dublin array

An Offshore Wind Farm
on the Kish and Bray Banks

Environmental Impact Statement

January 2012 - Revision 1

Reviewed and Updated by

MRG CONSULTING ENGINEERS LIMITED

Prepared by

SAORGUS ENERGY LTD

Volume 2 of 5
Main Environmental Impact Statement

DUBLIN ARRAY

An Offshore Wind Farm on the Kish and Bray Banks

Environmental Impact Statement

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1 INTRODUCTION

1.1 Document Outline

Kish Offshore Wind Ltd and Bray Offshore Wind Ltd propose to develop an offshore wind farm, to be known as Dublin Array, on the Kish and Bray Banks approximately 10 km off the coasts of Dublin and Wicklow (Figure 1.1). The proposed development will comprise up to 145 wind turbines with a maximum blade tip height of 160m (max. rotor diameter of 130m and max. hub height of 100m) above mean sea level and associated infrastructure including the turbine foundations, inter-turbine cabling and offshore substation. The electricity generated by Dublin Array will be exported to the national grid via a cable which will run from an offshore substation on the banks to a proposed connection point at the existing Eirgrid Substation in Carrickmines, Co. Dublin via a cable landfall site at Shanganagh, south of Shankill, Co. Dublin and north of Bray, Co. Wicklow (Fig 1.1). It is possible that, in addition to a connection at Carrickmines, the development may also be connected to the UK in conjunction with other offshore wind energy projects on the east coast. The feasibility of such a connection will depend both on Irish government and regulatory policy and on the adoption of arrangements by the UK Government which would allow the import of renewable electricity from Ireland.

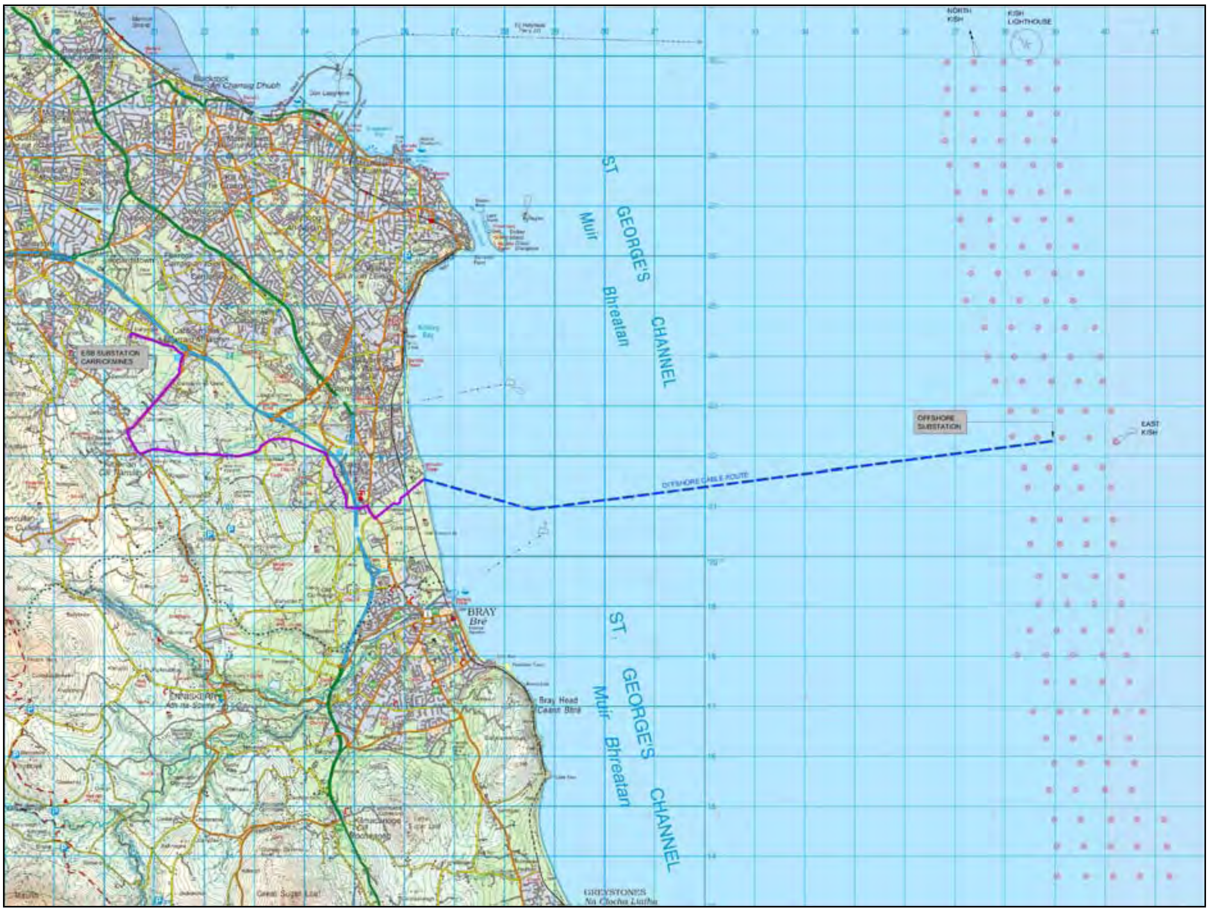


Figure 1.1 Development Layout and Cable Route

(Dashed Blue = Off-shore Cable Route, Purple = cable route on land) (OSI License No. EN0034812)

This volume (Volume 2) comprises the main Environmental Impact Statement (EIS) and forms part of the documentation submitted to the Department of the Environment, Community and Local Government as part of the Foreshore Lease application process for the proposed development. The EIS deals with the effects which the proposed offshore wind farm development would have on the physical, ecological and human environments in the vicinity of the banks through the construction, operational and de-commissioning phases of the project. It also considers the need for the development of renewable energy projects in an Irish, European and international context.

The EIS is structured in five volumes, as follows:

- Volume 1: Non-Technical Summary
- Volume 2: Main Environmental Impact Statement (this volume)
- Volume 3: Appendices to the Environmental Impact Statement
- Volume 4: Zone of Theoretical Visibility (ZTV) Maps
- Volume 5: Photomontages

This volume (Volume 2) comprises the main Environmental Impact Statement. The Non-Technical Summary (Volume 1) provides a summary of the findings of this volume. The appendices to the Environmental Impact Statement (Volume 3) include copies of reports on detailed studies that were undertaken as part of the EIS, as well as details of consultations that were carried out as part of the EIA process. This main volume should be read in conjunction with the relevant appendices contained in Volume 3, which comprise the following:-

VOLUME	APPENDIX	TITLE
EIS Volume 3	Appendix A	EIA Consultation
EIS Volume 3	Appendix B	Physical Environment Impact Assessment Study
EIS Volume 3	Appendix C	Marine Navigation Impact Assessment
EIS Volume 3	Appendix D	Archaeological Impact Assessment Study
EIS Volume 3	Appendix E	Commercial Fisheries Impact Assessment Study
EIS Volume 3	Appendix F	Marine Ecology Impact Assessment Study
EIS Volume 3	Appendix G	Seabirds Baseline Study (2001/2002)
EIS Volume 3	Appendix H	Seabirds Impact Assessment Study
EIS Volume 3	Appendix I	Offshore Wind Turbine Technical Specifications
EIS Volume 3	Appendix J	Visual Impact Study Methodology
EIS Volume 3	Appendix K	TV Reception/Broadcast Signal Impact Assessment
EIS Volume 3	Appendix L	Terrestrial Ecology Impact Assessment
EIS Volume 3	Appendix M	Habitats Directive Assessment
EIS Volume 3	Appendix N	Seabirds Survey (2010/2011)

Table 1.1 Schedule of Appendices included in Volume 3 of EIS

Finally, the Zone of Theoretical Visibility (ZTV) maps and photomontages that have been produced as part of the visual impact assessment are presented separately in Volumes 4 and 5 respectively.

1.2 Proposed Development

The proposed development will comprise the following works:

- Detailed geotechnical investigations
- Preparation of the seabed locally to facilitate installation of turbine foundations
- Installation of monopile foundations for turbines and substation
- Installation of rock armour scour protection on the seabed around each monopile
- Installation of transition piece on top of monopile foundation
- Laying of inter-turbine array cabling to connect turbines to offshore substation
- Laying of offshore section of export cable between offshore substation and proposed landfall site
- Laying of onshore section of export cable between landfall site and proposed connection point to national grid
- Installation and commissioning of up to 145 offshore wind turbines
- Installation and commissioning of offshore substation
- Installation of offshore anemometer masts (2 no.)

1.3 Site Description

A series of coast-parallel north-south trending offshore banks exist in the western Irish Sea at a distance of approximately 10 km offshore. These banks stand in 20 – 30 m of water and rise to within a few metres of the water surface. Dublin Array is a proposal to construct an offshore wind farm on two of these banks, the Kish Bank and the Bray Bank. These two banks lie approximately 10 km off the coast of Dublin and Wicklow, with the Bray Bank being a southerly continuation of the Kish Bank (see Chapter 2 for a more detailed description). The Kish Lighthouse marks the northern end of the Kish Bank and the Codling Bank lies to the southern end of the Bray Bank.

The narrow extent of the Kish and Bray Banks dictates that the turbines be arranged in a north/south direction. The wind turbines would be arranged in rows, four to five deep and placed 500 m apart, which would run parallel to the coast along the natural contour lines of the sand banks. Up to 145 offshore wind turbines can be accommodated in suitable water depths over the extent of the banks and on this basis the study area identified for the purpose of this Environmental Impact Statement extends for approximately 3 km in the east-west direction and approximately 18 km in the north-south direction giving an overall study area in the order of 54 km^2. The study area also includes the route of the subsea transmission cable which will connect the wind farm to the shore.

1.4 The Developers

The Kish Consortium was set up in early 1999 specifically to develop Dublin Array. It consisted of Saorgus Energy Ltd, Powergen Renewables Ireland Ltd and ESB Power Generation Holdings Ltd. The Powergen and ESB stakes in the consortium were subsequently purchased by Saorgus Energy. Saorgus Energy, an Irish owned company that was set up in 1993, specialises in the development of large-scale wind energy projects. Saorgus Energy has developed over 100 MW of onshore wind to date, and it owns and operates three onshore wind farms. It currently has over 150 MW of onshore wind power in development. Two special purpose companies, Kish Offshore Wind Ltd. and Bray Offshore Wind Ltd., have since been set up for the purposes of bringing the project to construction. These companies were incorporated as "special purpose vehicles" and are 100% owned and controlled by the owner-directors of Saorgus Energy Ltd. In the remainder of this EIS, "the Developers" refers to the development companies Kish Offshore Wind Ltd and Bray Offshore Wind Ltd.

