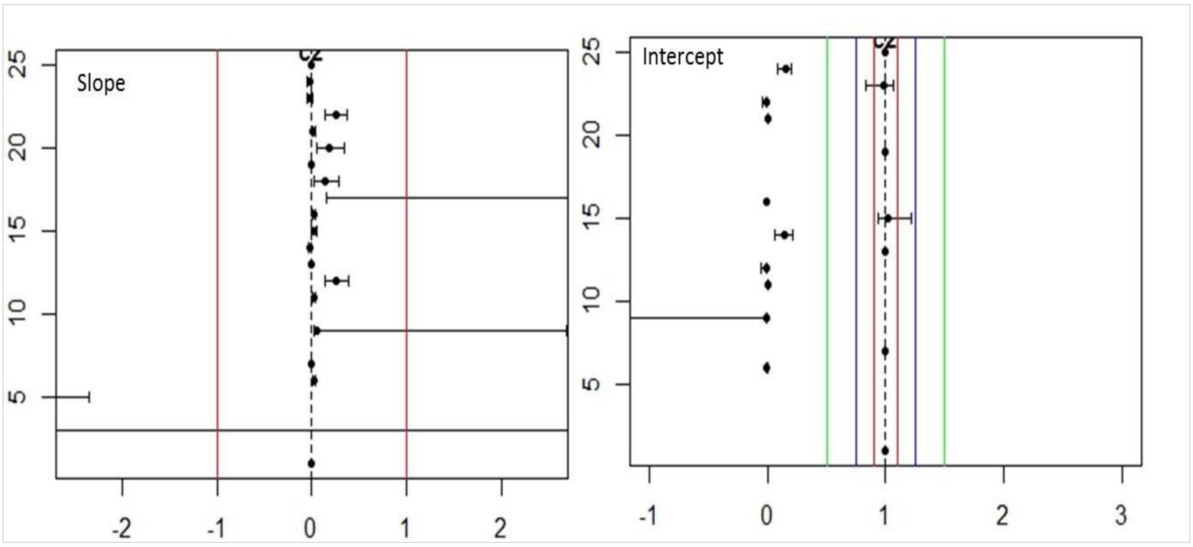

Figure 66. Centipede plot of the intercept and slope values (±std), of the orthogonal regression plots, for each pod performance comparison in calibration trail 1 at Money Point, January 2015.Deviation from the red dotted lines, 0 on the intercept plot and 1 on the gradient plot, indicates deviation from the null model assuming no variation. Plot indicates that a greater extent of variation is found within the gradient values

5.3.2 Static Acoustic Monitoring

Static Acoustic Monitoring using C-PODs was carried out at Loughshinny for a total of 189 days. Detections were recorded on 100% of days (Table 20). The number of Porpoise Positive Minutes (PPM) ranged from 8 to 475 per day with a mean of 139 PPM (Figure 67). Very few dolphin detections were recorded and those that were determined to be false positives. A monitoring index of the mean number of detection positive minutes per hour for porpoises was generated (Table 20). This unit of measurement can be compared across locations, or with results from previous studies that have taken place. This index will serve as a means to compare Loughshinny with the similar data derived from Portmarnock as part of the current study but additionally facilitate comparison with other sites regionally.

Table 20. Deployment summary from Loughshinny

Location	No of days	Dates	CPOD	PPM	% days detected	Mean DPM/Day	Mean DPM/hr	%DPM
Loughshinny	90	13 Mar-10 Jun	c950	7893	100	87.7	3.7	6.1
Loughshinny	99	10 Jun-16 Sep	c487	18388	100	185.8	7.7	12.9
TOTAL	**189**			**26281**	**100**	**137**	**5.8**	**9.6**

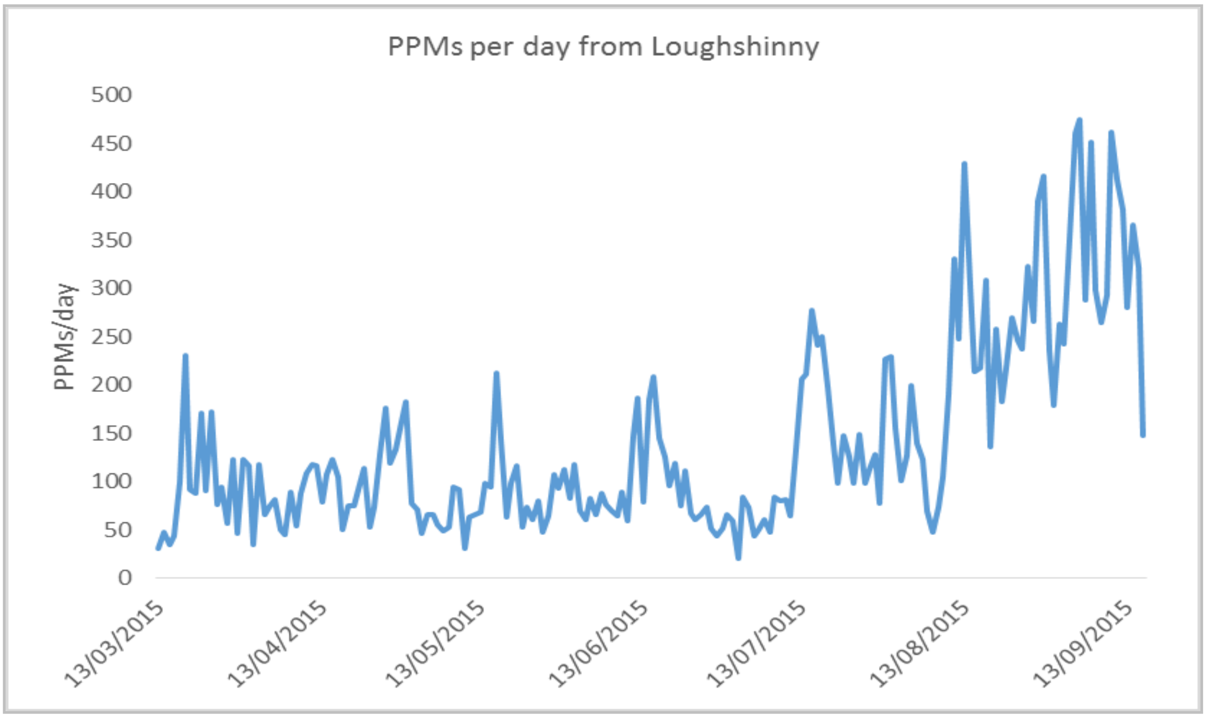

Figure 67. Porpoise Positive Minutes per dat (PPMs) recorded over the deployment period (March to September (139 days)).

5.3.2.1 *Generalized linear mixed-effect model (GLMM) analyses*

Results from the generalized linear mixed-effect model (GLMM) analyses (Figure 68) showed that season had a significant effect on the presence of porpoises at the site. A significant peak in porpoise detections was recorded during the autumn (χ^2= 174.5, p<0.000). Most porpoise detections were recorded during the diel phase morning, and from the raw data this peak can be seen during the early morning (χ^2= 174.5, p<0.000) showing they are more active at the site during night-time and early morning hours. Tidal cycle was not found to be a significant factor in the presence of porpoises off Loughshinny (χ^2= 5.3, p<0.2) but tidal phase was, with significantly more detection recorded during spring cycles (χ^2= 9.2, p<0.02). The box plots below show the distribution of the data or each of the variables, with the usual box plot format, representing the median, quartiles and outliers.

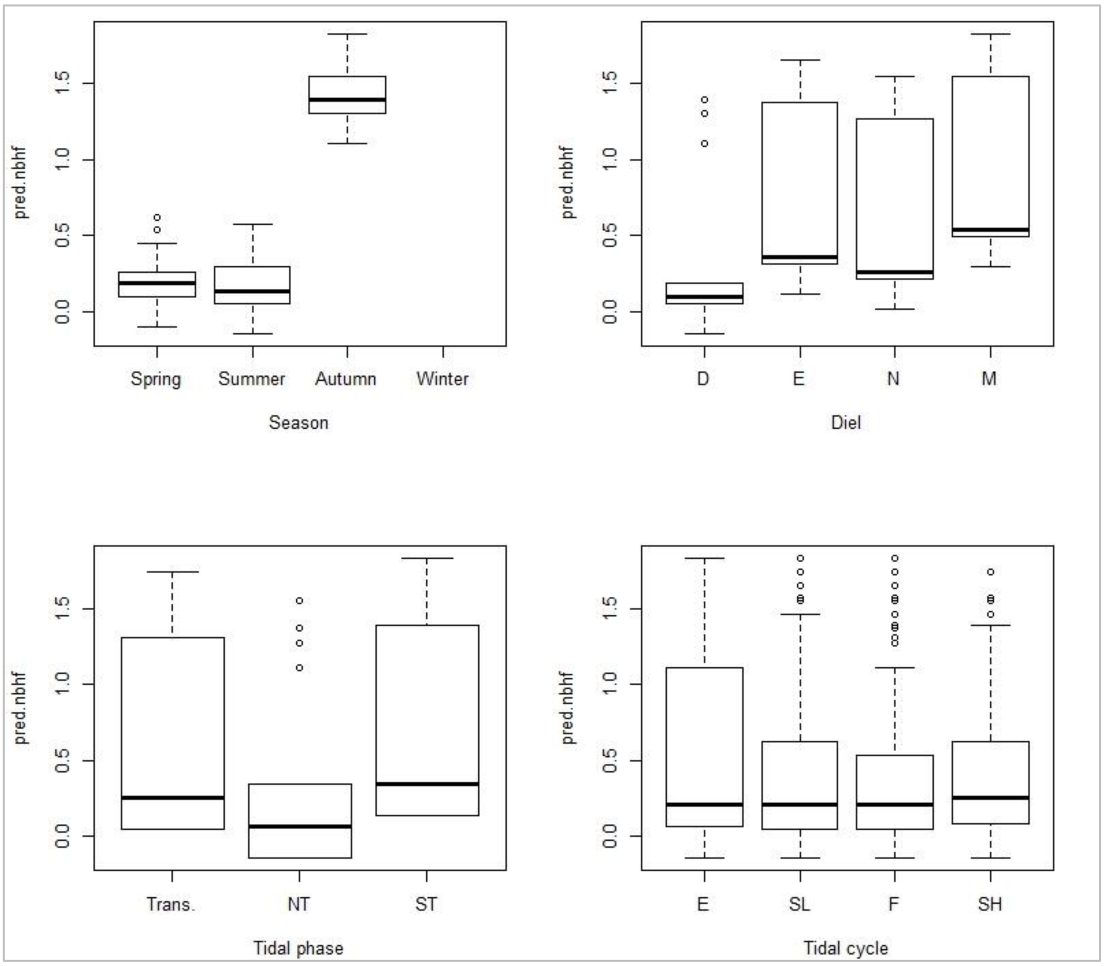

Figure 68. Predicted proportion of detection positive hours, in the narrow band high frequency channel at Loughshinny (Co. Dublin) Mar-Sept, 2015 across the four variables of season; diel, where D =day, E= evening, M= morning and N = night; tidal phase, where Trans.=transitional phase, NT= neap tide and ST=spring tide; and tidal cycle, where E =ebb, L = slack low, F= flood and H=slack high.

5.3.3 Assessment of usage of the site

Feeding buzzes and click bursts have been described in many odontocete species (Herzing, 2000; bottlenose dolphin; Miller *et al.*, 1995; narwhal, Leeney *et al.*, 2011; Heaviside's dolphin). Variation in *ICI* has been used as an indicator of certain behaviours in cetaceans (Wahlberg, 2002; Carlström, 2005; Koschinski *et al.*, 2008; Akamastu *et al*, 2010; and Leeney *et al*., 2011). The minimum *ICI* (MinICI) has been deemed the most appropriate value as the software often splits trains when the *ICI* is long (Carlström, 2005). This has been employed in recent cetacean studies using T-PODs (Todd *et al.*, 2009; and Leeney *et al.*, 2011). Carlström (2005) deemed a MinICI of less than 10ms (MinICI<10ms) to be an appropriate identification of probable foraging, based on the shape of frequency distribution graphs generated from the mean of the distribution of the MinICIs.

A total of 100,421 NBHF click trains were recorded at Loughshinny over the 6 month deployment. The average number of clicks per train was 13.5, with on average 131 clicks recorded per second, and with an average frequency of 128.1 kHz across all deployments. Click trains were classified into two categories based on the data presented above, where the category foraging was applied to trains with MinICI<10ms. All other trains were defined as "Other" as no definite behaviour category could be attributed. Results showed 95% (95,509 trains) of the total click trains recorded fell under the category foraging, highlighting Loughshinny as a very important feeding site. Modelling of the dataset according to the factors as previously done was not repeated given that 95% of trains were classed as foraging, showing that porpoises present at Loughshinny are feeding and more significantly during the times of night and morning, during the autumn and spring tidal cycle.

Table 21. Train details from porpoise detections at Loughshinny, Co. Dublin

No of trains	Foraging	Other	Min frequency	Max Frequency	clx per train
100421	95509	4911	124	132.4	13

5.4 Discussion

Despite the poor summer weather experienced during 2015, we successfully carried out this survey in favourable conditions. Only one boat-based survey was compromised with around 40% of effort above that stated in the contract. Although conducted over only over a relatively short duration the results do provide an insight into the use of the area by marine mammals and demonstrate its importance for harbour porpoise.

Although limited observations were made there was evidence of an increase in use of the site through the survey period peaking in September. A notable observation included a large group of 14 harbour porpoise in early September. This group contained two calves and was the only sighting of calves during the land-based surveys. Berrow and O'Brien (2013) showed a similar pattern of harbour porpoise numbers and group size increasing off North Co. Dublin in late August. No marine mammals were recorded during the July land-based survey, probably largely due to the sea state ≤2 for 92% of the sampling which could decrease the likelihood of sightings. Two focal follows of harbour porpoise were carried out in March and May for 18 minutes and 26 minutes respectively. During focal follows, harbour porpoise were tracked swimming in tidal currents. This and the presence of feeding gulls suggests that these individuals were foraging in the area.

For two of the three boat surveys carried out, the number of sightings were sufficient to derive density and abundance estimates. The track-lines surveyed an area to the south and a lesser extent to the north of the Loughshinny site. It is important to try and obtain as many sightings as possible to derive robust density estimates. During the two surveys analysed track-lines were 78 and 75km in length and sightings numbered a total of 11 and 20 respectively.

Within the area surveyed the number of sightings of harbour porpoise per survey varied considerably but the overall density estimate was quite consistent, to previous surveys in the area (Table 22). Harbour porpoise density estimates were previously generated for two Dublin sites in 2008 and for Rockabill to Dalkey Island SAC in 2013. North County Dublin was similar to the area surveyed in the present study. Density estimates in North County Dublin in 2008 varied very considerably and the highest density of porpoises recorded at any site in Ireland so far was recorded in August 2008 (i.e., 6.93 porpoises per km^2). However other individual survey estimates during 2008 were much lower, so this single survey had a strong influence on the overall pooled density estimate of 2.03 animals per km^2.

If we take the average of the overall density estimates in 2008 for the two sites it equates to 1.61 which is quite similar to 1.31 porpoises per km^2 from the present survey. The CV of the present density estimate is high (CV=0.32) compared to the other surveys but this was based on only two survey days while all others used data from six survey days. A previous wider-scale line-transect survey in the north Irish Sea, to the east and north of the current SAC, delivered a density estimate of 1.59±0.22 porpoises per km^2 (Berrow *et al.* 2011). This was also of a similar magnitude to that derived from the present survey. These density estimates are some the highest recorded anywhere in Ireland (Berrow *et al.* 2014).

Table 22. Density, abundance and group size estimates for harbour porpoise in the Greater Dublin Drainage area

Location	Year	Area (km²)	Mean group size	Density (per km²)	Abundance ± SE (95% CI)	CV	Reference
Greater Dublin Drainage	**2015**	**192**	**1.67**	**1.31**	**256±37** **(87-751)**	**0.37**	**This study**
Rockabill to Dalkey Island SAC	2013	273	1.47	1.44	391±25 (344-445)	0.06	Berrow and O'Brien (2013)
North County Dublin	2008	104	1.41	2.03	211±47 (137-327)	0.23	Berrow *et al.* (2008a)
Dublin Bay	2008	116	1.19	1.19	138±33 (86-221)	0.24	Berrow *et al.* (2008a)

Cetaceans live in an acoustic world and increasingly attempts have been made to develop acoustic monitoring techniques rather than relying on visual methods, whose efficiency is hugely dependent on light, weather conditions and sea-state, especially for species such as the elusive harbour porpoise. Additionally, the reliance on sound by these animals is extremely important and therefore SAM is a very valuable tool for determining presence and assessing fine scale habitat use by various odontocete species. The main advantage of SAM is that it can provide information on species that can go undetected visually for up 95% of the time (harbour porpoise; Read & Westgate, 1995). Patterns of cetacean presence have been described over seasonal scales (Canning *et al*., 2008, Bolt *et al*., 2009; Simon *et al*., 2010; Gilles *et al*., 2011; O'Brien *et al.* 2013) diel cycle (Cox & Read 2004; Carlström, 2005; Todd *et al*., 2009; O'Brien *et al.* 2013) and tidal patterns (Philpott *et al*., 2007; Marubini *et al*., 2009; O'Brien *et al.* 2013). In order to evaluate the importance of an area, it is fundamental that the presence of small cetaceans at a site is fully understood and this requires monitoring over varying time scales depending on monitoring methods. Although SAM can provide a much more complex account of cetacean activity at a site in comparison to visual monitoring, it fails to inform on the numbers present and hence the need for visual surveys.

The aim of the present study was to compile a dataset of cetacean occurrence at Loughshinny and use this dataset to compare with monitoring datasets gathered under the same Greater Dublin Drainage project but from monitoring locations further south, off Portmarnock Co. Dublin. From the data presented here, it is clear that the Loughshinny site is an important feeding area for the harbour porpoise especially in the autumn, during the night and early morning and during a spring tidal cycle.

Winter could not be analysed as monitoring only lasted six months at this particular site. In order to try to understand the relevance of these detections, comparisons can be made with other locations from around the coast where SAM was previously carried out. The index of mean porpoise positive minute per hour (PPM/hr) were compared across eight sites, with varying durations of monitoring. By using the mean PPM/hr, we can compare across sites for different monitoring durations (Table 23). Data highlighted in green were collected using T-PODs an earlier version of the C-POD. Previous work by O'Brien *et al*. (2013) has shown that C-PODs recorded an average of seven times more data than T-PODs during simultaneous deployments in Galway Bay and thus data are biased downwards.

However, it is clear that more DPM's are recorded per deployment from sites in Dublin than anywhere else. Previous deployment off Howth Head yielded 12.2DPM/hr, in comparison to the present study of 5.8. However, the Howth deployment was over a shorter duration but data was gathered using a T-POD.

When the present CPOD data are compared with other deployments around Ireland, such as the Blasket Islands SAC, the detections from Co. Dublin were much greater. These results support visual survey results by Berrow *et al.* (2014) where abundance estimates for North County Dublin produced some of the highest density estimates to date (e.g. O'Brien and Berrow, 2015).

Table 23. Monitoring results from SAM across Ireland (green line denotes data collection using T-PODs so some caution necessary when interpreting results.

County	Site	Total days	% DPD	Total PPM	%PPM	Mean DPM/day	Mean DPM/hr	Reference
Dublin	Loughshinny	189	100	26281	9.6	137	5.8	This study
Galway	Spiddal	572	541	27902	3.4	48.8	2.0	O'Brien *et al.,* 2013
Kerry	Inishtooskert	264	236	3930	1.04	14.9	0.6	O'Brien *et al.,* 2013
Kerry	Wild Bank	289	221	2097	0.51	7.3	0.3	O'Brien *et al.,* 2013
Kerry	The Gob	52	49	3015	4.1	58.0	2.4	O'Brien *et al.,* 2013
Dublin	Howth	47	100	13718	10.1	291.9	12.2	Berrow *et al.* (2008a)
Cork	Castlepoint	63	100	1379	2.0	21.9	0.9	Berrow *et al.* (2008a)
Cork	Sherkin	23	44	707	1.0	30.7	1.3	Berrow *et al.* (2008a)
Cork	Galley Head	63	30	1614	2.4	25.6	1.1	Berrow *et al.* (2008a)

Although SAM does not provide information on the numbers of animals using a site, it has given an insight into the temporal patterns of habitat use of the site which could not be identified from visual monitoring alone. Loughshinny is an important feeding site for porpoises who are present on a daily basis, especially during the hours of darkness and early mornings.

As harbour porpoises (Annex II species of the Habitats Directive) are present at such significant levels, strict habitat protection should be ensured at the site, and due care must be taken to ensure any development does not degrade this habitat or cause undue disturbance. These visual SAM results will serve to inform protocols of best practice for the area if work is to go ahead and thus ensure the presence of small cetaceans in the area is not negatively impacted upon.

5.5 Appendix References

Akamatsu, T.; Wang, D.; Wang, K.; Li, S. and Dong, S. (2010) Scanning sonar of rolling porpoises during prey capture dives. *The Journal of Experimental Biology*, 213, 146

Berrow, S.D., Hickey, R., O'Brien, J. O'Connor, I. and McGrath, D. (2008a) *Harbour Porpoise Survey 2008. Report to the National Parks and Wildlife Service.* Irish Whale and Dolphin Group, 31pp.

Berrow, S.D. and O'Brien, J. (2013). *Harbour porpoise SAC survey 2013. Report to the National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht.* Irish Whale and Dolphin Group. pp. 37.

Berrow, S., Hickey, R., O'Connor, I. and McGrath, D. (2014) Density estimates of harbour porpoise (*Phocoena phocoena*) at eight coastal sites in Ireland. *Biology and Environment* 114B (1), 19-34.

Bolt, H.E.; Harvey, P.V.; Mandleberg, L. and Foote, A.D. (2009) Occurrence of killer whales in Scottish inshore waters: temporal and spatial patterns relative to the distribution of declining harbour seal populations. *Aquatic Conservation*, 19, 671–675.

Carlström, J (2005) Diel variation in echolocation behaviour of wild harbour porpoises. *Marine Mammal Science* 21, 1, 1-12.

Canning, S.J.; Santos, M.B.; Reid, R.J.; Evans, P.G.H.; Sabin, R.C.; Bailey, N. and Pierce, G.J. (2008): Seasonal distribution of white-beaked dolphins (*Lagenorhynchus albirostris*) in UK waters with new information on diet and habitat use. *Journal of the Marine Biological Association of the United Kingdom* 88, 6, 1159-1166.

Cox, T.M.; Read, A.J.; Solow, A. and Tregenza, N.J.C. (2001) Will harbour porpoises *(Phocoena phocoena)* habituate to pingers? *Journal of Cetacean Research and Management*, 3(1), 81-86.

Gilles, A., Adler, S., Kaschner, K., Scheidat, M. and Siebert, U. (2011) Modelling harbour porpoise seasonal density as a function of the German Bight environment: implications for management. *Endangered Species Research* 14, 157-169.

Herzing, D.L (2000) Acoustic and social behavior of wild dolphins: implications for a sound society. In: *Hearing by Whales and Dolphins.* Au WWL, Popper and Fay RR (eds). Springer-Verlag, New York, 225-272.

Koschinski, S.; Diederichs, A. and Amundin, M. (2008) Click train patterns of free ranging harbour porpoises acquired using T-PODs may be useful as indicators of their behavior. *Journal of Cetacean Research and Management*, 10, 2, 147-155.

Leeney, R.H.; Carslake, D and Elwen, S.H. (2011) Using Static Acoustic Monitoring to Describe Echolocation Behaviour of Heaviside's Dolphins (*Cephalorhynchus heavisidii*) in Namibia. *Aquatic Mammals*, 37, 2, 151-160.

Marubini, F.; Gimona, A.; Evans, P.G.H.; Wright, P.J. and Pierce, G.J. (2009) Habitat preferences and interannual variability in occurrence of the harbour porpoise (*Phocoena phocoena*) off northwest Scotland. *Marine Ecology Progress Series*, 381, 5, 297–310.

Miller, L.A.; Pristed, J.; Mohl, B. and Surlykke, A. (1995) The click-sounds of narwhals (*Monodon monoceros*) in Inglefield Bay, Northern Greenland. *Marine Mammal Science*, 11, 4, 491-502.

O'Brien, J., Beck, S., Wall, D., Pierini, A., and Hansen, S. (2013). Marine Mammals and Megafauna in Irish Waters, behaviour, distribution and habitat use. Work Package 2: Developing Acoustic Monitoring Techniques. *PReCAST Final Report – Marine Research Sub-programme 2007-2013*, pp1-205.

O'Brien, J. and Berrow, S.D. (2015). Harbour porpoise surveys in Roaringwater Bay and Islands SAC, 2015. *Report to the National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht*. Irish Whale and Dolphin Group. pp. 43.

Read A.J. and Westgate A.J. (1997) Monitoring the movements of harbour porpoises (Phocoena phocoena) with satellite telemetry. Mar Biol, 130,315–322.

Simon, M., Nuuttila, H., Reyes-Zamudio, M.M., Ugarte, F., Verfuß, U.K. and Evans, P.H. (2010) Passive acoustic monitoring of bottlenose dolphin and harbour porpoise with implications for habitat use and partitioning. *Journal of the Marine Biological Association of the United Kingdom* 90, 8, 1-7. 13

Todd, V.L.G., Pearse, W.D., Tregenza, N., Lepper, P.A. and Todd, I.B. (2009) Diel echolocation activity of harbour porpoises (*Phocoena phocoena*) around the North Sea offshore gas installations. *ICES Journal of Marine Science* 66, 4, 734-745.

Wahlberg, M. (2002) The acoustic behaviour of diving sperm whales observed with a hydrophone array. *Journal of Experimental Marine Biology and Ecology*, 281, 53– 62.

Appendix D Quiet Oceans - Underwater Noise Modelling Report

Modeling Dredging & Piling Noise Offshore Dublin

Brief Technical Report

Identification	
Document reference	QO.20170329.01.RAP.001.04A
Beneficiary	TechWorks Marine
Customer	Laboratori d'Aplicacions Bioacústiques
Contract number	N/A

PROJET	DOC	CHRONO	VER	IND	CLIENT	ACRO	DATE	TYPE	CLASS
QO.20170329.01	RAP	001	04	A	LAB	GDD	29.03.2017	PROD	DR

Quiet oceans

Ocean Noise Forecasting Monitoring & Mitigation

Document history

Version	Ind.	Authorship	Date	Released	Description
04	**A**	T. Folegot	20.04.2018	20.04.2018	Integration of LAB comments
03	**A**	T. Folegot	16.03.2018	16.03.2018	Integration of beneficiary comments –Correction of Dedging source level correction
02	**A**	T. Folegot	26.07.2017	28.07.2017	Add piling scenario and important disclaimer
01	**A**	T. Folegot	29.03.2017	30.03.2017	Initial version

Citation

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Table of content

Terms and definitions

This section defines the technical terms used in the report.

1/3rd-octave frequency band

A frequency band with one third of an octave bandwidth. One octave is a doubling of frequency, whereas one third of an octave is a frequency ratio of 21/3 ≈ 1.26 between the highest and the lowest. [1] [2]

Bandwidth

The frequency range within which a recording system is sensitive. The frequency range (in Hertz) is obtained by subtracting the lower from the upper cut-off frequency.

Broadband level

The sound pressure level obtained over a wide frequency range with defined bandwidth.

Center frequency

The geometric mean of the lower and upper cut-off frequencies. Please note that the intensities should be averaged before converted into decibels.

Sound

The term “sound” is used to refer to the acoustic energy radiated from a vibrating object, with no particular reference for its function or potential effect. “Sounds” include both meaningful signals and “noise” (defined below), which may have either no particular impact or may have a range of adverse effects.

Noise

Noise is in direct contrast to signals, but always depending on the receiver and the context. What one receiver considers noise may be a signal to another receiver and even for the same receiver can the exact same sound be either signal or noise, depending on context.

“Noise” can be used in a more restrictive sense where adverse effects of sound are specifically described or when referring to specific technical distinctions such as “masking noise” or “ambient noise”.

Ambient noise

That part of the total noise background observed with a non-directional hydrophone, which is not due to the hydrophone and its manner of mounting (self-noise), or to some identifiable localized source of noise.