1.5 Application and Approvals Process

Following on from the enactment of the Foreshore and Dumping at Sea (Amendment) Act 2009 responsibility for certain foreshore functions, including all foreshore energy-related developments (including oil, gas, wind, wave and tidal energy) has transferred to the Minister for the Environment, Community and Local Government with effect from 15 January 2010 (responsibility rested formerly with the Minister for Agriculture, Fisheries and Food). The Foreshore Acts, 1933 to 2009, require that a lease or licence must be obtained from the Minister for Environment, Community and Local Government, for undertaking any works or placing structures or material on, for the occupation of or removal of material from, State-owned foreshore which represents the greater part of the foreshore. The foreshore is the seabed and shore below the line of high water of ordinary or medium tides and extends outwards to the limit of twelve nautical miles (approximately 22.24 kilometres).

Foreshore leases are generally granted under the Acts for development that requires exclusive use of the foreshore (e.g. jetties, bridges, piers, marinas, offshore wind farms and reclamation of any foreshore) whereas a foreshore licence is generally issued for a development that does not require exclusive occupation of the foreshore (e.g. repair work, some coastal protection work, undersea pipelines, cables, site investigation works and dredging works).

This project was awarded two foreshore licences in April 2001, one for the Kish Bank and another for the Bray Bank in order to facilitate the undertaking of an environmental impact assessment and associated preliminary site investigations and baseline surveys for the proposed development. The extent of the study areas granted under these foreshore licences is detailed in Chapter 2 of this EIS.

The Foreshore Acts, and the terms of the foreshore licence, require that a foreshore lease be obtained from the Minister of the Environment, Community and Local Government prior to undertaking any work on the construction and operation of an offshore electricity-generating station. This Environmental Impact Statement has been compiled on behalf of the Developers to accompany the application for such Foreshore Leases for this project. It is intended that this EIS will provide sufficient information to the relevant Minister to enable a decision to be made for the consenting of the project in the knowledge of the environmental impacts of the proposed development and of the proposed mitigation measures that would be put in place by the Developers.

1.6 Environmental Designations

Sandbanks which are slightly covered by seawater all the time are listed under Annex I of the EU Habitats Directive (92/43/EEC). Annex I highlights natural habitat types of community interest whose conservation requires the designation of a representative sample of the habitat type as Special Areas of Conservation (SAC). Ireland has already identified sandbanks for SAC designation which do not include the Kish and Bray banks.

No offshore Special Protection Areas (SPAs) have been designated or proposed anywhere in Ireland, including the Kish/Bray bank area, for marine birds listed on Annex I of the

EU Birds Directive. Listing of a bird species on Annex I requires member states to take "*special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution*". Similar measures must also be taken for migratory species. All existing SPAs for marine birds in Ireland relate to their breeding areas and waters immediately adjacent to them. Similarly there are no proposed Natural Heritage Areas (pNHAs) for marine birds in offshore areas on the informal listings proposed to date.

There are no Ramsar sites in the immediate vicinity of the Kish and Bray banks.

There are a number of SACs and SPAs along the east coast of Ireland which are within 35km of the proposed wind farm site. These are identified in the relevant chapters of this EIS and a Habitats Directive Assessment undertaken by EcoServe on behalf of the Developers is included in Volume 3, Appendix M.

1.7 Statutory EIA Requirements

The proposed offshore wind farm development on the Kish and Bray banks falls within the scope of an Annex II project of European Communities Directive 85/337/EEC (as amended by Directive 97/11/EC) - *"Installations for harnessing of wind power for energy production (wind farms)"* and is above the threshold level of more than 5 turbines or a total output of greater than 5 megawatts established in The Fifth Schedule of the Planning and Development Regulations, 2001. It therefore requires the preparation of an Environmental Impact Statement.

1.8 EIS Methodology

This Environmental Impact Statement has been prepared in accordance with the requirements of the EU Directive, relevant Irish Legislation and the following EPA publications:

- *Guidelines on the information to be contained in Environmental Impact Statements – EPA 2002*
- *Advice Notes on Current Practice (in the preparation of Environmental Impact Statements) - EPA 2003*

In addition, a number of other information sources were used in the preparation of the Environmental Impact Statement, including:

- *Wind Energy Developments: Planning Guidelines (DOEHLG, 2006)*
- *Best Practice Guidelines for the Irish Wind Energy Industry (IWEA/SEI, 2008)*
- *Offshore Electricity Generating Stations – Note for Intending Developers (DCMNR)*

This Statement addresses in detail the impact of the construction works and the installation, operational and decommissioning phases of the wind farm as well as the offshore section of the grid connection. The onshore section of the grid connection between the landfall site at Shanganagh and the proposed connection point to the national grid at Carrickmines substation is described for completeness but does not form part of this application.

The scoping of the aspects of the environment to be addressed in the Environmental Impact Statement will be limited to those in which the effects of the development thereon satisfy the following two statutory criteria:

- are ***'likely'*** to occur
- have ***'significant and adverse'*** effect

1.9 Structure of the Environmental Impact Statement

The structure of this Environmental Impact Statement is in line with that identified in the EPA Guidelines, and is presented as follows:

Volume 1: Non-Technical Summary

Volume 2: Chapter 1. Introduction

Chapter 2. Description of the Proposed Development

Chapter 3. Alternatives Considered

Description of Existing Environment, Likely Impacts, Mitigation Measures, Actual Impacts, Cumulative Impacts, Monitoring and Reinstatement, as appropriate, on the following attributes of the Receiving Environment:

Chapter 4. Physical Environment

Chapter 5. Human Environment

Chapter 6. Archaeology

Chapter 7. Fish & Commercial Fisheries

Chapter 8. Marine Ecology

Chapter 9. Birds

Chapter 10. Marine Mammals & Reptiles

Chapter 11. Terrestrial Ecology

Chapter 12. Landscape and Visual Impact

Chapter 13. Water, Air and Climate

Chapter 14. References

As outlined in Section 1.1, supporting documentation including copies of consultation correspondence, specialist reports, ZTV maps and photomontages are presented in Volumes 3, 4 and 5 of the Environmental Impact Statement.

1.10 EIS Preparation / Specialist Consultants

The initial co-ordination and preparation of the Environmental Impact Statement for Dublin Array was undertaken by Saorgus Energy Ltd, Kerry Technology Park, Listowel Road, Tralee, Co. Kerry. Specialist consultants and contractors (see Table 1.2 below) had been engaged by the Developers to undertake baseline studies and to assess the impact of the proposed development in their fields of expertise, as well as to complete surveys of the area to establish the baseline characteristics where appropriate. Each of these consultants produced reports outlining the findings of their studies (these reports are presented in Volume 3 of the EIS).

The following is the list of consultants that were engaged by Saorgus Energy to undertake baseline studies and to carry out impact assessments as part of the initial Environmental Impact Assessment.

EIS Volume 3 - Appendix B – Physical Environment Impact Assessment Study		
Geological Report	Dr. John R. Graham	Head of Department Department of Geology University of Dublin Trinity College Dublin 2
Hydrographic & Geophysical Report and associated drawings	Hydrographic Surveys	The Cobbles, Crosshaven, Co. Cork
Site Investigation Report	Glover Site Investigations	8 Dromahiskey Road, Balnamore, Ballymoney, Co. Antrim.
EIS Volume 3 - Appendix C – Shipping Collision Risk Assessment Study		
Shipping Collision Risk Assessment	Vectra Group Ltd. (Capt. Tom Proctor)	Europa House 310 Europa Boulevard Gemini Business Park Westbrook Warrington WA5 7YQ UK
Radar Impact Assessment	QinetiQ Samantha Dearman	Building Block 3 Room 8 Portsdown Technology Park, Southwick Road. Cosham, Portsmouth PO6 3RU
EIS Volume 3 - Appendix D - Archaeological Impact Assessment Study		
Archaeological Impact Assessment	Headland Archaeology (Tom Jones)	Unit 1, Wallingstown Industrial Park, Little Island, Co. Cork
Hydrographic Magnetometer Drawings for Site and cable route	Hydrographic Surveys	The Cobbles, Crosshaven, Co. Cork

Table 1.2 Schedule of Specialist Reports/Consultants for initial EIS (2009)

EIS Volume 3 - Appendix E - Commercial Fisheries Impact Assessment Study		
Commercial Fisheries Impact Assessment	Ecoserve	Apex House, Greenmount Industrial Estate, Harold's Cross Road, Dublin 12
EIS Volume 3 - Appendix F - Marine Ecology Impact Assessment Study		
Marine Benthos Impact Assessment	Ecoserve	Apex House, Greenmount Industrial Estate, Harold's Cross Road, Dublin 12
EIS Volume 3 - Appendix G - Seabirds Baseline Study (2001/2002)		
Seabirds Baseline Study	Ecology Consulting (Dr. Steve Percival)	71 Park Avenue Coxhoe Durham DH6 4JJ UK
EIS Volume 3 - Appendix H - Seabirds Impact Assessment Study		
Seabirds Impact Assessment	Coveney Wildlife Consulting Ltd (Dr. John Coveney)	56 Castle Farm Shankhill, Dublin 18
EIS Volume 3 - Appendix I - Offshore Wind Turbine Technical Specifications		
	Siemens	
	Vestas	
EIS Volume 3 - Appendix J - Visual Impact Study Methodology		
Visual Impact Study Methodology	Macro Works Ltd	1 Haigh Terrace, Dun Laoighre, Co. Dublin
EIS Volume 4 - Zone of Theoretical Visibility (ZTV) Maps		
Zone of Theoretical Visibility (ZTV) Maps	Macro Works Ltd	1 Haigh Terrace, Dun Laoighre, Co. Dublin
EIS Volume 5 - Photomontages		
Photomontages	Macro Works Ltd	1 Haigh Terrace, Dun Laoighre, Co. Dublin

Table 1.2 (ctd) Schedule of Specialist Reports/Consultants for initial EIS (2009)

1.11 EIS Review and Update 2010/2011

Following initial feedback from the Marine Licensing Vetting Committee (MLVC), who reviewed the EIS documentation on behalf of the Department, further surveys and assessments were commissioned by Saorgus Energy Ltd. in order to facilitate a detailed response to the additional information requested by the MLVC and MRG Consulting Engineers Limited were engaged to review and update the Environmental Impact Statement accordingly. A summary of the associated amendments included in Revision 1 of the EIS is included in Table 1.3 below.