Environmental background noise not of direct interest during a measurement or observation; may be from sources near and far, distributed and discrete, but excludes sounds produced by measurement equipment, such as cable flutter.

For a specified signal, all sound in the absence of that signal except that resulting from the deployment, operation or recovery of the recording equipment and its associated platform.

Natural ambient noise

Ambient noise in the absence of any contribution from anthropogenic sources.

Continuous sound

Imprecise term meaning a sound for which the mean square sound pressure is approximately independent of averaging time.

A sound with no clear definable beginning or end with no bandwidth restrictions and a large time bandwidth product when the frequency range is broadband. Continuous sounds have finite power, but may have infinite or at least undefined energy.

Sound pressure

The difference between instantaneous total pressure and pressure that would exist in the absence of sound. Instantaneous pressure at time t.

p(t) in [Pa]

Reference pressure

1 µPa in underwater acoustics. p_0 in [Pa]

Sound exposure

The integral of the square of the sound pressure over a stated time interval or event.

E in [µPa²s], $E = \int_0^T p(t)^2\, dt$, with T being the time period of the event of interest.

Sound Pressure Level

SPL in [dB re 1 µPa]

$$SPL = 10 \cdot log_{10} \frac{1/_T \int_0^T p(t)^2 dt}{p_0^2} = 10 \cdot log_{10} \left(\frac{p_{rms}}{p_0}\right)^2 = 20 \cdot log_{10} \left(\frac{p_{rms}}{p_0}\right)$$

with T = integration time.

Sound Exposure Level

SEL in [dB re 1 µPa²s]

$$SEL = 10 \cdot log_{10} \left(\frac{E}{p_0^2\, T_0}\right) = SPL + 10 log_{10}(T)$$

With reference time T_0 = 1 s

With T being the time period of the event of interest in seconds.

Percentile level

A percentile corresponds to the proportion of time and space for which the noise exceeds a given level. This concept is widespread even in everyday life. For example, the average income of the top 10% of income earners or the “income threshold corresponding to the 90th or to the 95th percentile”, i.e. the income earned by the poorest individual among the top 10% or top 5% richest individuals. Meanwhile, the 50th percentile corresponds to the median salary. For underwater noise, the percentile, or exceedance level, is meant to describe the noise level occurring at least.

In the context of underwater noise, it is defined as the level L_N that is exceeded for N percent of the time interval considered. For example, L_1 is the level that is exceeded 1% of the time. This is accomplished by (1) ordering all measured levels in the time interval numerically in descending order and (2) and picking the value 1% of the rows below the top of this ordered list. Both steps can be done together in Matlab with the quantile or prctile function (available in the Statistics Toolbox).

The L_1 is a measure for the maximum level. It is a more robust estimate than taking just the maximum observed level, since the latter may be an outlier caused by a single event, such as rattling of the anchoring system or other types of self-noise. Accordingly, L99 and L95 are used to describe the minimum level. L_{50} is the median level.

Chapitre I. Context and objectives

I.1. Context

As part of a data processing contract Techworks Marine has asked the Laboratori d'Aplicacions Bioacústiques to include noise level maps for pile driving and dredging operations. Quiet-Oceans has been asked to provide the propagation modelling for a few selected frequencies of interest.

I.2. Project information

The outfall pipeline consists of two elements, a tunnel section running from the Coast Road to approx. 500m off the beach, and a dredged section from this interface point to the final outfall point. The tunnel section will be constructed using a micro-tunnelling machine.

The dredged section will be constructed using Back Hoe Dredgers (BHD) and Trailer Suction Hopper Dredgers (TSHD) with the BHD working from the inshore outwards and the TSHD working from the Outfall point towards the inshore.

The dredging operation includes an excavation phase with material either side cast or placed in barrages for deposition a short distance away from the trench, and a backfilling phase where the excavated material will be replaced over the installed pipe.

I.3. Objectives and Scope of Work

Quiet-Oceans expert team was not involved in the definition of the Scope Of Work (SOW).

This work is solely meant to provide an indication of the noise propagation properties in the underwater environment where the construction will take place, taking into account the sources of interest, and does not constitute a noise impact assessment. No calibrated source recordings were available to evaluate the modelling results.

When there is interest in a noise impact study the internationally agreed methodology to assess the noise risks towards the marine species consist in the following steps [3] [9] :

- Baseline broadband mapping of the existing noise;
- Broadband calculation of the exceedance level of each individual project activities above the baseline (noise footprint calculation [10]);
- Perceived levels in the bandwidth of sensitivity for the species potentially exposed to the noise of the project (high frequency cetaceans, mid frequency cetaceans, high frequency cetaceans, pinnipeds, 3 categories of fish (with/without swim bladders, with/without sensitive cells), sea turtles and larvae;
- PTS, TTS, behavioural and masking risk areas mapping based on the perceived levels for each class of species.

Since noise impact study **was not the interest mentioned in the Scope Of Work provided to Quiet-Oceans**, a few specific frequencies for propagation modelling have been requested by the Laboratori d'Aplicacions Bioacústiques:

- to map the noise propagation of the dredging activity at one specific position for three frequencies: 125Hz, 1kHz and 8kHz third-octaves for a single environmental condition corresponding to a March situation;
- to map the noise from one piling activity at one specific position for two frequencies: : 125Hz and 1kHz third-octaves for a single environmental condition corresponding to a March situation.

Therefore, this report is limited a brief technical description, briefly explaining the modelling assumptions and giving a limited number if illustrations of the noise maps produced. Raw data of the modelled maps have been delivered jointly to the report for further exploitation.

Chapitre II. Introduction to Quonops©

Quiet-Oceans operates since 2010 the proprietary Quonops© ocean noise-monitoring and prediction system developed and owned by the company and protected by an international patent [3] . In a similar manner to weather forecasting systems, Quonops© produces an estimate of the spatio-temporal distribution of noise levels generated by human activities at sea, aggregating multiple sources, and assessing short-, mid- and long term source contributions to the global noise field (Figure 1). As demonstrated in a number of international projects, Quonops© caters for a broad range of maritime activities, including:

- maritime traffic [3] [6] ;
- oil exploration [7] ;
- underwater warfare exercises;
- offshore construction [8] ;
- fossil-fuel extraction;
- offshore wind-power construction and operations [9] ;
- underwater drilling and blasting operations.

Based on physical acoustic propagation models, Quonops© considers the reality of the area through input data and has been largely validated through in-situ measurements over the last 6 years.

The outputs from Quonops© are tailored to the requirements of existing and emerging national and international regulations regarding underwater noise, the conservation of habitats and marine ecosystems, and the protection of marine species [10] .

The production of statistical soundscapes effectively characterizes the spatio-temporal emergence of anthropogenic noise from the real environmental conditions of the area. The system also supports underwater noise impact assessments and assists in the formulation of optimized planning and focused mitigation of maritime industrial activities in terms of environmental compliance. Quonops© brings together relevant information and data into a noise prediction platform to deliver a series of services, such as:

- the geo-referenced mapping of statistical, historical or real-time human and environmental situation of the areas of interest,
- the geo-referenced mapping of noise pollution according to given ocean-meteorological and human scenarios.

Such a tool aims to support management decisions by assessing, quantifying and prioritizing direct and indirect anthropogenic pressures on marine life, according to the emerging national and international regulations on underwater noise, especially the descriptor 11 of the European Marine Strategy Framework Directive [11] .

Quonops© is able to provide:

- real-time regional survey of shipping noise and natural noise from waves;
- historical statistical regional noise maps at a daily, weekly, quarterly and/or annual resolution;
- noise maps of single or multiple customized noise sources through a large selection of maritime activities.

Figure 1 : Principle of Quonos©, Quiet-Oceans' underwater noise prediction and monitoring system.

Chapitre III. General principles of noise mapping

The noise received at a particular position in the marine environment depends on the characteristics of the sound source(s) and the propagation through the marine environment (Figure 2). Noise propagation and therefore noise levels are mainly determined by the following (Table 2):

- ✓ Bathymetry (underwater terrain);
- ✓ The nature of the seabed (sediment type);
- ✓ Oceanographic conditions such as temperature and salinity, currents, sea level;
- ✓ Weather conditions such as the wind (and consequently waves) and rainfall intensity.

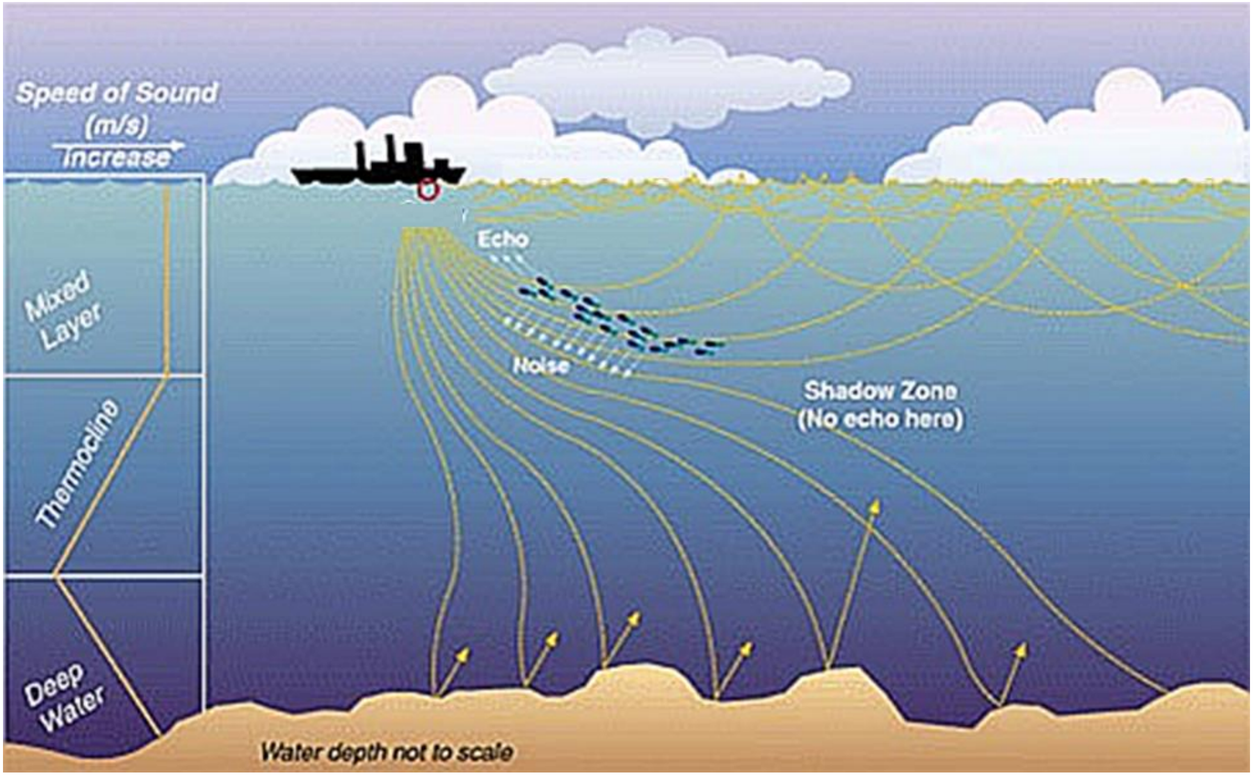


Figure 2: In the warm upper layer of the ocean, sound is refracted toward the surface. As sound waves travel deeper into colder water, they slow down and are refracted towards the seafloor, creating a shadow zone. Image courtesy of the National Academy of Sciences. Source: www.dosits.org.

III.1. Key ocean variables affecting sound propagation

Sound propagation losses increase as water depth lessens, and this is a cumulative loss effect which applies to shoaling caused by bathymetry and tidal fluctuations together. The effect is linked to the interaction of sound waves with the interfaces of the oceanic waveguide (surface and seabed). Furthermore, it should be noted that ocean waves (waves at the sea surface) tend to surge as they encounter shallower water, which increases their contribution to the ambient noise.

Propagation losses are more significant when the seabed is loose and fine-grained (i.e. silt absorbs sound waves better than gravel). However, the denser the sediment, the more reverberant it is; sound waves with significant angles of incidence on sediment are better reflected when the sediment is dense.

Wind generated ocean-surface waves propagate and absorb sound waves, an effect that increases with increasing sea-state. However, the noise generated by surging waves also increases the level of ambient noise. In other words, rough seas increase natural noise levels, but other noise sources do not carry as far as they would in calm conditions.

In shallow water, sedimentary particles are mobilized by currents and/or waves, and noise is generated when sedimentary particles collide with each other. The coarser the sediment and faster the speed of sound in the sediment, the higher the noise level.

Rainfall exerts a negligible effect on underwater sound propagation; however the sound generated by droplets falling on the sea surface does contribute to an increase in natural noise levels.

Table 1: Effect of physical properties of the ocean environment on acoustic propagation and noise generation.

	Influence noise propagation	Generate noise and contribute to ambient noise
Bathymetry	✓	✖
Bottom parameters	✓	✓
Temperature/salinity	✓	✖
Sea level	✓	✖
Currents	✖	✓
Wind/waves	✓	✓
Rain	✖	✓

✓*indicates that the effect exists* ✖ *indicates that the effect does not exist or is marginal.*

III.2. Underwater noise modelling

Underwater modelling benefits from more than 50 years of scientific and operational development for military purposes, ranging from basic propagation modelling to more sophisticated sonar performance modelling. The military research in the field of experimental ocean acoustics has involved extensive equipment, with typically at least one ship and often an assortment of at-sea platforms equipped with sound projectors and receiving arrays. The objective of this research was to incorporate the acoustic propagation phenomena into a theoretical and numerical formalism, which gives a quantitative prediction of the sound field for arbitrary ocean environments. The progress in the field of numerical computing has largely contributed to the development of the modelling capability.

There are essentially five types of models (computer solutions to the wave equation) to describe sound propagation in the sea: spectral, normal mode, ray, and parabolic equation models, and direct finite-difference, or finite-element solutions of the full wave equation. All these models permit the ocean environment to vary with depth. Models also permit horizontal variations in the environment, i.e., slopping bottom or spatially variable oceanography [13] .

The acoustic models accurately reflect the propagation of noise in the water column in realistic oceanographic conditions by resolving the Helmholtz Equation, the State Equation:

$$\Delta p - \frac{1}{c^2}\frac{\partial^2 p}{\partial t^2} = \delta(t - t_0, r - r_0)$$

$$\rho c^2 = p \quad \rho_0 \frac{\partial \vec{v}}{\partial t} + \vec{\nabla} p = 0$$

$$j 2\pi f \rho_0 \vec{v} + \vec{\nabla} p = 0$$

where p is the acoustic pressure, c is the sound speed in the medium (water or sediment), t is time, t_0 the instant of emission of the signal, and r the three-dimensional position of observation and r_0 the three-dimensional position of the source, assumed to be punctual.

III.2.1. Modelling bellow 2kHz

For frequencies bellow 2kHz, we have used state-of-the-art parabolic equation [14] [15] [16] [17] . Developed before World War II, and widely used in many areas of physics, parabolic equation methods are based on fast Fourier transforms. It has become the most popular wave-theory technique for solving range dependent problems in ocean acoustics. It consists in a parabolic approximation of the Helmholtz equation into an elliptic wave equation. We have used the model developed by Collins et al. which is among the state-of-the-art parabolic equation implementation which especially solves the equation for elastic media, such as the marine environment.

III.2.2. Modelling above 2kHz

For frequencies above 2 kHz, we have used an energy distribution to Gaussian beams approach to limit calculation times. Used since the early 1960's, the ray modelling is based on a high frequency approximation. Ray methods are still used extensively in operational environment where speed is critical and where the environmental uncertainties pose more constraints on the accuracy. Quonops© use Bellhop [18] which is among the state-of-the-art ray tracing codes which handles Gaussian ray bundles to somewhat overcome the high frequency approximation.

Table 2: Validation of Quonops through in-situ acoustic measurements in a very large number of different marine environments and projects.

Project Name	Year	Area	Type of noise	Effort	Partners
ERATO	2011	Atlantic Ocean	Shipping and natural	6 hydrophones, 24 hours	French Hydrographic Office (France)
STRIVE	2011	Irish seas	Shipping and natural	1 hydrophone, 21 days	Environmental Protection Agency, Cork University (Ireland)
AQUO	2013-2015	Mediterranean Sea	Shipping and natural	1 hydrophone, 9 months	Laboratory of Bioacoustics Applications, Barcelona (Spain)
AQUO	2013-2015	North-sea	Shipping	Cross-models validation	TNO (Netherland), FOI (Sweden), Leiden university (Netherland)
MaRVEN	2013 - 2015	North-sea	Piling noise & Windfarm operation	2 hydrophones	DHI (Denmark), Royal Belgian Institute of Natural Sciences (Belgium), European Commission
NRL	2013-2014	Indian Ocean	Shipping and natural	2 hydrophones, 7 months	Biotope (La Réunion)
FEC-COU	2013	English Channel	Shipping and natural	4 hydrophones, 20 days	EMF, EDF, WPD (France)
SNA	2013	Atlantic Ocean	Shipping and natural	3 hydrophones, 20 days	EMF, EDF, WPD (France)
BENTHOSCOPE	2015	English Channel	Tidal device in operation	1 hydrophone, 1 day	Marine Energy France (France)
POSTE H	2013	Indian Ocean	Vibrodriving Shipping and natural	2 hydrophones	Biotope (La Réunion)
ETM	2014	Caribbean	Shipping and natural	1 hydrophone, 30 days	AKUO (France)
JETSKI	2014	Atlantic Ocean	Watercraft	1 hydrophone	Marine Protected Area (France)
PORTIER	2014 2016	Mediterranean Sea	Shipping and natural	2 hydrophones, 5 months	BYTP (France)
EMDT	2015-2016	English Channel	Shipping and natural	4 hydrophones, 12 months	ENGIE (France)
EMYN	2015-2016	Atlantic Ocean	Shipping and natural	4 hydrophones, 12 months	ENGIE (France)
GOEMONIER	2016	Atlantic Ocean	Fishing device	1 hydrophone	Marine Protected Area (France)

III.3. Calibration of the maps

It is essential to bear in mind that no underwater noise measurements made with hydrophones have been used to calibrate the noise maps. An active acoustic calibration measurement is strongly recommended.

Chapitre IV. Input data and assumptions

The data used to perform the modelling describes:

- the bathymetry of the area provided by EMODNet [20] and illustrated in Figure 3;
- the coast line of the area provided by [21] ;
- the sediment provided by EMODNet [20] ; The original sediment data has a spatial resolution of 1/40°. The EMODnet database classifies the sediments into 6 categories:
    - ✓ Boulders & bedrock;
    - ✓ Till/diamincton;
    - ✓ Coarse-grained sediment;
    - ✓ Mixed sediment;
    - ✓ Muddy sand and sand;
    - ✓ Mud and sandy mud.

  The geo-acoustic parameters used in the acoustic model as boundary conditions are reported in Table 4. Since the sediments being assumed to be fluid-elastic, the geo-acoustic parameters are limited to density (in ton per m3), compressional speed (m/s) and compressional attenuation (in dB/λ, λ being the acoustic wavelength) as illustrated in Figure 4. Shear waves propagating in solid materials are neglected.
- the sound speed derived from temperature and salinity of the sea water provided by the Copernicus Marine Environment Monitoring Service (CMEMS) which provides regular and systematic reference information on the physical state, variability and dynamics of the ocean and marine ecosystems for the global ocean and the European regional seas. The Mackenzie equation (1981) has been used to derive temperature and salinity into sound speed (Figure 5):

$$c(D,S,T) = \begin{array}{l} 1448.96 + 4.591T - 5.304 \times 10^{-2}T^2 + 2.374 \times 10^{-4}T^3 + 1.340\ (S-35) + 1.630 \times 10^{-2}D + \\ 1.675 \times 10^{-7}D^2 - 1.025 \times 10^{-2}T(S - 35) - 7.139 \times 10^{-13}TD^3 \end{array}$$

  In which T is the temperature in degrees Celsius, S is the salinity in parts per thousand, and D is the depth in meters. The range of validity: temperature 2 to 30 °C, salinity 25 to 40 parts per thousand, depth 0 to 8000 m.
- the sea-state or sea surface roughness provided by the Wave Watch 3 model.

The type and source of data used is summarized in Table 3. The background noise is set using the Wenz model [22] for natural noise derived from the surface roughness of the sea in the area.

Table 3 : Summary of the input data used for the modelling

Data Type	Provider	Coverage	Spatial resolution
Bathymetry	EMODNet	European seas	7.5"
Coast line	Open Street Map	World	-
Sediment	EMODNET	European seas	7.5"
Temperature	Copernicus Ocean	World	5'
Salinity	Copernicus Ocean	World	5'
Surface roughness	Wave Watch 3	World	30'

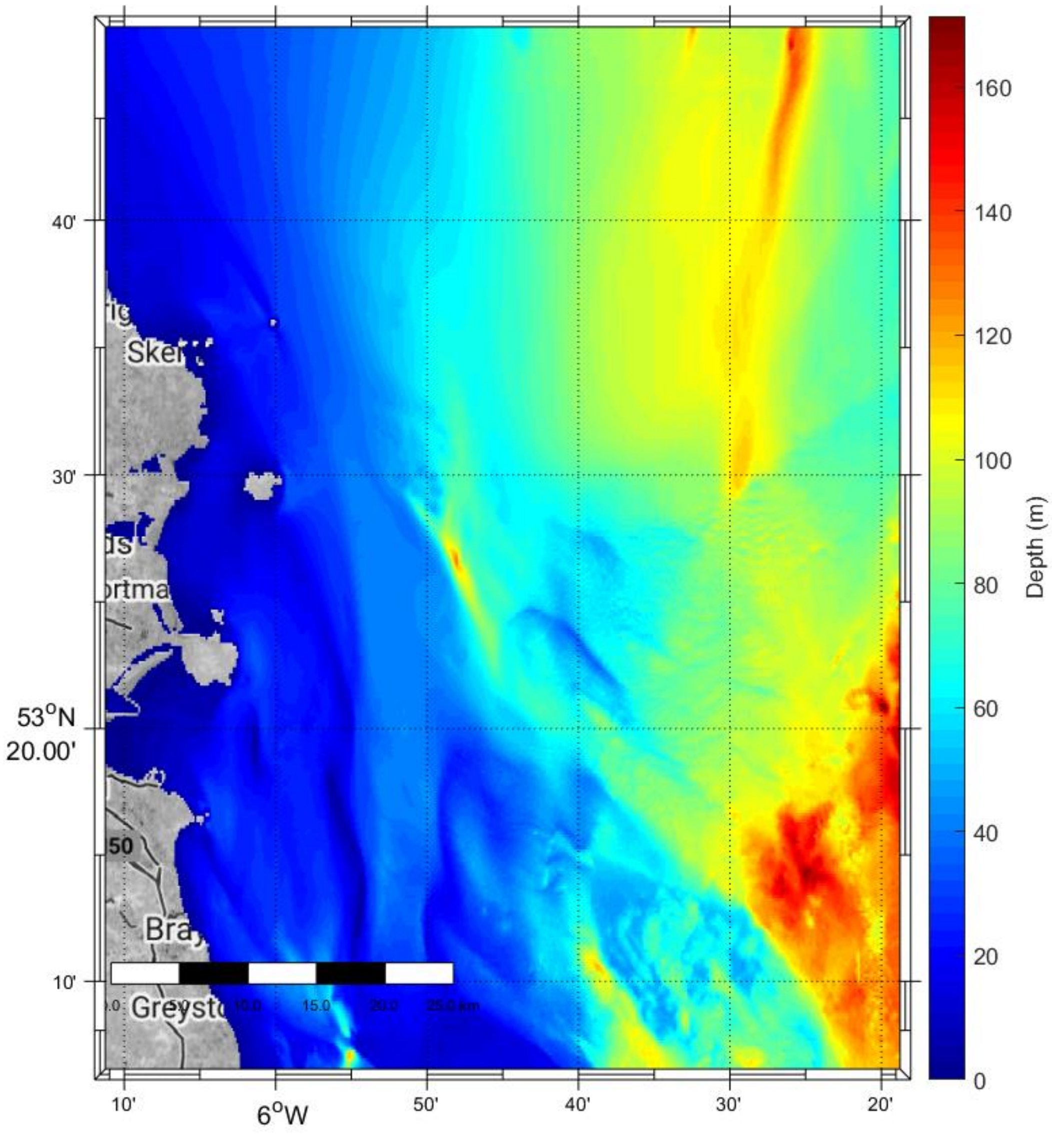


Figure 3: Bathymetric map used for modelling offshore Dublin extracted from [20]

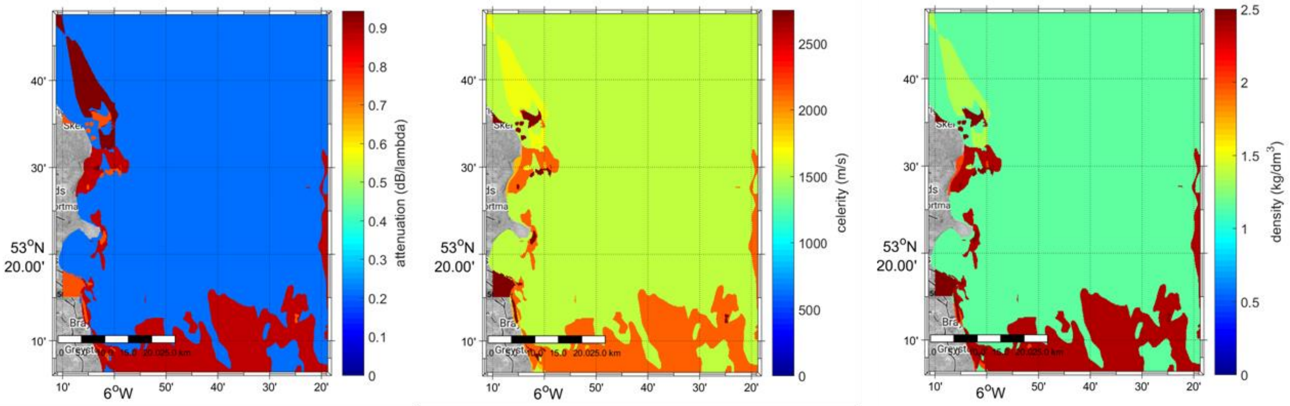


Figure 4: Distribution of values of compressional attenuation of sound (left), compressional sound speed (middle), and density (right) of the sediment provided by [20] .

Table 4: Bottom characteristics used for modelling.

Sediment Name	Density		Compressional Speed		Compressional Attenuation	
	Ton/m3		m/s		dB/lambda	
	Mean	Uncertainty	Mean	Uncertainty	Mean	Uncertainty
Boulders & bedrock	2,50	0,08	3 820	23	0,75	0,04
Till/diamincton	2,50	0,08	2 750	23	0,75	0,04
Coarse-grained sediment	2,37	0,10	2 122	315	0,88	0,07
Mixed sediment	2,03	0,26	1 855	79	0,89	0,01
Muddy sand and sand	1,53	0,22	1708	70	0,91	0,06
Mud and sandy mud	1,16	0,03	1517	32	0,37	0,41

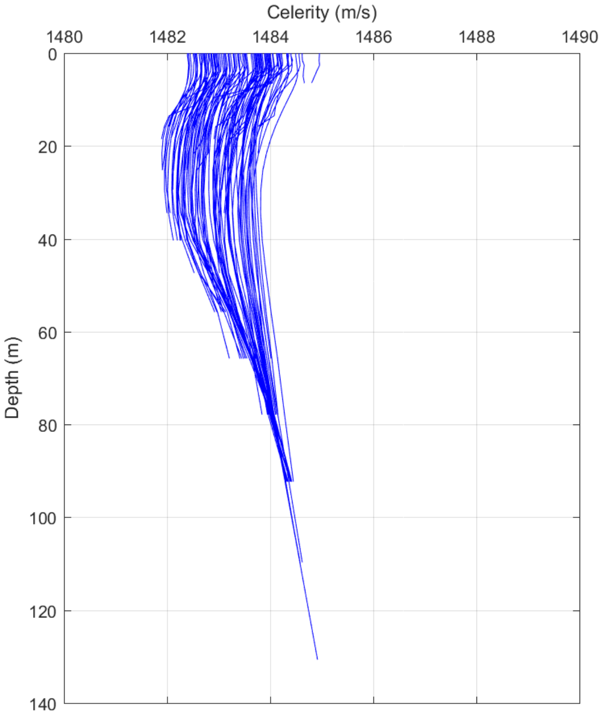


Figure 5: Sound speed profiles in the area the 17th of March 2017 provided by CMEMS.