EIS Volume 1 – Non-Technical Summary		
Volume reviewed and updated to reflect amendments to EIS	MRG Consulting Engineers (Kevin Harty)	North Point House North Point Business Park Mallow Road, Cork
EIS Volume 2 – Chapter 1 - Introduction		
Chapter reviewed and updated.	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 2 – Chapter 2 - Description of the Proposed Development		
Chapter reviewed and updated.	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 2 – Chapter 3 – Alternatives Considered		
New Chapter added	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 2 – Chapter 4 – Physical Environment		
Chapter re-numbered, reviewed and edited.	MRG Consulting Engineers (Kevin Harty)	North Point House North Point Business Park Mallow Road, Cork
EIS Volume 2 – Chapter 5 – Human Environment		
Chapter renumbered, reviewed and updated.	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 2 – Chapter 6 – Archaeology		
Chapter renumbered, reviewed and updated including addition of Terrestrial Archaeology.	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 2 – Chapter 7 – Fish & Commercial Fisheries		
Chapter renumbered, reviewed and updated to reflect updated fisheries data included in EcoServe Report (Vol.3, Ap. 3) and current data relating to noise impacts from piling.	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 2 – Chapter 8 – Marine Ecology		
Chapter renumbered, reviewed and updated	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 2 – Chapter 9 – Birds		
Chapter rewritten based on results of updated baseline survey undertaken by Bird Watch Ireland (2010/2011) and current conservation status of species. It should be noted that this Chapter now supercedes the previous impact assessment included in Volume 3 – Appendix H	EcoServe (Dr. Roisin Nash)	B23 KCR Industrial Estate Kimmage, Dublin 12
Chapter renumbered, reviewed and updated	MRG Consulting Engineers (Kevin Harty)	As above

Table 1.3 Schedule of Amendments included in Revision 1 of EIS (January 2012)

EIS Volume 2 – Chapter 10 – Marine Mammals & Reptiles		
Chapter rewritten based on results of dedicated baseline marine mammal surveys undertaken byEcoServe(10/11)	EcoServe (Dr. Roisin Nash)	B23 KCR Industrial Estate Kimmage, Dublin 12
Chapter renumbered, reviewed and updated to reflect current data relating to noise impacts from piling	MRG Consulting Engineers (Kevin Harty)	North Point House North Point Business Park Mallow Road, Cork
EIS Volume 2 – Chapter 11 – Terrestrial Ecology		
New Chapter based on Terrestrial Impact Assessment Report prepared by EcoServe (Vol. 3 – Ap. J).	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 2 – Chapter 12 – Landscape and Visual Impact		
Chapter renumbered, reviewed and updated	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 2 – Chapter 13 – Water, Air and Climate		
Chapter renumbered, reviewed and updated	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 2 – Chapter 14 – References		
Chapter renumbered, reviewed and updated	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 3 – Appendix A – EIS Consultations		
Further correspondence added	MRG Consulting Engineers (Kevin Harty)	As above
EIS Volume 3 - Appendix C – Marine Navigation Impact Assessment		
Updated Marine Navigation Impact Assessment Added Appendix Title amended	Arcadis UK Limited (Capt. Thomas Proctor)	Portland Tower Portland Street Manchester (M1 3AH)
EIS Volume 3 - Appendix D – Archaeological Impact Assessment Study		
Terrestrial Archaeological Report added	Headland Archaeology (Tom Jones)	Unit 1, Wallingstown Ind. Pk., Little Island, Co. Cork
EIS Volume 3 - Appendix E – Commercial Fisheries Impact Assessment Study		
Report updated / amended	EcoServe	As above
EIS Volume 3 - Appendix H – Seabirds Impact Assessment Study (Superceded)		
This report is superceded by the impact assessment prepared by EcoServe and included in Chapter 9 of Main EIS (Vol. 2) as noted above	Coveney Wildlife Consulting Ltd (Dr. John Coveney)	56 Castle Farm Shankhill, Dublin 18
EIS Volume 3 - Appendix K – TV Reception/Broadcast Signal Impact Assessment Study		
New Appendix/Report	G Tech Surveys Ltd (Gareth Philips)	Accountancy House, 4 Priory Road, Kenilworth, Warwickshire, CV8 1LL.
EIS Volume 3 - Appendix L – Terrestrial Ecology Impact Assessment Study		
New Appendix/Report	EcoServe (Dr. Roisin Nash)	B23 KCR Industrial Estate Kimmage, Dublin 12
EIS Volume 3 - Appendix M – Habitats Directive Assessment		
New Appendix/Report	EcoServe (Dr. Roisin Nash)	B23 KCR Industrial Estate Kimmage, Dublin 12
EIS Volume 3 - Appendix N – Seabirds Survey 2010/2011		
New Appendix/Report	BirdWatch Ireland (Steve Newton & Mike Trewby)	Unit 20, Block D, Bullford Business Park Kilcoole, Co. Wicklow

Table 1.3 (ctd): Schedule of Amendments included in Revision 1 of EIS (January 2012)

1.12 Policy and Legislation

1.12.1 Introduction

There is a recognised need for an increase in the level of sustainable energy to combat global warming and to help reduce greenhouse gas emissions. This is evidenced by Irish and European policy, which supports the increased use of renewable energy. Ireland's support of renewables is required under its commitment to international agreements that aim to reduce emissions of greenhouse gases. However, increasing electricity production from renewables would also reduce our reliance on the importing and burning of finite fossil fuels and, since renewables are indigenous sources of energy, would also help to increase Ireland's security of energy supply. Recently, rising oil prices have heightened the awareness of the economic benefits of indigenous wind energy.

Renewable energy sources such as the wind, the sun, wood, waste and water are abundantly available in Ireland. Installation of wind farms in coastal waters around Ireland as well as onshore can contribute to the reduction in emissions of greenhouse gases, helping Ireland to meet its commitments to international agreements.

1.12.2 International Policy

The United Nations "Earth Summit" was held in Rio de Janeiro in 1992. At this summit most countries signed a UN climate convention treaty (the United Nations Framework Convention on Climate Change) in light of the rising levels of global warming and pollution. By doing so, these countries agreed to adopt measures to reduce greenhouse gas emissions (particularly carbon dioxide emissions).

At the 1997 World Summit Conference in Kyoto, Japan, a new Protocol was drawn up. This aims at reducing emissions of the six main greenhouse gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) from developed countries overall to 5.2% below the 1990 levels over the "commitment period" 2008-2012. This target is legally binding. The EU has agreed to reduce emissions to 8% below 1990 levels over the period 2008-2012. Within this target, Ireland has agreed to limit its production of the six greenhouse gases to 13% above 1990 levels over the same period. In the event that Ireland fails to meet its target under the Kyoto Protocol, Ireland will be penalised.

1.12.3 European Renewable Energy Policy

In 2005 the EU Commission published its "Concerted Action for Offshore Wind Energy Deployment (COD)". This was followed by the EU Council of Energy Ministers meeting in Copenhagen on 27 October 2005 which itself followed the EU Policy Workshop on Development of Offshore Wind Energy. The Copenhagen Strategy on Offshore Windpower Development was the result of this meeting. This recommended that the EU Commission initiate a European policy for wind power starting with the production of an Action Plan on offshore wind power deployment.

In March 2007, European leaders signed up to a binding EU-wide target to source 20% of their energy needs from renewable sources, including biomass, hydro, wind and solar power, by 2020. To achieve this objective, the EU adopted the EU Renewable Energy Directive (Directive 2009/28/EC) in April 2009, which divided the EU's overall 20% renewable energy target for 2020 into individual legally binding targets for each of the 27 Member States. Under the Directive, each Member State was obliged to outline the 'appropriate measures' it will take to achieve its 2020 target in a National Renewable Energy Action Plan (NREAP) submitted to the European Commission by 30 June 2010.

1.12.4 Trans-European Energy Networks (TEN-E) & Co-ordination of Offshore Grids

The EU Commission's Communication on the Priority Interconnection Plan (COM (2006)846 final), adopted by the Commission in January 2007, identifies key interconnection projects which are vital to completing the internal market, integrating generation from renewable energy sources into the market and to significantly improve security of supply, and projects where facts are known which may lead to delays in implementation. As a follow-up to the Priority Interconnection Plan, the Commission has appointed EU Co-ordinators to promote the European dimension of these projects and initiate a cross-border dialogue between promoters, the public and the private sector as well as local and regional authorities and the local population. A European Co-ordinator has been appointed to oversee the completion of the offshore wind connections in the Baltic and North Sea areas (Denmark-Germany-Poland). The aim of the project is to facilitate the integration of the offshore wind energy produced in the Baltic Sea and North Sea in the continental grid. This project will be a major contribution to the development of a more environmentally sustainable network.

The third "European Policy Workshop on Offshore Wind Power Deployment" was held in Berlin in February 2007. The workshop was a follow-up to the meetings in Egmond (2004) and Copenhagen (2005). The Copenhagen Strategy formed the basis for all discussions. The resulting Berlin Declaration contained the following recommendations:

Those Member States with coastlines on the North, Baltic, Black and Mediterranean Seas and the Atlantic Ocean are encouraged to make use of their enormous resource of offshore wind energy in order to achieve their respective targets for electricity and to quantify this expected contribution in their National Action Plans.

The Commission should make use of all measures to encourage Member States to streamline consenting procedures for offshore wind farms, taking into account the statements of the Copenhagen Strategy.

The Framework Programme for research and technological development (FP1) is the European Union's chief instrument for funding research and innovation. There is one working group (WG4: "Offshore Development & Operation") focused on offshore aspects not addressed by the other Working Groups. Following the declaration of the European Policy Workshop on Offshore Wind Power Deployment (Berlin, 2007), WG4 was invited to provide a roadmap for a large-scale deployment of offshore wind energy, focusing on the relevant Research & Development topics. In the recent updating of the TP Wind Strategic Research Agenda (March 2008), the Offshore Working Group has identified the following key-priority areas: I) substructures II) assembly, installation and decommissioning III) electrical infrastructure IV) turbines V) operations and maintenance VI) safety, environment and education. The European Strategic Energy Technology Plan (SET-Plan), adopted by the Commission in November 2007, proposes a new energy technology policy in Europe. In essence, it aims to accelerate the development of low carbon technology and bring it rapidly to the market. Wind energy development (incl. getting large scale offshore wind competitive within the short term) is one of the key-technological challenges addressed in the SET-Plan. The two specific references to wind energy are the following:

- *"Key EU challenges to meet the 2020 targets: Double the output of the largest wind turbines,* with offshore wind as the lead application;
- *European Wind Initiative: focus on large turbines and large systems validation and demonstration (relevant to on and offshore applications)."* (Source EU Commission 2008).