IV.1. Noise introduced in the marine environment from dredging

The Scope of Work describe a dredged section using Back Hoe Dredgers (BHD) and Trailer Suction Hopper Dredgers (TSHD) with the BHD working from the inshore outwards and the TSHD working from the Outfall point towards the inshore. For modelling, the Scope of Work has requested to consider as sources a Trailing Suction Hopper Dredger (TSHD) (see illustration Figure 6).

The location for modelling is at 53.4169° latitude and -6.075° longitude, offshore Dublin, which correspond to the far end of the dredging track length (about 4 km offshore). The physical geometry of the sound source is modelled as two points of generation: 50% of the generated energy is at 6m depth to describe the noise from the vessel, and 50% of the energy is located close to the bottom to describe the noise generated by the suction pipe.

The activity selected for the modelling is the flattening and removal of rocks. The wideband source level is derived from [24] and [25] and estimated at 188 dB ref 1µPa in the 50Hz to 89 kHz. Detailed source levels for the frequencies modelled are reported in Table 5.

Table 5 : Source levels used for modelling the dredging activities

Source level dB ref1µPa²@1m	Sound Pressure Level in the 125Hz 1/3 octave	Sound Pressure Level in the 1kHz 1/3 octave	Sound Pressure Level in the 8kHz 1/3 octave
TSHD	175.5	173.4	172.2

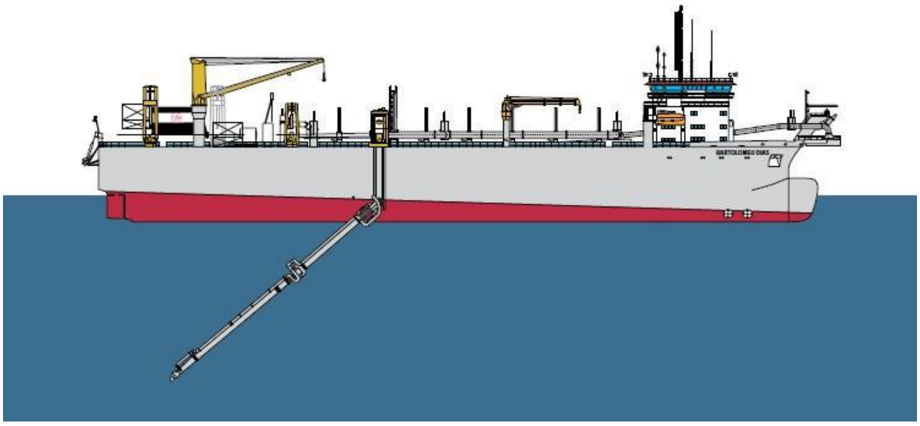


Figure 6 : Illustratio of a Trailing Suction Hopper Dredger (TSHD)) (vessel name: Bartolomeu Dias)

Source : Jan De Nul

IV.2. Noise introduced in the marine environment from piling

We will consider as sources the piling of 600mm piles using an impact hammer (see illustration).

The location for modelling the piling is at 53.42466° latitude and -6.098955° longitude, offshore Dublin. During a piing phase, the sounds generated are impulsive. In order to translate the potential impacts more accurately, the scientific community (NOAA, 2016) now agrees to quantify the level as Sound Exposure Level (SEL), expressed in dB 1µPa².s). The sound exposure energy corresponds to the acoustic energy received at a point, integrated over a given frequency band and over the significant duration of the sound pulse (Ti). In this study, Ti is chosen to be 100ms, according to the literature (De Jong, et al., 2008), for example.

Earlier modeling and measurement research programs have shown that the level of sound exposure in water increases logarithmically as a function of the diameter of the pile, which makes it possible to extrapolate with confidence measurements reported in the literature. The source levels used in the modeling study are derived from measurement taken at the Q7 and OWEZ construction projects (De Jong et al., 2008), Beatrice (Talisman Energy et al., 2004) and Horns Rev II (ITAP, 2008).

The piling source is modelled using an ensemble of four punctual sources. 40% f the total energy is at the bottom end of the pile, while 60% of the energy is equally distributed along the pile. Detailed source levels for the frequencies modelled are reported in Table 6.

Table 6 : Source levels used for modelling the piling activities

Source level dB ref1µPa²@1m	Sound Pressure Level in the 125Hz 1/3 octave	Sound Pressure Level in the 1kHz 1/3 octave	Sound Pressure Level in the 8kHz 1/3 octave
600mm diameter pile driving **Per stroke**	186 dB ref1µPa²@1m	172 dB ref1µPa²@1m	Not modelled as requested in the Scope of Work

Chapitre V. Noise maps produced

V.1. Important disclaimers

Maps have been produced at 125Hz, 1kHz and 8kHz third-octaves (for dredging). Therefore, the levels obtained **cannot** be directly compared to cetaceans' nor seals' PTS or TTS thresholds, since the thresholds are valid for the total energy contained in the audibility band of the species (NOAA, 2016), which is much larger than a third-octave band. To be able to compare and estimate a risk area, modelling should be performed for the full audibility band of each species, which has not been required by the costumer. For example, the source level in the auditory band of seals for a single-stroke piling of a 600mm diameter pile is 178 dB ref1µPa²@1m, while the source level in the 1kHz third-octave band is only 172 dB ref1µPa²@1m, which makes a significant difference.

The maps are purely modelling maps using the best known description of the environment. Usually, an acoustic calibration measurement is needed to ground truth the maps and reduce uncertainties.

V.2. Summary of maps produced

For each scenario (dredging and piling), a total of 21 maps have been produced and delivered in a NetCdf Format. The noise maps correspond to:

- March 2017 environmental context;
- The full water column;
- Three third-octave bands, centred at 125 Hz, 1kHz and 8 kHz (only for dredging) as required by the costumer ;
- Seven percentiles, 0th (maximum), 10th, 25th, 50th, 75th, 90th and 100th (minimum) percentiles to characterise the variability of the sound field with depth;
- Three depth ranges (Surface to -15m, 30m to the bottom, and the full water column).

V.3. Delivery

Quiet-Oceans has delivered noise ambient maps in NetCDF format version 4. Files format respect principals rules of NetCdf Climate and Forecast (CF) Metadata Conventions release 1 [23] .The NetCdf provided is described by :

- global attributes : attributes used for context, history or versioning file ;
- dimensions : scalar data that describes dimensions for the variables contained in file ;
- variables : vectors or matrix that describes the data.

The following sections detail the content of the delivered data.

V.3.1. File name

Files are named as follow: Dredging_DublinNorth_20170330.nc for the dredging scenario and Piling_600mm_DublinNorth_20170728.nc for the piling scenario.

V.3.2. Dimensions

The dimensions of the variables contained in the delivered Netcdf are detailed in Table 7.

Table 7: Summary of the dimensions of the variables contained in the delivered Netcdf files.

Group	Name	Value	Statut (Mandatory, Optionnal)
AcousticData	Lat	number of latitudes, configuration dependent	M
	Lon	number of longitudes, configuration dependent	M
	frequency	number of frequency	O
	percentile	number of percentiles, configuration dependent	M
	Layer	Number of immersion layers	M
	maxLayerNameLen	Max length of layer names	M

V.3.3. Variables

A variable can be associated with attributes. When CF conventions describes it, standard attributes are mentioned:

- ✓ standard_name : name for variable according to CF conventions
- ✓ long_name : description for variable according to CF conventions
- ✓ units : : units according to UD Units Unidata dictionnary
- ✓ valid_min : minimal value for data validation
- ✓ valid_max : maximal value for data validation

For geographic reference, SPL is linked to a coordinate reference system (CRS) which defines all the parameters attached to a mapping projection :

- ✓ grid_mapping_name : naming of projection as defined in conventions (Appendix F. Grid Mappings). In our case, latitute_longitude is equivalent to geodesic projection in which coordinates positions are latitude and longitude,
- ✓ epsg_code : EPSG code (4326) for correspondant geodesic projection with WGS84 ellipsoid
- ✓ longitude_of_prime_meridian : longitude of prime meridian in geodesic projection
- ✓ semi_major_axis : half the major axis of the ellipsoid linked to the projection
- ✓ inverse_flattening : 1/flattening of the ellipsoid linked to the projection

Table 8: Description of the variables of the Netcdf delivered.

Name	Dimensions	Datatype	Statut (Mandatory/ Optionnal)	Attributes		Description
layer	Layer	int8	M	Standard_name Long_name bounds layer_names	Layer Layer layer_bnds layer_names	Immersion field.

Name	Dimensions	Datatype	Statut (Mandatory/ Optionnal)	Attributes	Description
layer_names	Layer, maxLayerNameLen	char	M		Immersion identification (Ex : High, Low, Full).
layer_bnds	layer, nv	int	M	unit m positive down	Immersion bounds
frequency	frequency	int	O	Standard_name frequency long_name Central band frequency units Hz order_convention IEC 61260 : 1995"; order_octave 3.0	
percentile	percentile	int8	M	Standard_name percentile Long_name percentile comment QO definition : The value above which a given percentage of observations in a group of observations fall unit Percent	
Lon	Lon	double	M	Standard_name longitude Long_name longitude comment None unit degrees_east	
lat	Lat	double	M	Standard_name latitude Long_name latitude comment None unit degrees_north	
energy	layer, frequency percentile, lon, lat	single	O		

crs		Single	M	grid_mapping_name latitude_longitude
				epsg_code EPSG:4326
				longitude_of_prime_meridian 0.0; // double
				semi_major_axis 6378137.0; // double
				inverse_flattening 298.257223563; // double	

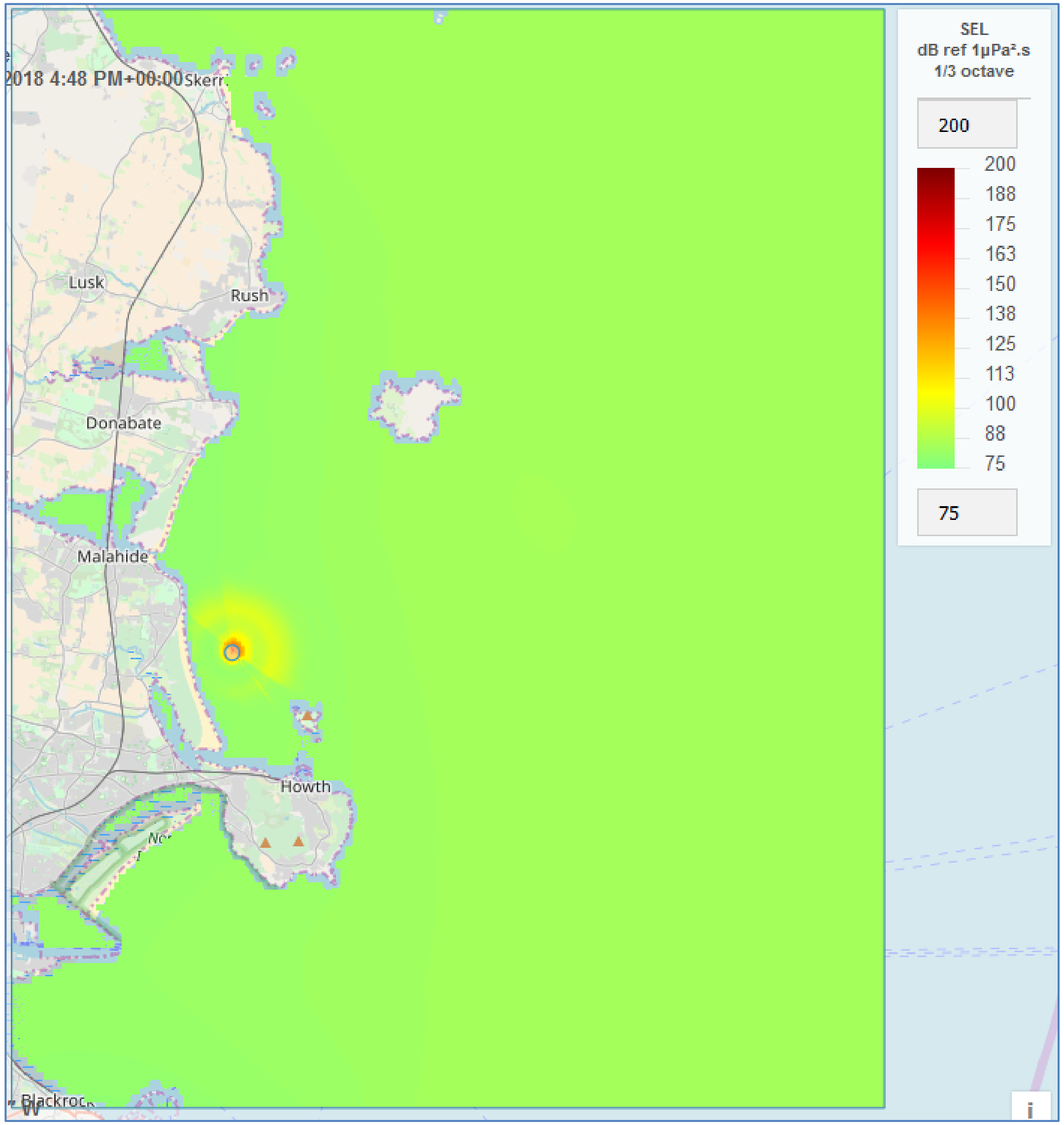
V.4. Selection of noise maps

This section gives **a non-exhaustive overview** of the noise maps for dredging. The maps reported hereafter are only for illustration purposes, and shows either the maximum levels or the 5th percentile (or exceedance level) for the full water column for the 125 Hz, 1kHz and 8 kHz third-octave bands.

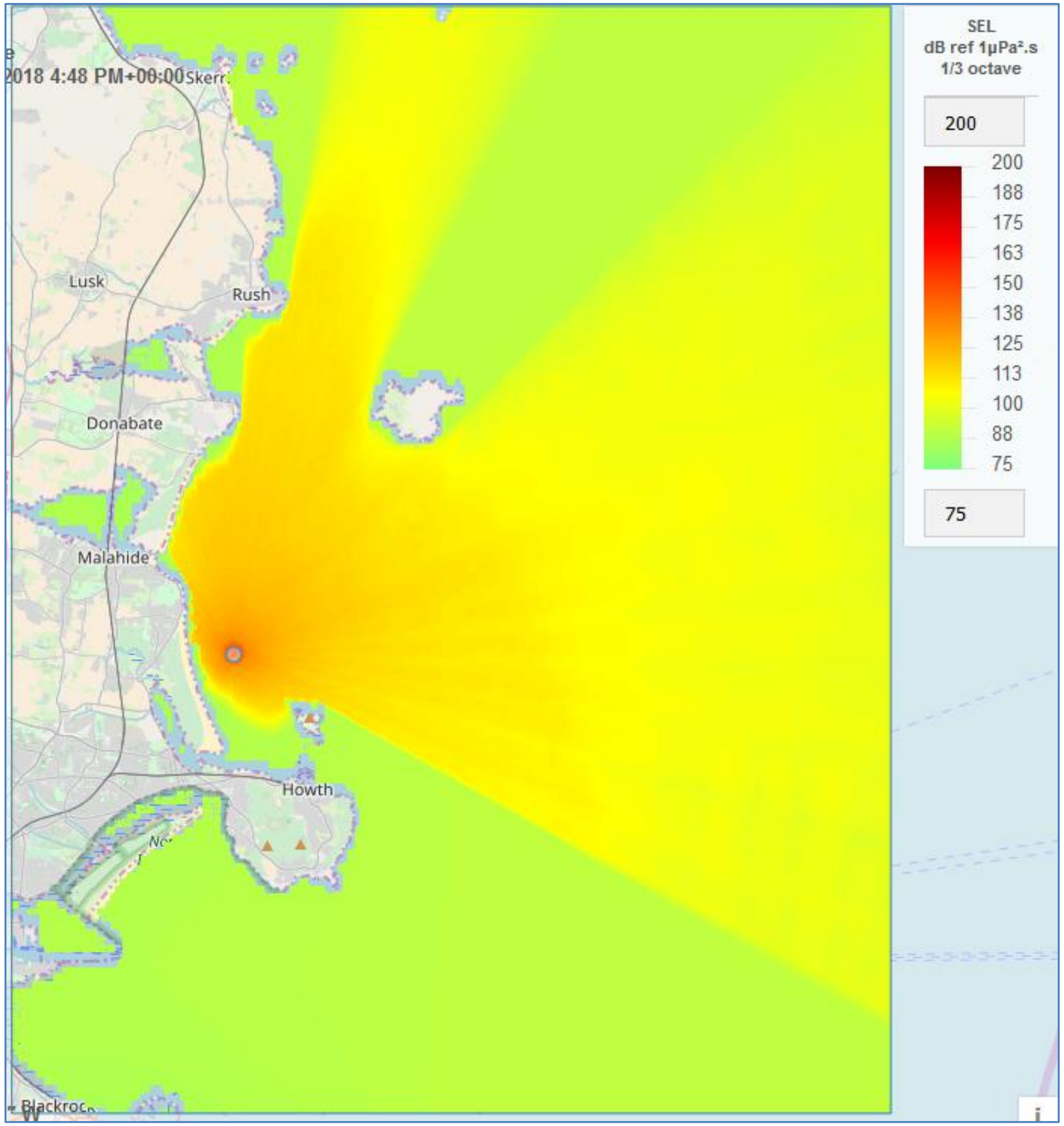
All raw data of modelled maps have been delivered in a Netcdf format for further exploitation by the customer.

V.5. Noise maps of dredging

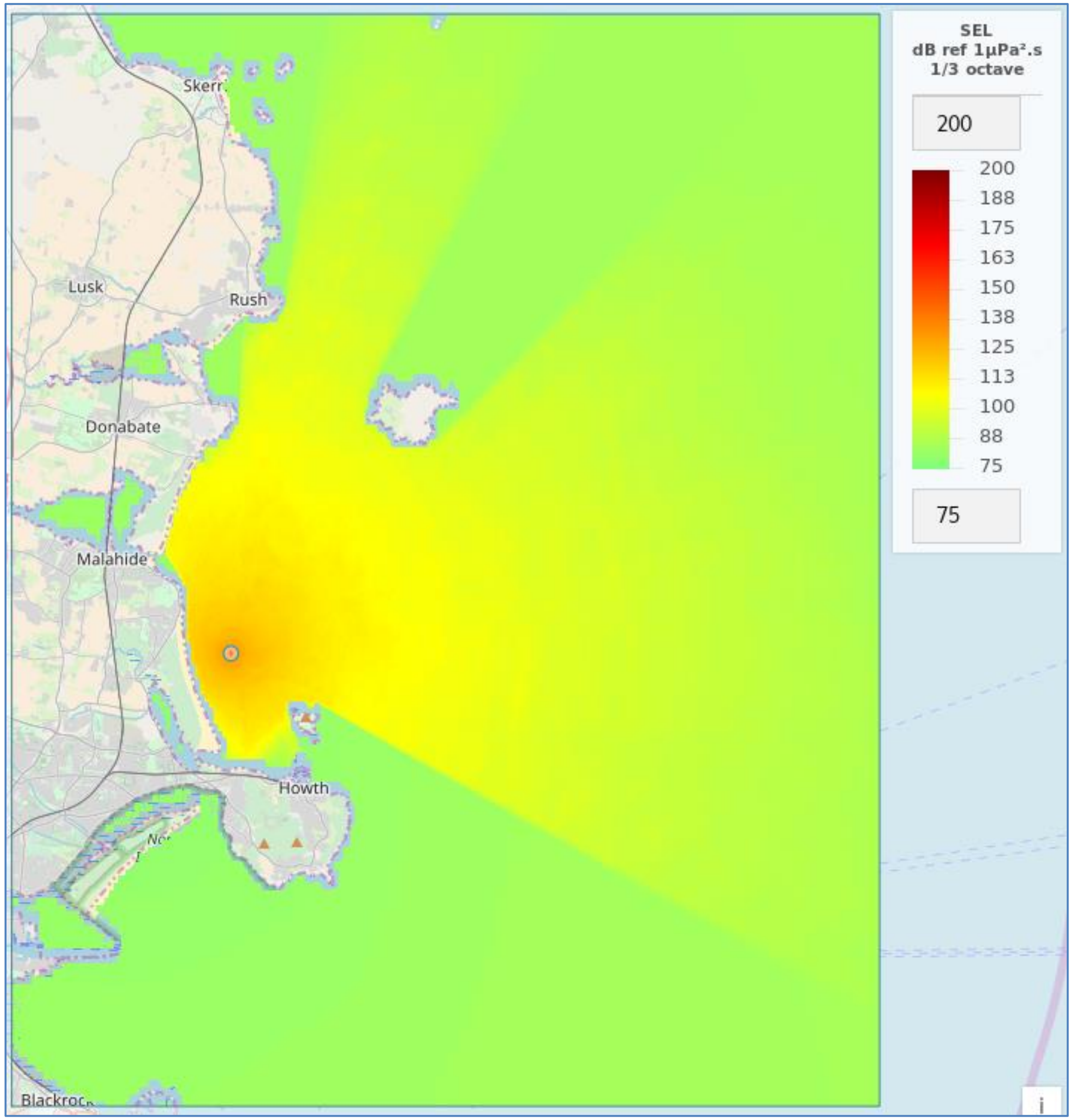
5th
percentile
levels at
125 Hz 1/3
octave
band



5th percentile levels at 1kHz 1/3 octave band



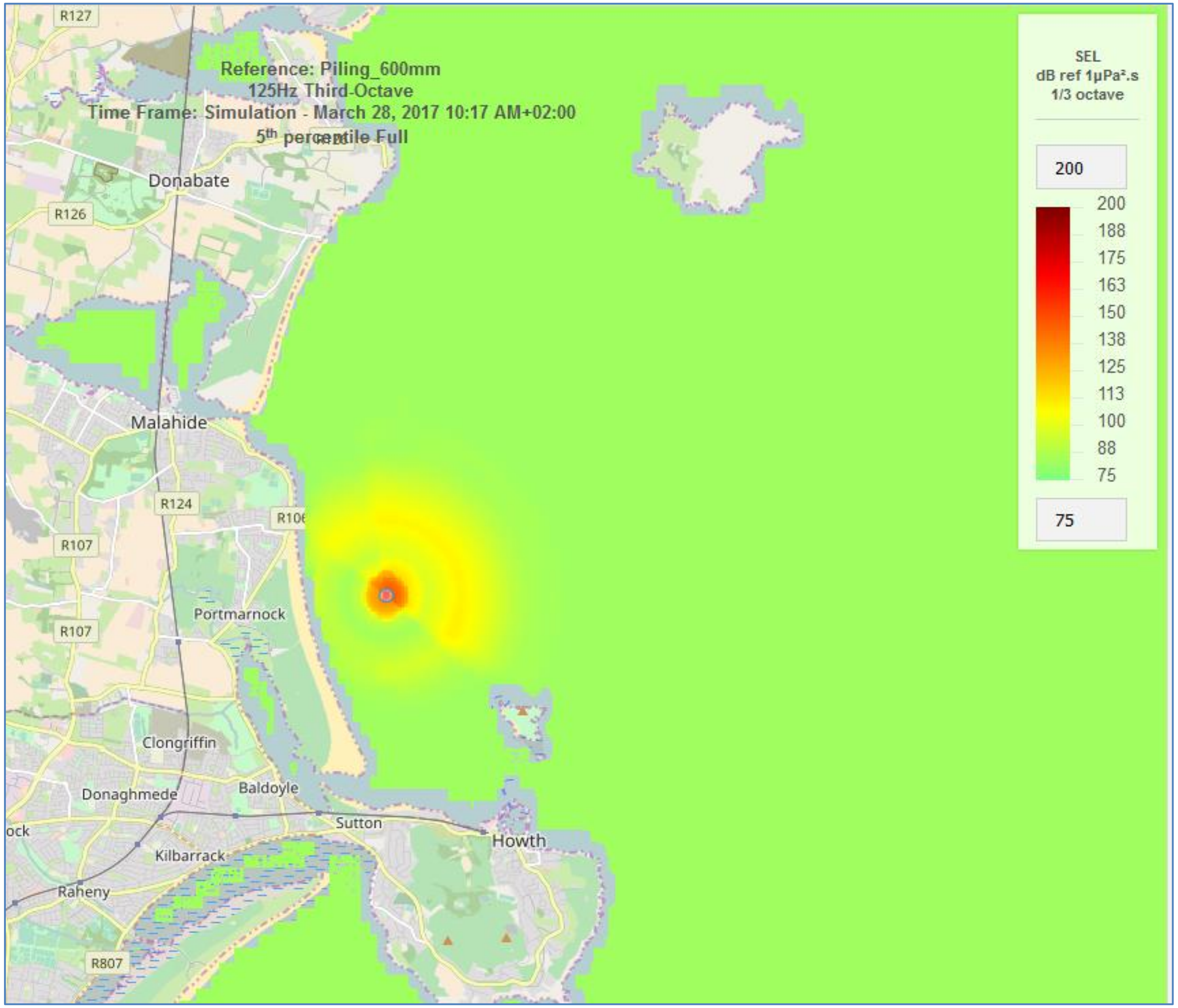
5th percentile levels at 8kHz 1/3 octave band



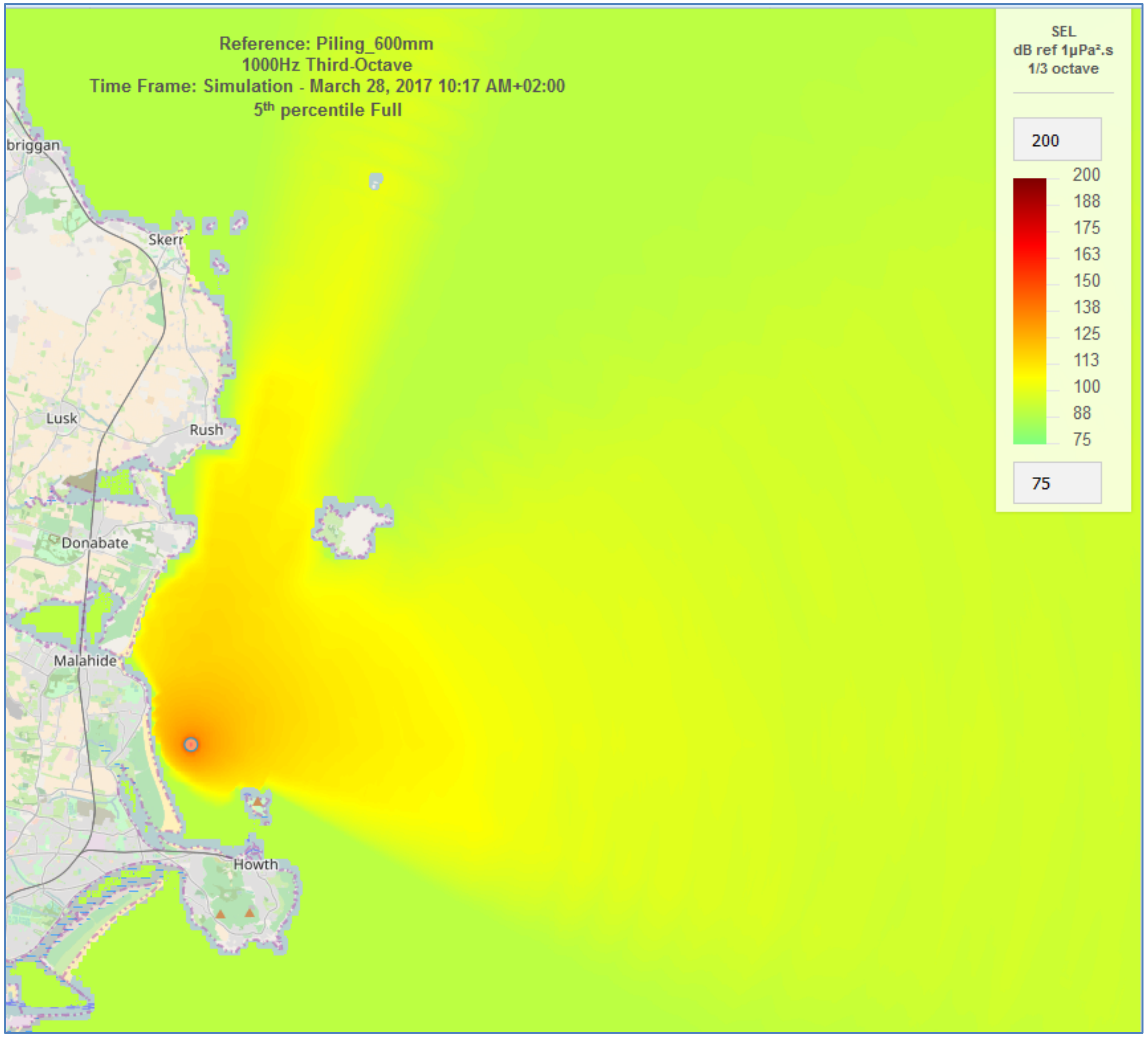
V.6. Noise maps of piling a 600mm pile

Piling 600mm diameter

Maximum 1sec SEL levels
at 125 Hz 1/3 octave band



Maximum 1sec SEL levels
at 1kHz 1/3 octave band



Bibliographie

[1] ANSI S1.11-2004: Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters, American National Standard Institute, USA, Reaffirmed by ANSI 2009.