The structural and cohesion funds, such as the European Regional Development Fund (ERDF) and the European Cohesion Fund, are among the largest Community funding instruments. According to the Community strategic guidelines on cohesion the development and use of renewable and alternative energy technologies should be supported. The possibility of funding renewable energy projects depends on the National and Regional Programmes, which are managed at national and regional level. Member States have allocated around 3% or around 9 billion Euros for sustainable energy projects from the cohesion funds. Supporting the development of renewable energy sources is a top priority of the European Investment Bank (EIB). Its Corporate Operational Plan 2007-2009 has an annual subtarget of EUR 600-800 million for renewable energy projects and a relative target of 50 % of EIB lending to electricity generation associated with RE technologies. These targets are to be interpreted as a minimum, and the amount will be raised in the next plan. In the last few years, wind energy has constituted a substantial part of EIB renewable energy lending, and the Bank has already financed several off-shore wind projects for a total amount of 349.7 M EUR. The bank considers offshore wind as being an "emerging technology" (source EU Commission 2008).

On November 13 2008, the EU Commission proposed a new EU Energy Security and Solidarity Action Plan which sets out five areas where more action is needed to secure sustainable energy supplies, one of which is the importance of the provision of electrical grids to enable the connection of offshore wind farms. In October 2011, The European Commission proposed a regulation for guidelines for trans-European energy infrastructure to accelerate and finance new energy infrastructure. Support from the EU budget to priority projects is €9.1 billion, substantially more than was provided in the past TEN-E programme. The Commission intends to cut authorisation times for new priority European power lines by putting forward a binding time line of three years for procedures concerning Projects of Common Interest (PCI). The proposed legislation is now being negotiated with the European Parliament and Council, with an agreement foreseen by the end of 2012.

1.12.5 UK Renewable Energy Policy

The UK Government has actively promoted the usage of wind energy resources in UK waters; see Table 1.4 below. A system of allocation of offshore wind energy sites exists and in September 2008, the Crown Estate issued an Invitation to Negotiate to registered Developers for the Round 3 offshore wind farm leasing programme for the delivery of up to 25 GW of new offshore wind farm sites by 2020. In June 2011, the British and Irish governments, through the British-Irish Council, announced a proposal to link the electricity grids of the UK and Ireland to allow large amounts of electricity generated from renewable sources to be exported from Ireland to the UK. Further details are provided below in section 1.12.6.3.

UK

Project	Location	Capacity (MW)	Number of turbines	Water depth (m)	Distance to shore (km)	On line
IN OPERATION						
Barrow	Off Walney Island	90	30	>15	7	2006
Beatrice	Beatrice Oilfield, Moray Firth	10	2	>40		2007
Blyth Offshore	Blyth Harbour	3.8	2	6	1	2000
Burbo Bank	Crosby	90	25	10	5.2	2007
Kentish Flats	Off Whitstable	90	30	5	8.5	2005
North Hoyle	Prestatyn & Rhyl	60	30	5 to 12	7.5	2003
Scroby Sands	NE of Great Yarmouth	60	30	2 to 10	3	2004
Inner Dowsing	Ingoldmells/Skegness	90	27	10	5.2	2008
Lynn	Ingoldmells/Skegness	97	30		5.2	2008
	Total:	590.8				

Project	Location	Capacity (MW)	Number of turbines	Water depth (m)	Distance to shore (km)	On line
UNDER CONSTRUCTION						
Ryhl Flats	Abergele	90	25	8	8	2009
Thanet	Kent coast	300	100	20 to 25	11	2009/2010
Gunfleet Sands 1 and 2	Clacton-on-sea	172	48	2 to 15	7	2010
Solway Firth/Robin Rigg A	Maryport / Rock Cliffe	90	30	>5	9.5	2010
Solway Firth/Robin Rigg B	Marypor / Rock Cliffe	90	30	>5	9.5	2010
Redcar/Teeside	Teesmouth	90	30			est.2010
Ormonde	Walney Island	150		20	11	est.2010
Greater Gabbard phase 1	Off Felixstowe/Clacton-on-Sea,	300				late 2010
Greater Gabbard phase 2	Off Felixstowe/Clacton-on-Sea	200				late 2010

Project	Location	Capacity (MW)
PLANNED 2015		
Aberdeen Offshore Windfarm	N of Aberdeen Harbour	115
Gwynt y Mor	N of Wales	750
Docking Shoal	Off Skegness/Hunstanton, Greater Wash	500
Dudgeon East	Off Cromer, Greater Wash	300
Humber Gateway	Off Spurn Head, Greater Wash	300
Lincs	Off Skegness, Greater Wash	250
London Array East	Thames Estuary, London	475
London Array West	Thames Estuary, London	525
Race Bank	Greater Wash	300
Shell Flat (Cirrus Array)	Off Cleveleys, Morecambe Bay	270
Sheringham Shoal	Off the Norfolk Coast in the Greater Wash	315
Walney phase 2	Off Walney Island	450
West Duddon	Off Walney Island	500
Westermost Rough	N of Spurn Head	240

Table 1.4: Offshore UK as of late 2008.
(Source www.ewea.org.)

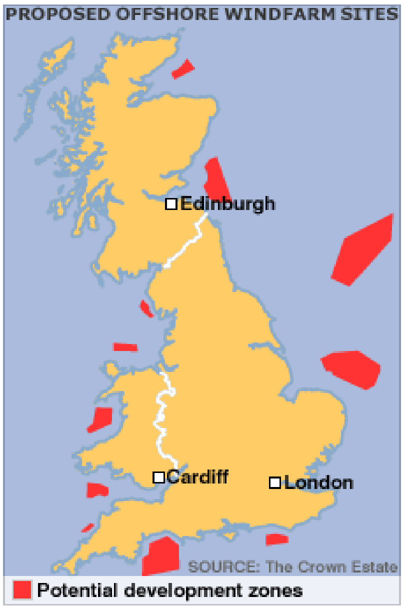


Figure 1.2: Round 3 offshore wind development zones in the UK

Ninety-six UK and international companies registered their interest in Round 3. Potential Developers who registered were invited to bid for one or more of nine (9) development zones identified through the Marine Resource System (MaRS) by The Crown Estate. Figure 1.2 shows the zones licensed in Round 3 of the Crown Estate Scheme. Round 3 aims to deliver a quarter of the UK's electricity needs by 2020.

In January 2009, the UK Department of Energy and Climate Change published an Environmental Report that concluded that 25,000 MW of wind energy could be built in UK waters, equivalent to several thousand turbines.

1.12.6 Irish Renewable Energy Policy

1.12.6.1 Energy White Paper 2007

In March 2007, the government published its White Paper on Energy entitled 'Delivering a Sustainable Energy Future for Ireland' which set out its policy framework for the period 2007 to 2020. It established targets of 15% of electricity from renewable energy sources by 2010 and 33% by 2020. In October 2008, the government increased the 2020 target to 40%. The White Paper noted that wind energy would provide the pivotal contribution to achieving the 2020 target.

1.12.6.2 National Renewable Energy Action Plan

Under EU Directive 2009/28/EC each member state was required to submit to the European Commission a 'National Renewable Energy Action Plan (NREAP) setting out how it plans to reach its overall individual target. Ireland's NREAP was published in July 2010. The figures included in the Plan are broadly in line with targets previously set in the Government's White Paper and Programme for Government. The overall 16% target is to be achieved by 12% heat from renewable sources (RES-H), 10% transport from renewable sources (RES-T) and 42.5% electricity from renewable sources (RES-E). As set out in the NREAP, the Gate 3 process provides for sufficient grid connections for renewable generators for the achievement of the renewable electricity element of the NREAP.

1.12.6.3 Grid Development

In terms of grid development for renewable generation and the achievement of our RES-E target, a 'Gate' process was put in place by the Energy Regulator, the Commission for Energy Regulation (CER). It is a group processing approach (GPA) towards the processing and issuing of grid connection offers to renewable generators. Under the GPA or 'Gate' process, applications for connections are processed in batches rather than sequentially. To date there have been three 'Gates'. Under Gate 1 and Gate 2, 1,755 MW of connection offers to renewable generators were made and accepted. Under Gate 3 a further 3,900 MW of connection offers have been made. Three offshore wind energy developments have been included in Gate 3 including Dublin Array which secured a connection offer for 364 MW of installed capacity.

Ireland is involved in several initiatives in relation to development of further interconnection and offshore grid development including the All Island Grid Study, All Island Facilitation of Renewables Studies, Grid 25, Eirgrid's Interconnection Economic Feasibility Report and Offshore Grid Studies, the ISLES Project, the North Seas Offshore Grid Initiative, ERGEG and ENTSO-E work.

The All Island Grid Study, commissioned jointly by the Department of Communications, Energy and Natural Resources (Ireland) and the Department of Enterprise, Trade and Investment (Northern Ireland), was published in 2008 and comprises a study as to how the electrical network on the island might be cost effectively developed to the period 2020 so as to facilitate the addition of further levels of renewable energy. This was followed in 2010 by the publication of the All Island Facilitation of Renewables Studies, the objective of which were to more fully understand the technical and operational implications associated with high shares of wind power in the All Island power balance.

The Irish Transmission System Operator (TSO), EirGrid, published a grid development strategy (Grid 25) in 2009 which sets out a fifteen year plan for the development of Ireland's electricity transmission network. The plan envisages a doubling of Ireland's grid capacity over the period to 2025 and will involve an investment of €4 billion.

Eirgrid also undertook a study to look at the economic case for further interconnection to Britain and potentially France following completion of the East-West Interconnector in 2012 on the basis of a number of potential future generation scenarios. This includes a high-renewable scenario with 80% of electricity generation from renewable sources.

The Eirgrid Offshore Grid Study was published in August 2011. A key finding of the study was that a well designed offshore grid to cater for offshore generation could minimise the need for combined onshore and offshore reinforcement and would facilitate the development of more interconnector capacity between Ireland and Great Britain, and potentially France. Dublin Array is an integral part of the scenarios modelled by Eirgrid in their Offshore Grid Study.

A report on the Irish-Scottish Links on Energy Study (ISLES), commissioned by the governments of Scotland, Northern Ireland and Ireland, on the feasibility of creating an offshore interconnected electricity grid based on renewable resources (wind, wave and tidal) was published in late 2011. The study concludes that an ISLES cross-jurisdictional offshore integrated network is economically viable and competitive under certain regulatory frameworks and can potentially deliver a range of wider economic, environmental and market related benefits. Dublin Array is considered as an integral part of the development of such a network in the study.