[2] IEC 1995 (EN 61260), Electroacoustics - Octave-band and fractional-octave-band filters, International Electrotechnical Commission, Geneva, Switzerland, 1996.

[3] Folegot, T., Clorennec, D.,(2014), From Footprint prediction to risk assessment and focused mitigation, Proceedings of the ECS/ASCOBANS/ACCOBAMS Joint Workshop on introducing noise into the marine environment – what are the requirements for an impact assessment for marine mammals ?, European Cetacean Society's 28th Annual Conference, Liege, Belgium, 6th April 2014

[4] Folegot, Thomas, Method for monitoring, predicting and reducing the level of acoustic energy of a plurality of sources in an aquatic environment and method for monitoring, predicting, and reducing the risk of noise annoyance for marine species, European Union Patent EP2488839, 10 October 2009.

[5] Folegot, Thomas, Ship traffic noise distribution in the Strait of Gibraltar: an exemplary case for monitoring global ocean noise, Conference on the effect of noise on aquatic life. Cork, Ireland: Springer, 2010.

[6] Folegot, T., Clorennec, D., Brunet, P., Six, L., Chavanne, R., van der Schaar, M., et al. (2015). Monitoring Long Term Ocean Noise in European, Proceedings of the IEEE OCEANS International Conference, . Genova, June 2015.

[7] Sutton, G., Jessopp, M., Folegot, T., Clorennec D. (2013), Mapping the spatio-temporal distribution of underwater noise in Irish Waters, Environmental Protection Agency, STRIVE Programme 2007-2013, technical report 2011-W-MS-7

[8] F. Thomsen, A. Gill, M. Kosecka, M. Andersson, M. Andre, S. Degraer, T. Folegot, J. Gabriel, A. Judd, T. Neumann, A. Norro, D. Risch, D. Wood et B. Wilson (2015), MaRVEN: Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewable Energy, Editor: European Commission, Brussels, 2015.

[9] T. Folegot, D. Clorennec, A. Norro, A. Gill et F. Thomsen, (2016), Modelling the risk of noise exposure to marine life during offshore wind farms construction and operation, 4th International Conference on the Effects of Noise on Aquatic Life, Dublin, Ireland, 2016.

[10] C. Audoly, C. Rousset, E. Baudin and T. Folegot (2016), AQUO Project: Research on solutions for the mitigation of shipping noise and its impact on the marine fauna, a Synthesis of guidelines, International Conference and Exhibition on Underwater Acoustics, Athens, Greece, 2016.

[11] EC (2010), Criteria and methodological standards on good environmental status (GES) of marine waters, Directive 2010/477/EC, Euroean Commission, Brussels, 2010.

[12] Haw-Jye, S., & Hillson, R. (2006). A software workbench for estimating the effects of cumulative sound exposure in marine mammals. *IEEE Journal of Oceanic Engineering*, vol.31, no.1, pp.8-21.

[13] Jensen, F. B., Kuperman, W. A., Porter, M. B., & Schmidt, H. (2000), Computational Ocean Acoustics, AIP Series in Modern Acosutics and Signal Processing, Springer.

[14] Collins, M. D. (1994). Generalization of the Split-Step Pade. J. Acoust. Soc. Am., 96, 382-385.

[15] Collins, M. D., Kuperman, W. A., & Siegman, W. L. (1995). Parabolic Equation for poro-elastic media. J. Acous. Soc. Am, 98(3), 1645-1656.

[16] Collins, M. D., Cederberg, R. J., & King, D. B. (1996). Comparison of Algorithms for Solving Parabolic Wave Equations. *J. Acoust. Soc. Am.*, 100, 178-182.

[17] Collins, M. D. (1991). A higher-order energy conserving parabolic equation for range-dependent ocean depth, sound speed and density. J. Acoust. Soc. Am. 89, 1068–1075.

[18] Porter, M. B., & Reiss, E. L. (1984). A numerical method for ocean-acoustic normal modes. *Journal of the Acoustical Society of America*, 76, 244-252.

[19] Reine K., C. D. (2012). *Characterization of underwater sounds produced by a backhoe dredge excavating rock and gravel.* DOER Technical Notes Collection (ERDC TN-DOER-E36), 1-29. [Publication 2].

[20] EMODnet, 2012: Seabed substrate data (version 28.6.2012) made available by the EMODnet (European Marine Observation and Data Network) Geology project, funded by the European Commission Directorate General for Maritime Affairs and Fisheries. http://www.emodnet-geology.eu.

[21] OpenStreetMap Foundation, 2017, OpenStreetMap® is open data, licensed under the Open Data Commons Open Database License (ODbL); http://www.openstreetmap.org, march 2017.

[22] Wenz, G. (1962). Acoustic Ambient Noise in the Ocean: Spectra and Sources. J. Acosut. Soc. Am., 34:1936-1956.

[23] http://cfconventions.org/Data/cf-conventions/cf-conventions-1.6/build/cf-conventions.pdf.

[24] Parvin (2008), Assessment of underwater noise from dredging operations on the Hastings shingle bank,

[25] Robinson S.P., Theobald, P.D., Hayman, G, Wang, L.-S., Lepper, P. A., Humphrey, V.F., Mumford, S. (2011), Measurement of underwater noise arising from marine aggregate dredging operations Final Report, MALSF (MEPF Ref no. 09/P108), Published February 2011.

Appendix E Site-Specific Detailed Conservation Objectives List Links

Site Name	Type	Conservation Objectives Date	Link
Baldoyle Bay	SPA	27/02/2013	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004016.pdf
Ireland's Eye	SPA	21/02/2018	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004117.pdf
North Bull Island	SPA	09/03/2015	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004006.pdf
Malahide Estuary	SPA	16/08/2013	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004025.pdf
Howth Head Coast	SPA	21/02/2018	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004113.pdf
South Dublin Bay and River Tolka Estuary	SPA	09/03/2015	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004024.pdf
Rogerstown Estuary	SPA	20/05/2013	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004015.pdf
Lambay Island	SPA	21/02/2018	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004069.pdf
Dalkey Island	SPA	21/02/2018	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004172.pdf
Skerries Islands	SPA	21/02/2018	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004122.pdf
Rockabill	SPA	08/05/2013	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004122.pdf
Baldoyle Bay	SAC	19/11/12	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO000199.pdf
Rockabill to Dalkey Island	SAC	07/05/13	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO003000.pdf
North Dublin Bay	SAC	06/11/2013	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO000206.pdf
Malahide Estuary	SAC	17/05/13	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO000205.pdf
Howth Head	SAC	06/12/16	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO000202.pdf
Rogerstown Estuary	SAC	14/08/13	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO000208.pdf
South Dublin Bay	SAC	22/08/2013	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO000210.pdf
Lambay Island	SAC	22/07/2013	https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO000204.pdf

Appendix F Vessel Management Plan

Greater Dublin Drainage

Appendix F

Vessel Management Plan

23 May 2018

Project Number: SEC7909

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	Signature:	Simon Zisman		
Current Status:	**Final**			
Issue Date:	**23 May 2018**	Revision Number:	20180523_F1	
		Revision Notes:	**-**	
Project File Path:	**W:\7909SEC - RPS Belfast, WW EIS NIS Ornithology\Technical\Reports\EIS\2017_12_05_VMP\2017_12_05_GDD_VMP_dv5.docx**			

This report has been prepared within the RPS Planning and Development Quality Management System to British Standard EN ISO 9001 : 2008

CONTENTS

FIGURES

1. VESSEL REPRESENTATIVE SIGNATURE PAGE

1.1 By signing this page, you confirm that as a vessel representative:

- Have read, understand, and will comply with the information contained in this document;
- Will ensure that the master and crew of the vessel you represent are shown this document, and confirm that they have read, understood and will abide by it; and
- Will ensure that at least one copy of this document is kept onboard the vessel in question at all times, in a location it can be easily accessed for reference.

Name	Vessel	Signature	Date

2. INTRODUCTION

Background

2.1 Chapter 10, Marine Ornithology, of the Environmental Impact Assessment Report (EIAR) for the Greater Dublin Drainage project (GDD; “the project”) has assessed the potential for impacts on marine birds during the construction and operation of the project.

2.2 During the breeding season (April to August), high numbers of birds are present in the vicinity of the proposed subsea pipeline route between Velvet Strand and Ireland’s Eye, where there is a large seabird colony on the cliffs. The island and surrounding waters are designated as a Special Protection Area (SPA), which means that it is one of Ireland’s most important sites for seabirds. No activity that would result in adverse effect on site integrity can be permitted. This includes the construction and operation of the project and the operation of vessels associated with it. The “site” applies to the nests of qualifying bird species on the cliffs, and to qualifying species that are using the sea for foraging, loafing and other activities.

2.3 A chart showing the Ireland’s Eye SPA boundary with reference to the project is presented in Figure 1.

2.4 In the EIAR, it was identified that the production of a suitable vessel management plan (VMP) would serve two purposes with respect to the impact assessment for the construction of the project:

- Increase in confidence of prediction of the Negligible impact significance on the seabird colony of Ireland’s Eye during the April to August breeding season (i.e. adult birds and chicks at their nest sites), by providing clear instructions to vessels regarding the SPA location to help them avoid approaching it.
- Reduction in the impact significance of flightless auk chicks (generally guillemot or razorbill) attempting to leave the area along with adults at the end of the breeding season, by providing an ornithological watching brief, and clear protocol applicable only at this time of year.

Purpose and Structure of Document

2.5 Chapter 3 of this document details the following aspects of the VMP:

- What it entails;
- Who it applies to;
- When it applies to them;
- Where it applies;
- How it is administered, and by whom; and
- Why it needs to be implemented.

2.6 Annex 1 provides a version of this information which is designed to be quickly referred to by those responsible for controlling vessels operating in support of the project.

2.7 Whilst they should read the details of the VMP to ensure it is fully understood, it is envisaged that Annex 1 will be the ‘operational’ section of the VMP that should be referred to by vessel operators when working on the project.

3. VMP DETAILS

What Does the VMP Entail?

3.1 The VMP contains two conditions, both of which must be met.

3.2 Condition A requires that all vessels associated with the project do not unnecessarily approach, and never cross the boundary of the Ireland's Eye SPA when working on the project, unless there is a risk to human safety in not doing so. The SPA boundary is shown on Figure 2 along with a box. The outline of this box represents the boundary of the exclusion area.

3.3 Condition B requires that between July and August, a bird observer will be positioned either on Ireland's Eye or a vessel to observe the distribution of flightless, rafting auks on the water that are attempting to leave the colony at the end of the breeding season. The direction that these birds travel in when on the water is heavily influenced by local weather conditions. The observer will be in communication with all of the vessels onsite and possesses the authority to instruct them. If it is judged that flightless birds are drifting towards vessels working on the project, the observer has the authority to request via the Marine Co-ordinator that boats leave the area as soon as it is safe for them to do so. Vessels will be expected to move in a north-westerly direction unless otherwise instructed. Vessels can return to their previous work areas when an "all clear" has been given by the bird observer (via the Marine Co-ordinator).

Who Does the VMP Apply to?

3.4 The VMP applies to any vessel conducting any operations concerned with the construction of the project. Vessels working closer to Ireland's Eye are more likely to have to consider the VMP in their day to day activities.

3.5 A nominated representative for each project vessel must sign the table in Section 1 once they have read and understood the VMP, and agreed to the conditions above the table. A copy of the VMP must be carried by each vessel.

When Does the VMP Apply?

3.6 Condition A of the VMP applies throughout the construction phase of the project, at all times of day, and all times of year.

3.7 Condition B of the VMP applies at all times of day between the dates 8th to 31st July inclusive.

Where Does the VMP Apply?

3.8 Condition A of the VMP relates specifically to the boundary of the Ireland's Eye SPA. This location in relation to the subsea section of the project is provided in Figure 1. Regardless of where vessels are working, all vessels associated with the project should be given a copy of this VMP.

3.9 Condition B of the VMP does not refer to any specific boundaries, but is more likely to apply to vessels working on the marine diffuser section of the project where the subsea pipeline terminates. The likelihood of flightless auks encountering vessels will generally decrease the further towards the coast of the mainland a vessel is. Nevertheless, as with Condition A, all vessels associated with the project should be given a copy of this plan.

How is the VMP Implemented?

3.10 The contractor will be responsible for ensuring that the conditions of the VMP are met. Any site induction for vessels will include information on the VMP, and a copy of the plan must be read and signed by a representative from each vessel. A copy of the VMP must be carried by each vessel.

3.11 Where possible, the position of vessels undertaking work will be routinely reviewed to ensure that vessels working under the VMP are compliant.

Why Does the VMP Need to be Implemented?

3.12 Ireland's Eye, and the area of sea which surrounds it, is an SPA. This means that it is one of Ireland's most important sites for seabirds and is subject to high levels of environmental protection.