The North Seas Offshore Grid Initiative was established following a political declaration at the December 2009 Energy Council and complements the work being carried out by the EU on the development of offshore grids in Europe. This includes the work of ENTSO-E (European TSOs); ERGEG (European electricity regulators) and the Adamowitsch group on which industry and other interested parties are represented.

In June 2011, the Irish and British governments announced plans to expand electricity grid connections between both countries to facilitate the export of power from new wind farms in Ireland to Britain. The aim of the plan, which was discussed between the Taoiseach, the UK's deputy prime minister, Scotland's first minister and senior members of the British-Irish Council, is to provide Britain with electricity generated from renewable energy in Ireland and exported by underground cables across the Irish Sea. The construction of a new 500 MW cable linking the national grids of Ireland and the UK is already nearing completion. Under the proposal put forward by the British-Irish Council, a number of new interconnectors would be built to carry the power from renewable projects in Ireland, the bulk of which is expected to come from wind.

1.12.6.4 Irish Offshore Wind Development Policy

There are currently two proposed offshore wind developments that have already secured a foreshore lease and separate to this, there are three offshore wind projects that have received a grid connection offer under the Gate 3 process. Both a grid connection and a foreshore lease are necessary for projects to be developed.

The two foreshore leases that have been granted for the construction and operation of offshore wind farms in Irish waters include:

- Arklow Bank Wind Park (520 MW) in the Irish Sea off the coast of Wicklow.
- Codling Bank Wind Park for the generation of up to 1100MW from 220 turbines in the Irish Sea off the coast between Greystones and Wicklow

Seven turbines totalling 25.2MW have been installed on the Arklow Bank. The remainder of the two consented sites have no grid connection offer to the Irish Grid.

Approximately 800 MW of offshore wind projects have received a grid connection offer under the Gate 3 process. These include the following offshore wind projects:

- Dublin Array Wind Farm on the Kish and Bray banks, which is the subject of this EIS and which has received an offer for 364 MW of grid capacity.

- Oriel Offshore windarm in Dundalk Bay has received an offer for 330 MW of grid capacity

- Sceirde Wind Farm (Fuinneamh Sceirde Teo) which has received an offer of 100 MW and proposes to construct 20 turbines off the west coast of Galway.

As noted above both a grid connection and a foreshore lease are necessary for projects to be developed.

In late 2008, the Joint Committee of the Oireachtas for Climate Change and Energy Security published a draft Offshore Renewable Energy Development Bill 2009. This provided for a new framework for the allocation of offshore energy sites and for the administration of the consenting process. It provides for a continuity of process for those projects currently in the permitting system.

In late 2010, the Department of Communications, Energy and Natural Resources published the Draft Offshore Renewable Energy Development Plan (OREDP) for public consultation. The main aim of the OREDP is to establish scenarios for the development of offshore renewables in Irish waters up to 2030 and set out a longer term vision for the growth of the offshore renewable energy sector. The publication of the Draft OREDP was accompanied by a report presenting the results of a Strategic Environmental Assessment (SEA) of the potential effects that the proposals contained in the OREDP would have on the marine and coastal environment of Ireland. The SEA considered three development scenarios (low, medium and high) in the period to 2030 as follows:

- Low Scenario – this scenario consists of the 800 MW of offshore wind which has received grid connection offers under the Gate 3 process (Oriel, Sceirde and Dublin Array as outlined above). It also includes 75 MW of wave and tidal development included in the National Renewable Energy Action Plan (NREAP).

- Medium Scenario – the medium scenario comprises of 2300 MW of offshore wind on the basis of the non-modelled scenario presented in Table 10 of the NREAP (broadly based on the combination of offshore wind projects with either foreshore lease or grid connection – Arklow Bank (Phase 2), Codling Bank, Oriel, Sceirde and Dublin Array). It also includes 500 MW of wave and tidal energy included in the same table of the NREAP.

- High Scenario – the high development scenario originates from the OREDP SEA Scoping document and consists of 4,500 MW of offshore wind and 1,500 MW of wave and tidal energy.

It is noted that the three projects, including Dublin Array, which have received grid connection offers under the Gate 3 process are considered as “already existing renewable infrastructure” for the purpose of the OREDP SEA.

Overall, the OREDP SEA concluded that, based on the extent of the offshore renewable energy resource within Irish waters, in particular offshore wind and wave energy, and the geographic scale of the overall study area, that it would be possible to achieve the high scenario of 4,500 MW from offshore wind and 1,500 MW from wave and tidal energy without likely significant adverse impacts on the environment.

On the basis of the above it is clear that the development of the proposed Dublin Array offshore wind farm development on the Kish and Brays banks forms an integral part of Ireland's policy towards achieving our commitments presented in the National Renewable Energy Action Plan (NREAP) and in ensuring we realise our potential for offshore development foreseen in the Offshore Renewable Energy Development Plan (OREDP).

1.13 Public Attitudes to Wind Energy in Ireland

Ireland's first independent study of the Irish public's attitude towards the development of wind energy and the integration of wind farms on the Irish landscape was published by Sustainable Energy Ireland in 2003 ("Attitudes Towards The Development of Wind Farms in Ireland"). Two studies were conducted: the first, a national survey aimed at identifying public attitudes to renewable energy and to wind energy in Ireland; the second, a catchment-area survey which focused specifically on people living with a wind farm in their locality or in areas where wind farms are planned. The survey was designed by an independent cross-sector steering group and carried out by Landsdowne Market Research and MosArt. It sought to establish the attitudes and opinions of the public to specific aspects of wind energy, including visual, environmental, social and economic effects. It also assessed the acceptance of wind farms at local level and attitudes to wind farm development in differing landscapes. The national survey sampled 1,200 people in face-to-face interviews, while the catchment survey sampled 200 people in the areas where wind farms already exist and 150 people in areas where full planning permission for a wind farm had been granted but construction had not yet taken place.

The study indicated that the overall attitude to wind farms amongst the public is almost entirely positive, with more than eight out of ten people being favourably disposed to the construction of more wind farms in Ireland. Two-thirds of Irish adults (67%) are either very, or fairly, favourable to having a wind farm built in their locality and, interestingly, this percentage increases (79%) when the people questioned are restricted to those that have actually seen a wind farm. This suggests that the structures themselves do not significantly contribute to any negative views of wind energy.

The survey found that people with direct experience of a wind farm in their locality are generally impressed with it as an additional feature in the landscape and that they do not consider it to have adversely affected their area - *"those with direct experience of wind farms in their locality do not in general consider that they have had any adverse impact on the scenic beauty of the area, on wildlife in the area, or on tourism"*. Indeed the survey finds it encouraging that *"over 60% of those living in close proximity to existing wind farms would favour either an additional wind farm in the area or an extension to the existing one"*.

1.14 Offshore Wind Energy

1.14.1 Offshore Wind Energy Technology

The world's first offshore wind farm was constructed in 1991 at Vindeby off the west coast of Lolland in Denmark. The success of this pilot project, which consisted of eleven 450 kW turbines, paved the way for a number of subsequent offshore projects in Denmark, Sweden, the Netherlands and the UK; see Figure 1.3.

As offshore wind energy technology developed, the trend in wind turbine design has been towards the use of larger turbines. In 2000, the first offshore wind farm using 2 MW wind turbines was built and grid connected. Since then the size of offshore wind turbines has been steadily increasing and by 2011 the average size of turbines being installed in European waters was 3.6 MW, 20% more than in 2010 (3 MW) and more than 6 times more than the first offshore turbines installed in the early nineties. In 2011

Repower installed the first turbines with a rated capacity above 5 MW (5.075 MW) at Ormonde in the UK.

There continues to be dynamic growth in the development of offshore wind turbines with 41 companies announcing their intention to launch new offshore-dedicated turbine models over the past couple of years. The new models announced are mostly large machines with a rated capacity in excess of 5 MW. Turbines with rated capacities in the range of 6-7 MW are currently being tested by established manufacturers such as Siemens and Vestas and several companies, including GE and Gamesa, are already looking at turbines in the 10 to 15 MW range.

Figure 1.3: The Middelgrunden Offshore Wind Energy Project in Copenhagen Harbour
(Photo courtesy Middelgrundens Vindmøllelaug (www.middelgrund.com))

Since 2002, the offshore wind industry has flourished. The latest offshore statistics gathered by EWEA (www.ewea.org) give a total of 1,371 turbines installed and grid connected, totalling 3,813 MW in 53 wind farms in ten European countries at the end of 2011: up from 1,136 turbines, totalling 2,946 MW in 45 wind farms in nine European countries at the end of 2010. Once completed, a further nine offshore projects currently under construction will increase installed capacity by a further 2,375 MW, bringing cumulative capacity in Europe to 6,188 MW.

The offshore wind capacity installed by the end of 2011 will produce, in a normal wind year, 14 TWh of electricity, enough to cover 0.4% of the EU's total consumption. In 2010, a 300 MW project in the UK (Thanet) was the largest offshore wind farm completed and fully grid connected in the world. During 2011 over 380 MW were installed at Greater Gabbard, also in the UK. Once completed, Greater Gabbard's total capacity will be 504 MW. However, construction has also started on the first phase of the

London Array project. Once completed, it will be 630 MW. The UK is by far the largest market with 2,094 MW installed, representing over half of all installed offshore wind capacity in Europe. Denmark follows with 857 MW (23%), then the Netherlands (247 MW, 6%), Germany (200 MW, 5%), Belgium (195, 5%), Sweden (164, 4%), Finland (26 MW in near-shore projects) and Ireland with 25 MW. Norway and Portugal both have a full-scale floating turbine (2.3 MW and 2 MW respectively).

2 DESCRIPTION OF THE PROPOSED DEVELOPMENT

2.1 The Study Area

The study area for the proposed wind farm development on the Kish and Bray Banks, located approximately 10km off the coasts of Dublin and Wicklow in the Irish Sea, is defined by the Foreshore Licence Applications submitted by the developer to the Minister for Marine and Natural Resources, under the Foreshore Acts, 1933 to 1998, for the purpose of investigating the suitability of the area as a site for the ultimate construction of and operation of an offshore electricity generating station. The boundaries of the areas defined in the foreshore licences for the Kish and Bray Banks are identified in Table 2.1 below and illustrated on Figure 2.1.

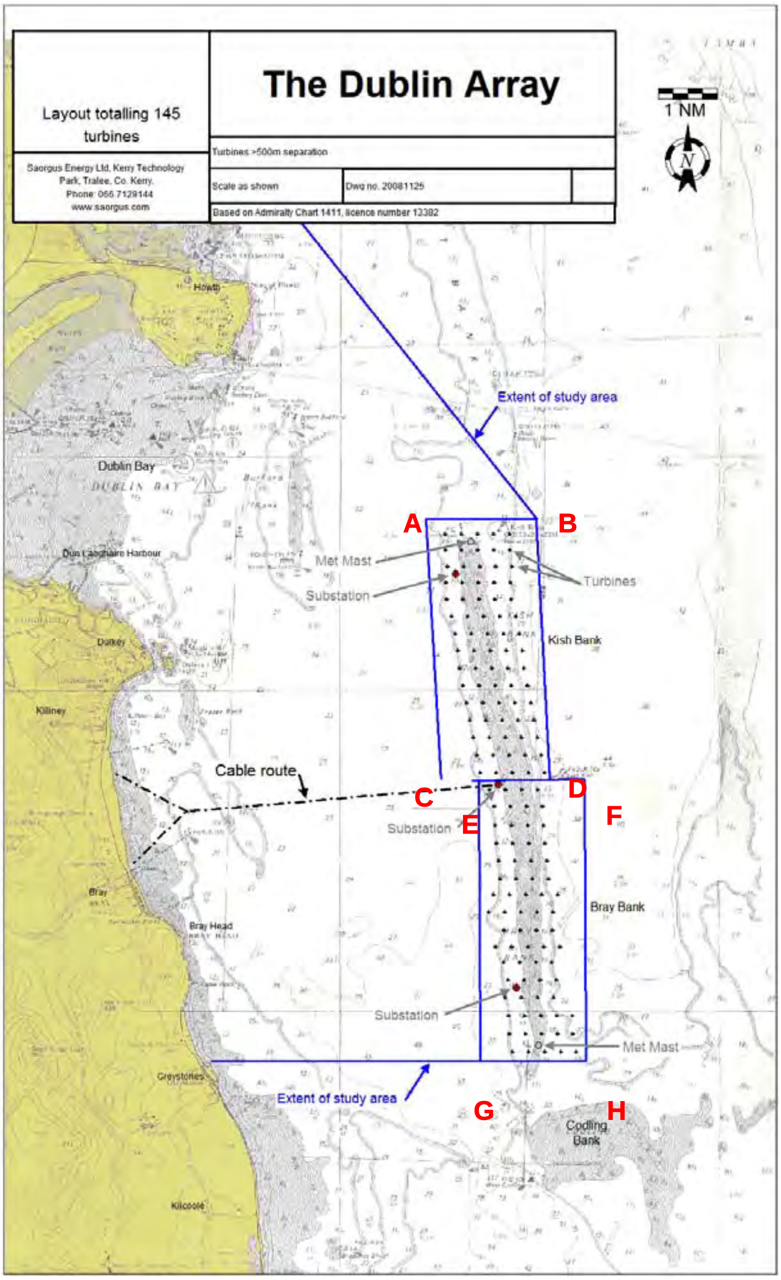


Figure 2.1 Location and layout of Dublin Array

Ref.	Latitude	Longitude
A	53° - 14′-00″N	5° - 57′-00″W
B	53° - 18′-30″N	5° - 57′-00″W
C	53° - 18′-30″N	5° - 54′-00″W
D	53° - 14′-00″N	5° - 54′-00″W
Ref.	Latitude	Longitude
E	53° - 14′-00″N	5° - 56′-00″W
F	53° - 14′-00″N	5° - 53′-00″W
G	53° - 09′-00″N	5° - 53′-00″W
H	53° - 09′-00″N	5° - 56′-00″W

Table 2.1 Co-Ordinates of Foreshore Licence Areas Kish and Bray Banks

The study area identified above extends for approximately 3 km in the east-west direction and approximately 18 km in the north-south direction giving an overall study area in the order of 54 km^2. The study area, for the purpose of this Environmental Impact Statement, also includes the route of the subsea transmission cable which will connect the wind farm to the shore along the route indicated in Fig. 2.1

2.2 The Site

There are numerous potentially excellent offshore wind farm sites off the coast of Ireland, particularly off the east coast in the Irish Sea where there are a number of coast parallel sand banks approximately 5 to 10 km off the Dublin and Wicklow coastlines. The Kish Bank and Bray Bank were earmarked several years ago by the Developers as potentially suitable sites for an offshore wind farm installation, primarily due to their shallow nature, proximity to the electricity demand of Dublin and obvious wind resource potential. This section describes the criteria considered by the Developers in assessing the suitability of the proposed site on the Kish and Bray Banks for a wind farm installation.

2.2.1 Wind Resource

Wind speeds offshore are generally higher than average onshore speeds. The favourable wind resource offshore mainly results from the low surface roughness over the sea and the absence of topographical and physical obstructions offshore compared to on land. In general, wind speeds increase both with distance from the coast and with height above sea level. Compared to on shore, average wind speeds are generally higher, wind gradients smaller, and turbulence intensities lower in an offshore environment. On this basis offshore wind turbines are expected to generate higher energy yields and to be subjected to lower stresses and fatigue loading, which should lead to longer lifespans.

Initial desk-based assessment by the Developers concluded that wind speeds at the Kish and Bray Banks should be high enough (greater than 8.7 metres per second average wind speed at 100 m height above sea level) to justify conducting a feasibility study on the viability of installing of an offshore wind farm on the site including measurement of wind speeds and assessment of wind resource. The Developers arranged for the installation of meteorological instruments on the Kish Lighthouse (see Figure 2.2) at the northern tip of the Kish Bank in July 1999 to record wind speed and direction. Since then these instruments have been providing data on the wind resource at the site to the Developers. The data has also been made available to Met Éireann for forecasting purposes. In order to account for the potential influence of the Kish Lighthouse itself on the measurement equipment and associated data, a computer generated fluid dynamics model, validated by experimental work in a wind tunnel, was then commissioned in order to establish the true wind speeds at the site. This formed the basis for a wind yield assessment study to determine the expected long term energy yield, risk factor on annual yield and 50 year extreme wind for a wind farm on the site. The results of this wind yield assessment confirmed the Developers expectations regarding the potential wind resource at the site. A sophisticated Lidar (Laser) windspeed monitoring system was installed on the Kish Lighthouse Helipad in June 2010. This system accurately measures the windspeed and direction at 40, 70, 100, 130 and 160 meter above sea level and is used to verify the the existing readings and calculations of energy yield.

Figure 2.2 The installation of anemometry equipment on the Kish Lighthouse
(courtesy of Irish Rope Access and Safety Consultants Ltd)

2.2.2 Overall Area

A key factor in determining the viability of an offshore site as an appropriate location for a wind farm development is the overall area of the site and its capacity to accommodate a sufficient number of turbines. The area of the Kish and Bray Banks that has been identified for exploration on the basis of suitable water depths for the deployment of turbines (see section 2.2.3) extends approximately 18 km north-south and 3 km east-west. In order to eliminate potential wake effects and associated impacts on energy yields, wind turbines need to have a spacing of approximately five rotor diameters between turbines. For the size of turbine being proposed for this development with rotor diameters in the order of 100-130m a minimum separation distance of c. 500m between turbines is required. The proposed site can accommodate up to 145 turbines on this basis.

2.2.3 Water Depth

Current fixed foundation technology for offshore wind turbines limits their deployment to water depths of up to 40m and on this basis an assessment as to the feasibility of a site for an offshore wind farm development needs to consider existing water depths over the area of the site.

Existing bathymetric data for the Kish and Bray Banks, as represented on Admiralty Chart No. 1468, indicates water depths over the area of the site generally in the range of 2 to 26 m to chart datum, with shallower depths (~ 1 m) being observed towards the north of the site.

A more recent bathymetric survey (Wheeler *et al.* 2000) showed that the Kish and Bray Banks lie in 20 – 30 m of water and rise in places to within two metres of the surface towards the centre of the axis that runs north-south along the banks.

As part of the Environmental Impact Assessment for the project, Hyrdographic Surveys were engaged by the Developers to undertake a bathymetric survey of the site in order to confirm the data available in the above sources. According to the surveyor's measurements, the shallowest depth at which a turbine is proposed to be located is 2.0m and the deepest is 28.7m. Local variations in water depth are mainly due to the characteristics of the seabed; the most prevalent features are sand-waves (underwater sand-dunes) of heights ranging between 0.5m and 1.3m, and the largest features are sand-peaks, giving the Banks their undulating profile.

A more detailed analysis of water depths over the area of the site is included in Chapter 4 – Physical Environment.

Bathymetric comparisons between the recently acquired bathymetric data and that represented on the Admiralty Charts suggest that the structure of the offshore banks is stable over time (Wheeler *et al*., 2000). The scientific literature (Hanna 2002) also indicates that near-shore Irish Sea sandbanks such as the Kish Bank and Bray Bank formed as moraines (immobile mounds of glacial debris) at the end of the last ice age. These moraines are now overlain by sand and gravel.

2.2.4 Seabed Conditions

Seabed sediments and the marine sedimentary processes of erosion, transport and deposition that control their distribution, character and thickness are very relevant to the viability of installing foundations for offshore wind turbines as well as the inter-turbine cabling and cable route to shore.

The Kish and Bray Banks are submarine banks consisting mainly of sand and gravel. While sedimentary bedforms observed visually and using side-scan sonar (Wheeler *et al.* 2000, Hydrographic Surveys 2008) indicate that sediments on the banks are actively mobile and migrating northwards, the overall bank structure is in a stable state. Sediment mapping, based on both sampling and sonar techniques indicate that the upper parts of the banks are composed of extensive thicknesses of sand-to-gravel sized material, with coarser gravel material located towards the crest of the banks and evidence of sediment fining towards the north of the bank. A site investigation, using examination of material extracted from inspection boreholes drilled by Glover Site Investigations, revealed that the soil profile of the banks is loose/medium in the upper layers, soil of medium density down to 12m and very dense soil 12m and greater below the sea-bed. The banks' seabed conditions are suitable for the installation of offshore wind turbine foundations, and for the placement of subsea cables. The seabed conditions are discussed in more detail in the section describing the physical environment, Chapter 4.

The side-scan survey, carried out by Hydrographic Surveys, was also used as an input into a desk-top study by Headland Archaeology into any archaeological remains present on the Banks. Several items were detected in the course of the survey, some of which were known wrecks, others of which were items of possible significance. The density of items of archaeological, or possible archaeological, significance is low enough to allow the wind farm to be constructed as proposed, moving individual turbines where necessary to avoid archaeological remains, in such a way as to retain the overall pattern of the wind farm and also to avoid any compromise of the integrity of the archaeology present on the Banks.