3.13 No activity that would result in adverse effect on site integrity can be permitted. This includes the construction and operation of the project and the operation of vessels associated with it. Measures are required to ensure the vessels operating as part of the construction of the project are aware of the SPA boundary location, and do not cross it, or approach it unnecessarily. This is the first objective of the VMP.

3.14 The protection afforded by SPA status applies to the nests of qualifying bird species on the cliffs, the waters around Ireland's Eye which form part of the SPA, and to qualifying species that are using the sea (both inside and outside the SPA boundary) for foraging, loafing and other activities.

3.15 Most of the birds that are part of the SPA population use areas of sea beyond the SPA boundary. However, they will not be substantially impacted by the construction of the project, as they are mobile and can use areas of sea not occupied by vessels associated with the project. However, certain elements of the bird assemblage are more sensitive. This is because their offspring, which are hatched on rock ledges on the cliffs of Ireland's Eye, are flightless when leaving the nest. When they drop into the sea and try to leave the area at the end of the breeding season, they and the adult that accompanies them are especially sensitive to vessel disturbance. The second objective of the VMP is to reduce the risk of such issues occurring. This only occurs in a period of several weeks from 8th to 31st July each year, so this is the only time at which this part of the VMP will apply.

ANNEX 1: GREATER DUBLIN DRAINAGE: VMP

Introduction

During construction of the Greater Dublin Drainage (GDD), a Vessel Management Plan (VMP) must be adhered to.

The purpose of the VMP is twofold:

1. To avoid all vessels associated with the project unnecessarily approaching or crossing the boundary of the Ireland's Eye Special Protection Area (SPA) at all times.
2. To protect flightless rafting auks originating from the SPA in July and August. Particular winds and currents can cause these flightless auks to drift towards GDD working areas. A procedure is required to ensure their safety, and to avoid disturbance and collision with employed vessels.

The Ireland's Eye SPA is located in close proximity to the GDD subsea section and diffuser, and the accompanying chart shows the location. This memo outlines the protocol and its implementation at GDD.

Procedure

Marine Coordination

The Marine Co-ordinator will ensure that every vessel associated with the project is acquainted with the VMP. This is ensured by incorporating the below procedure in the Masters' induction and in the Marine Coordination Procedure which is handed to every vessel working on the project.

The Marine Co-ordinator will periodically ensure that vessels continue to understand and adhere to the VMP. Point 1 of the VMP is relevant at all times.

During July and August, the Marine Co-ordinator will ensure added awareness of the VMP procedure, particularly point 2, by incorporating a general reminder of the rafting Auk procedures in the coordination meetings held at site.

In addition, a bird observer will be appointed by the contractor. They will be on site providing a watching brief during this time. These observations will occur from Ireland's Eye at all times of operation between the following dates: 8th July to 31st July. Should the surveyor identify groups of auks drifting towards the vessel working area the Marine Co-ordinator would be informed and vessels may be requested to stand down from the working area until such time that the birds have left.

If currents or winds for several days have come from a south-easterly direction, extra attention to the possibility of rafting auks must be highlighted on the daily coordination meetings.

Upon receipt of a rafting auk sighting (from either vessels or the dedicated observer) the Marine Co-ordinator must inform all vessels on site immediately and remind vessels to follow the procedure for such an event.

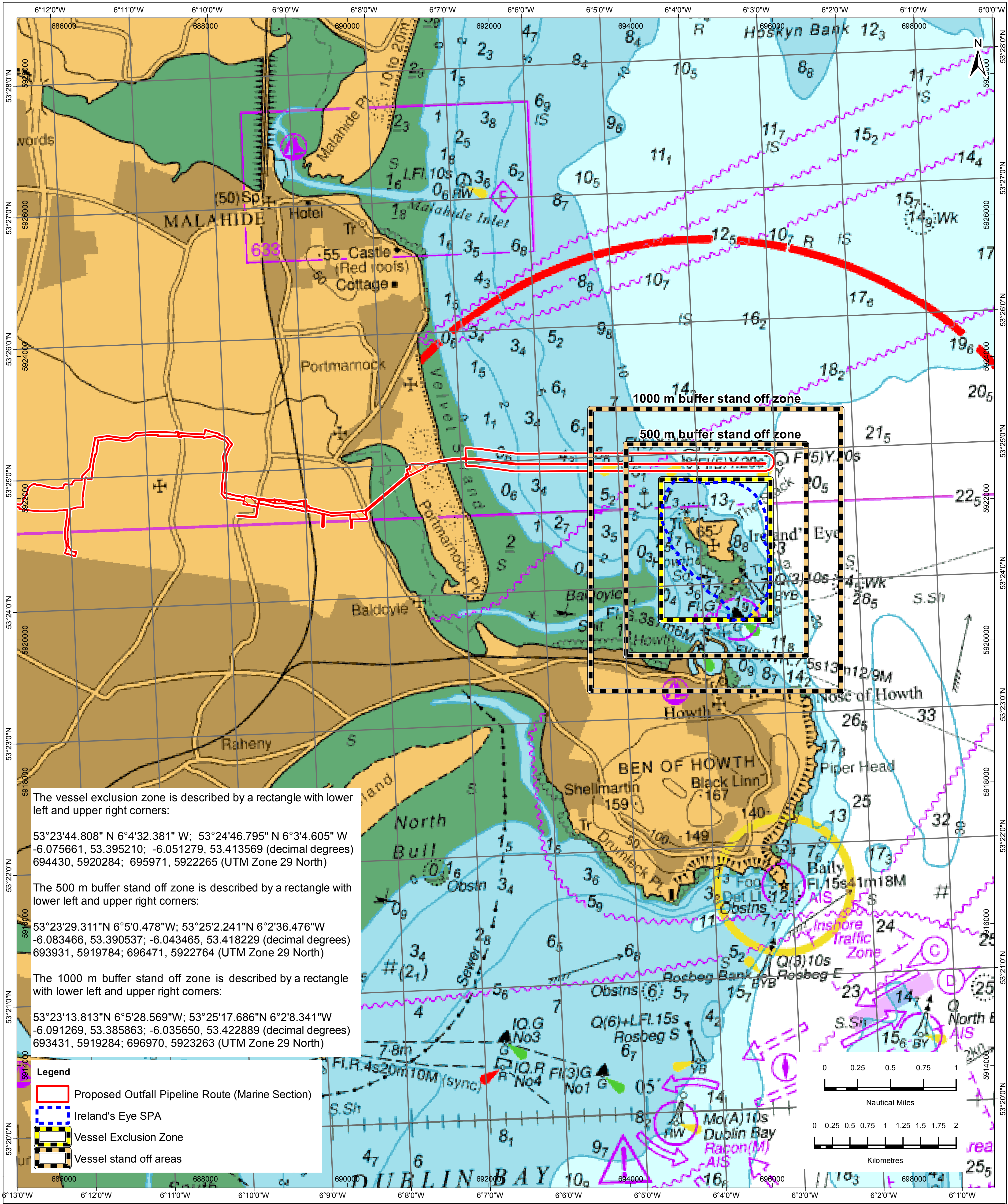
The Marine Co-ordinator will keep all vessels up to date with sightings of rafting auks.

Vessels

If rafting auks are sighted within or close to the WMR wind farm area all vessels are obliged to:

- Immediately report the sighting to the Marine Coordination with exact position of sighting
- When within 1000m of Ireland's reduce speed to less 10 knots
- If working within 500m of sighting vacate this area as soon as it is safe to do so to at least 1000m. Leave the area in north-westerly direction unless other instructed by Marine Coordination
- Keep extra lookout for rafting auks and report to the Marine Coordination immediately if sighted

FIGURES



The vessel exclusion zone is described by a rectangle with lower left and upper right corners:

53°23'44.808" N 6°4'32.381" W; 53°24'46.795" N 6°3'4.605" W
-6.075661, 53.395210; -6.051279, 53.413569 (decimal degrees)
694430, 5920284; 695971, 5922265 (UTM Zone 29 North)

The 500 m buffer stand off zone is described by a rectangle with lower left and upper right corners:

53°23'29.311"N 6°5'0.478"W; 53°25'2.241"N 6°2'36.476"W
-6.083466, 53.390537; -6.043465, 53.418229 (decimal degrees)
693931, 5919784; 696471, 5922764 (UTM Zone 29 North)

The 1000 m buffer stand off zone is described by a rectangle with lower left and upper right corners:

53°23'13.813"N 6°5'28.569"W; 53°25'17.686"N 6°2'8.341"W
-6.091269, 53.385863; -6.035650, 53.422889 (decimal degrees)
693431, 5919284; 696970, 5923263 (UTM Zone 29 North)

Legend

- 🟥 Proposed Outfall Pipeline Route (Marine Section)
- ▭ Ireland's Eye SPA
- ▭ Vessel Exclusion Zone
- ▭ Vessel stand off areas

Greater Dublin Drainage

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
a	26/02/18	Stand off zone added	CH	Draft	Draft	Draft

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UISCE ÉIREANN : IRISH WATER

JACOBS

TOBIN
Patrick J. Tobin & Co. Ltd.

Project: Greater Dublin Drainage Project

Drawing Title: Figure 1 Vessel management restrictions

Drawing Status: Final
Scale @ A3: 1:50,000
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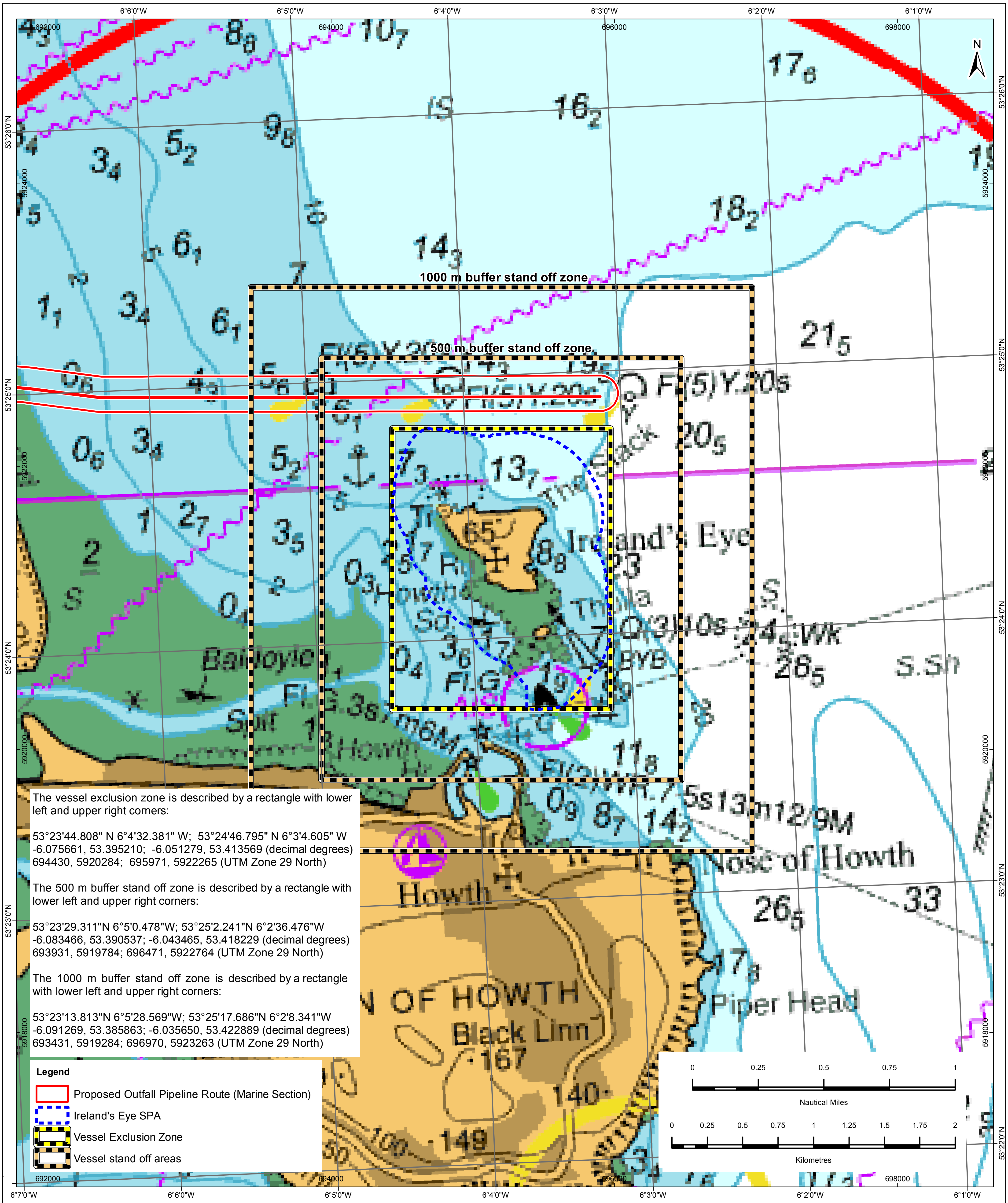
Drawing No.: 32102902



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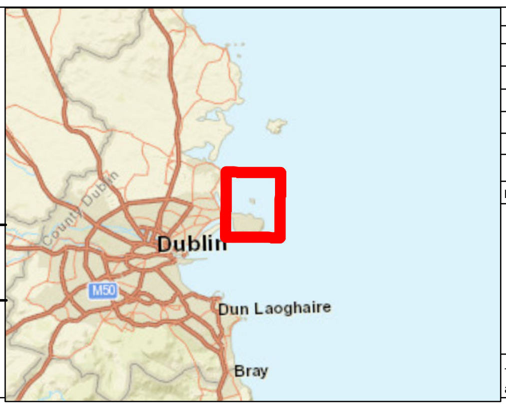
Legend

- 🟥 Proposed Outfall Pipeline Route (Marine Section)
- ▭ Ireland's Eye SPA
- ▨ Vessel Exclusion Zone
- ▨ Vessel stand off areas

Greater Dublin Drainage

Project
Greater Dublin Drainage Project

Drawing Title
Figure 2 Vessel management restrictions



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
a	26/02/18	Stand off zone added	CH	Draft	Draft	Draft

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Drawing Status	Final	
Scale @ A3	1:25,000	DO NOT SCALE
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Drawing No.	32102902