The type and method of installation of foundations (monopile, multipile or gravity caisson foundations) depends on the seabed conditions at each turbine location. The method of burial of the subsea cables connecting each turbine also depends on seabed conditions.

2.2.5 Wave, Current and Tidal Climate

Wave heights, currents and tides can have a significant impact on the construction and operation of an offshore wind farm particularly at exposed locations and need to be considered when assessing the suitability of a particular site for such a development.

2.2.5.1 Waves

Wave heights experienced in the Irish Sea are generally not as high as those experienced on the more exposed Atlantic coast, due to the protection afforded to the Irish Sea by the land mass of Ireland. In general, there is a reduction in wave height as water depth decreases although waves may become focussed by refraction as they pass over the shallow areas of the Kish and Bray Banks. Wave heights are likely to be further reduced due to the influence of seabed friction and wave breaking as they pass over the very shallow areas of the banks.

Analysis was carried out on wave data from a data buoy located in the Irish Sea for a three year period. It was found that, as expected, the largest waves in the area come from the south and southeasterly directions. The average wave height over the four years was found to be 1.28 m, while the maximum wave height over the period was 5 m.

While the wave environment on the Kish and Bray Banks is quite vigorous, and it is expected that breaking waves would be experienced on the banks, it is not anticipated that the wave environment would have an adverse effect on the construction or operation of the wind farm.

2.2.5.2 Currents and Tides

Strong currents and tidal flows are experienced around the Kish and Bray Banks. The area experiences approximately southern flow during ebb tide and a northern flow during the flood tide. This is evidenced by the sediment transport found on the banks (Wheeler 2000). Data presented on the Admiralty Chart for the area suggests that tidal flows have a velocity of 2.2 knots (approximately 1.13 m/s). The pattern of bedforms that is observed at the site indicates that the strongest tidal flow conditions are found closest to the banks (see Chapter 4). The Admiralty Chart also gives information on tidal amplitudes, with the mean high water spring tide being 4.1 m above chart datum. This correlates well with tidal data on record for Dublin, where the 1 in 50 year return period extreme water level is 5.32 m above chart datum (Natural Power 2002).

While the strong tidal and current regime may pose certain challenges during construction, it would not jeopardise the proposed development.

The wave, current and tidal climate is discussed in more detail on the section describing the physical environment, Chapter 4.

2.2.6 Environmental Designations

Potential impacts on the integrity of designated sites, habitats or species need to be considered when assessing the suitability of a proposed site for the development of an offshore wind farm.

There are no EU designated sites in the immediate vicinity of the study area and the closest are several kilometres to the west of the proposed development along the Dublin and Wicklow coastline. These are identified, as appropriate in the relevant sections of this Environmental Impact Statement.

2.2.7 Proximity to the Electrical Grid Connection

The electricity generated by an offshore wind farm needs to be exported to the National Grid along a route and over a distance which will ensure that connection costs are economically feasible and transmission losses not too high. The proposed wind farm site on the Kish and Bray Banks was considered to be close enough to the existing Transmission Network infrastructure on the east coast to enable the power to be economically and efficiently connected to the grid. The connection of Dublin Array to the National Grid is treated in detail in Section 2.2.8 below.

2.2.8 Visual Impact

Because of the lack of obstructions between the coast and the proposed wind farm site on the Kish and Bray Banks, turbines would be widely visible from many locations along the coastline. In addition, many areas around Dublin, such as Howth Head and Killiney Hill, provide an elevated view of the Kish Bank area and, as a result, the wind farm would appear more prominent from these view points than from surrounding low lying areas. However, the distance between the coast and the wind farm (in excess of 10 km) would reduce the visual impacts to acceptable levels. In addition, the area along the Dublin and north Wicklow coast is one with a high level of urbanisation and human use. In the national context the choice of location would seem to be the most appropriate given its close proximity to the maximum national electrical demand in the Dublin area. In the site selection process these factors were considered to mitigate the likely visual impacts. A detailed assessment of the visual impact of the proposed development is presented in Chapter 12.

2.2.9 Ease of Access

Close proximity to shore and suitable port facilities are an important feature of an offshore wind farm site. During the construction phase, suitable port facilities are required for installation activities including equipment storage and assembly, personnel facilities, etc., while proximity to the suitable port facilities would also allow for easier access of maintenance or emergency personnel during the operational phase of the wind farm. The Kish and Bray Banks site is easily served from several ports and harbours along the east coast, including Arklow, Dublin and Wicklow.

2.2.10 Proximity to Residences

While close proximity to shore is required for ease of access, it is also important that the wind turbines be sited at a sufficient distance from the nearest onshore habitation. This is mainly because of the possibility of the turbines being audible at onshore residences. In the case of this project, the closest house would be located at a distance in excess of 10 km from the nearest turbine. This distance is significantly farther from habitation than any onshore wind farm in Ireland and is more than sufficiently far from the onshore residents so as not to cause any nuisance, while being close enough to allow ease of access to the wind farm. The effects of noise during the construction and operation of the project are discussed in more detail in the section describing the human environment, Chapter 5.

2.2.11 Military Restrictions

This site is not located in a restricted military area; neither are there any such areas in the vicinity of the site. As part of the consultation process for the EIA, the Department of Defence was informed about the development and comments were sought from them.

A response was received stating that the Department had no objection to the proposed development. This response can be viewed in Volume 3, Appendix A.

2.2.12 Petrochemical Installations and Pipelines

There are no petrochemical installations or pipelines in the immediate vicinity of the Kish and Bray Banks.

2.2.13 Subsea Cables

The Developers consulted with electricity and telecommunications companies as part of the EIA to determine if there were any subsea cables in the vicinity of the proposed development. It is understood that there are no power cables in the vicinity of the Kish and Bray Banks. While there are some communications cables to the north and east of the banks there are none in the immediate vicinity of the proposed turbines nor are there any along the route of the proposed cable route to shore from the wind farm. Responses were received from a number of the relevant bodies stating that they had no objection to the development. These responses are presented in Volume 3, Appendix A.

2.2.14 Shipping Activities

The area around the Kish and Bray Banks is a busy one for shipping, with established marine transit routes passing to the north, south, east and west of the banks. However, due to the dangerous nature of the shallow water and wave action that is posed by the banks to shipping, the banks themselves do not see any shipping activity. There would be no loss of shipping routes resulting from the development, since ships already avoid the banks and the improved navigational marking will aid the marine users and improve marine safety in the area. A safety zone would be established around the working area on the banks during construction of the project to maximise marine safety. During operation of the wind farm small craft would continue to enjoy access to the area; however, it would not be permitted for such craft to make fast to the turbines. A treatment of the effects of the proposed development on marine traffic and marine navigation safety is presented in Chapter 5.

2.2.15 Aviation Activities

The Irish Aviation Authority was consulted as part of the EIA consultation process and a response was received stating that the IAA has no objections to the proposed development. A treatment of the effects of the proposed development on aviation navigation safety is presented in Chapter 5.

2.2.16 Fishing Activities

A study was commissioned to determine the impacts of the proposed development on commercial fisheries. In addition the relevant fishing organisations were consulted as part of the EIA. No information has been received to indicate any difficulty that the proposed development would pose to fishing interests. The construction and operation of the wind farm is not expected to have a negative impact on fishing interests since, apart from potential fishing for whelks, the banks are not used extensively for fishing. See Chapter 7 for a treatment of the effects of the proposed development on commercial fishing interests.

2.2.17 Aggregate Extractions

The Kish and Bray Banks offer potential for the extraction of aggregate materials, and the utilisation of the banks as a wind farm is not compatible with its use as a site for aggregates extraction. It is understood that there are currently no plans to use the banks as a site for aggregates extraction.

2.3 Description of the Proposed Development

2.3.1 Wind Farm Layout

Dublin Array is a proposal to construct up to 145 offshore wind turbines, an offshore substation, 2 meteorological masts and associated cabling on a site extending over both the Kish and Bray Banks off the coast of Dublin and Wicklow in the Irish Sea. The final number of turbines and installed generation capacity of the wind farm will be determined by the latest offshore wind turbine technology available to the Developers at the time of construction.

It is envisaged, given the configuration and water depths in the vicinity of the banks, that the turbines will be arranged in rows four to five turbines deep in a regular grid pattern along the entire length of the banks as illustrated on Figure 2.1. A minimum separation distance of 500m will be provided between the turbines in both directions in accordance with the advice of the turbine suppliers to minimise wake effects and associated impacts on energy yields for the scale of turbine envisaged for this development.

With the development of turbine technology, larger capacity turbines may be available at the time of purchasing the turbines (these could have a capacity of upwards of 5 or 6 Mega Watts (MW)). Should such a turbine be used in the development, this would mean that fewer turbines, with a wider spacing, would be installed on the banks. For instance, a capacity of close to 520 MW could be achieved using 145 no. 3.6 MW turbines or 104 no. 5 MW turbines. The turbine dimensions would not exceed the maximum dimensions specified in this chapter of the EIS in either case. For the purposes of assessing the visual impact of the proposed development in this EIS, the largest number of turbines is assumed i.e. 145 turbines.

2.3.2 Turbine Description

Given the continuing and rapid evolution in offshore wind turbine technology, as manufacturers continue to develop and refine their turbines for use in the offshore environment, and the Developers intention to install the latest available technology once it comes to commencing construction on the Kish and Bray Banks, it is not possible at this stage to provide an exact specification for the wind turbine that would be used for Dublin Array. However, a generic description of the turbines likely to be used in terms of hub height and rotor diameter, are outlined below.

All turbines for Dublin Array would be of the same generic three-bladed type. The turbine hub heights will be between 85 and 100m above mean sea level with a maximum rotor diameter of 130m and a maximum blade tip height of 160m. The distance between the sea level at Mean High Water Springs and the blade tip at its lowest point will be not less than 25m.

The wind turbines would consist of the following components: foundation and access platform/transition piece, cylindrical tower section (up to 100 m high), nacelle (which contains the turbines main parts including gearbox, generator and controls) and the hub and rotor blades (up to 65 m length). Tower sections for turbines in use today are made from steel, treated for corrosion during manufacture, or from concrete. Rotor blades in today's wind turbines consist of glass-reinforced polyester and / or carbon fibre. Each wind turbine would contain an electrical transformer located within the turbine at either the base of the tower or within the nacelle. Once installed the combined weight of the turbine tower, nacelle and rotor blades could be up to approximately 500 metric tons.

The turbines will start to generate electricity when wind speeds reach approx. 3 metres per second (m/s) or approx. 7 mph and reach full power at approx. 13 m/s (30 mph).

For safety reasons and to prevent damage to the turbines they cut out when wind speeds consistently exceed 25 m/s (approx. 60 mph – equivalent to a Force 9 gale).

The rotor blades on all wind turbines would rotate in the same direction i.e. clockwise when viewed from the windward direction. All wind turbines would be painted the same colour. The Developer has consulted with a leading offshore turbine manufacturer and it has been recommended that the turbines be painted a mid grey colour with a matt finish to minimise contrast with the backdrop in the prevailing weather conditions. The final choice of colour would be agreed with the regulatory authorities prior to construction.

As noted in Chapter 1, there continues to be dynamic growth in the development of offshore wind turbines with 41 companies announcing their intention to launch new offshore-dedicated turbine models over the past couple of years. The new models announced are mostly large machines with a rated capacity in excess of 5 MW and turbines with rated capacities in the range of 6-7 MW are currently being tested by established manufacturers such as Siemens and Vestas. With this in mind, the turbine spacing in the layout of Dublin Array has been designed to allow for flexibility in the choice of turbine.

The specifications of two current offshore wind turbines that meet the general specification above are included in Volume 3, Appendix J (Vestas Wind Systems V90 and Siemens SWT-3.6MW-107).

Figure 2.3 Siemens SWT-3.6MW-107
(courtesy Siemens Wind Power GmbH)

2.3.3 Foundations

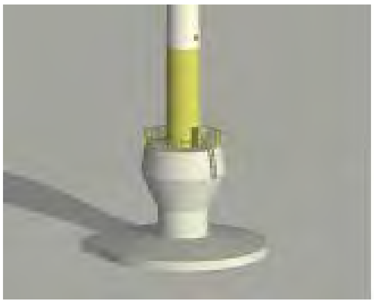
Depending on seabed conditions and water depth, there are a number of different types of offshore turbine foundation in use today (see Figure 2.4). These include:

- Gravity Foundation - Concrete Caisson or Steel Caisson
- Monopile Foundation
- Piled Tripod Foundation

- Universal Foundation (Suction Pile)

A more detailed description of each of the above offshore wind turbine foundation types in the context of their suitability for use on the proposed development on the Kish and Bray Banks is included in Section 3.5 of this Environmental Impact Statement.

Given the existing water depths on the banks, the nature of the sediments which form the banks and the low environmental impacts it is envisaged that the monopile solution will be adopted as the preferred option for the turbine foundations for the Dublin Array.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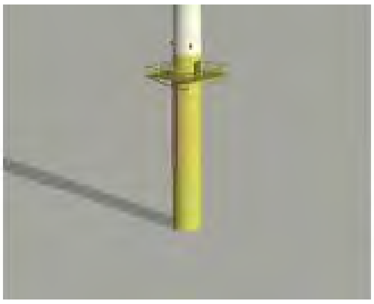
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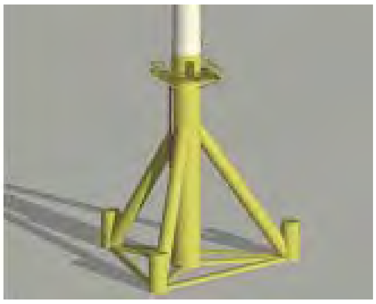

(C)


(D)

Figure 2.4 Offshore Wind Turbine Foundations

Gravity Caisson (A), Monopile (B) and Tripod (C) Foundations (courtesy Vestas Wind Systems A/S), Universal (Suction Pile) Foundation (D) (courtesy Harland and Wolff Heavy Industries Limited).

A monopile is a long cylindrical steel tube with a diameter in the range 4.0 to 5.5 m, wall thickness of 60 to 80 mm and weights of up to 600 tonnes. The piles are driven into the seabed to a depth of between 20 and 40 metres by a large special purpose ship or rig. Once the monopile is installed a transition piece is lifted on to the top of the pile and grouted in place. The use of a transition piece allows for adjustment in the foundation to take account of any deformation resulting from the installation process and ensures that the flanged connection to the tower is not damaged during pile driving. The transition pieces are brought to the project area by barge and lifted into place. The grout is pumped into the gap between the monopile and the transition piece and allowed to set. Spillage of grout will be prevented using either inflatable or wiper seals, with at least 100% redundancy. The transition piece has ladders and platforms for maintenance access which are generally painted yellow so that they are clearly visible at sea. Once the transition piece is fitted the turbine tower is bolted onto a flange on top of the transition piece, at a point high enough above mean sea level to be above the highest wave crest.

The use of heavy duty piling equipment to install the piles into the seabed may pose a potential source of noise pollution. However, subject to the appropriate monitoring and mitigation measures, given the distance of the proposed development on the Kish and Bray Banks from noise sensitive receptors onshore, it is not envisaged that the noise impacts associated with the piling operations on this project would be significant. Furthermore, soft start piling would be used to provide an early warning to marine mammals in the vicinity of the foundations.

Figure 2.5 Installation of Steel Monopile at London Array Offshore Wind Farm
(Photo coutesy of London Array Limited)

2.3.4 Scour Protection

Scour is the term that is used to refer to erosion occurring on the seabed caused by the presence of obstacles placed on the seabed, such as marine structure foundations. It is caused by the erosive action of currents that increase in speed as the current is forced to move around such obstacles. There are two types of scour – local and global. Local scour occurs around individual obstacles on the seabed and tends to result in deep localised pits. Global scour can affect whole foundation installations though it leads to more shallow erosion. The level of scouring around a structure placed on the seabed depends on a number of factors, including the composition of the seabed material and the speed of localised currents.

Given the highly energetic sea current and tidal regimes that exist in the vicinity of the Kish and Bray Banks, it is envisaged that scour protection will be required. Details of the different types of scour protection that can be considered are outlined in Section 3.6 of this Environmental Impact Statement. Given the likely use of monopile foundations to support the turbines for the proposed Dublin Array Offshore Wind Farm it is envisaged that rock armour will be transported to the site and placed on the seabed around the base of the monopile as the most likely scour protection method to be adopted in this case.

The final design of the extent of rock armour scour protection for each turbine will be subject to detailed geotechnical investigations and will vary depending on pile diameter and embedment, water depth and the exact nature of the substrata in the immediate vicinity of each turbine. However it is envisaged that it will comprise a c. 300mm thick filter layer of finer material (10-80mm grading) laid on the seabed and overlaid by up to c. 1000mm of larger graded stone designed to withstand the erosive effects of the waves/currents in the vicinity of the pile. The filter layer of finer material prevents the fine seabed material from being washed through the larger rock armour. It is envisaged that c. 250 to 600 m^3 of filter rock and c. 500 to 1000 m^3 of armour rock will be required for each pile. The rock will be sourced from a quarry on-shore and be delivered to Dublin Port where it will be loaded on to a specialist side stone dumping vessel which will transport the material to the site and tip it onto the seabed.

2.3.5 Wind Farm Electrical Design

2.3.5.1 Inter-turbine cabling

The turbines within the wind farm will be connected to each other in groups by submarine array cables which will transmit the power generated by each turbine to the offshore substation. The number of turbines that are connected on any one electrical circuit depends on a number of factors, such as the power output of the turbines, the type of cable used and the length of the cable run. These cables typically consist of three cores of copper conductor surrounded by galvanised steel armouring and insulated with either EPR (Ethylene Propylene Rubber) or XLPE (Cross-Linked Polyethylene), and they typically have a diameter of approximately 150 mm. The cables are buried in the seabed using a plough which forms the trench, installs the cable and backfills the trench in a single operation.

2.3.5.2 Offshore substation

As noted above the wind turbines of The Dublin Array will transmit power along relatively low voltage array cables to an offshore substation where the voltage will be increased for transmission along a higher voltage export cable to the shore for connection to the national grid. It is envisaged that a single offshore substation will be used to transform the power from the turbine circuits to the higher voltage suitable for export to the National Grid. The proposed substation will be located towards the centre of the array and is likely to be supported on a multipile foundation structure given its size. A typical offshore substation is illustrated in Figure 2.6.

2.3.6 Cable Route to Shore

The proposed cable route to connect the offshore substation to the grid connection point onshore is illustrated in Figure 2.1. The first part of this route will be along the seabed from the centre of the wind farm to the proposed landfall site in the townland of Shanganagh, Co. Dublin approximately 2 km north of Bray. The distance from the wind farm to the cable landfall is approximately 12.5 km. The cable landfall is described in detail in the next section.

There is an option to place the cables on the seabed or to bury them. Burying cables is the preferred option in most environments as this provides greater cable protection and it prevents the risk of the cable snagging on anchors or fishing equipment. Given the sandy nature of the seabed along the route of the export cable to the shore burial of the cable is a viable and the preferred option in this instance.

Figure 2.6 Typical Offshore substation

Subsea cable burying is a specialised exercise that has been widely employed in the oil, gas and telecommunications industries. Cables can be buried using specialised ploughing equipment or by means of a trenching unit. In both of these techniques, the seabed material is displaced, the cable buried and the excavated trench backfilled.

As part of the survey of the sea-bed, the Developers commissioned Hydrographic Surveys to examine the proposed cable route to the shore, so that assurance could be reached that the route would be viable, from a physical point of view, and have the least impact, from an archaeological point of view. The survey, and interpreted images from the readings taken there, are included in Volume 3, Appendix B. In summary, the route is seen to be of typical characteristics (coarse deposits – sand to gravely sand and some boulders), for the Western Irish Sea, and of uniform composition to a depth of 10m depth below the seabed. For the purposes of laying a cable, which will be much less than 10m below the sea-bed, the sub-surface is uniform.

An archaeological survey was also carried out by Hydrographic Surveys and correlated with the literature by Headland Archaeology. Headland note that there is only vague information as to the existence of possible archaeological remains on the cable route. The Magnetometer survey has identified 11 possible sites on and around the cable route (see Volume 3, Appendix D) and Headland have noted a further one. All these sites are only rated as "possible" sites and where there is a possibility that there is an item of significance present then the cable route will be altered locally to avoid it.

2.3.7 Cable Landfalls

The Developers considered two options for the proposed Landfall (denoted A & B) at locations just North of Bray, Co. Wicklow (see Figure 2.1.). The more northern option near the townland of Shanganagh, Co. Dublin (Figure 2.8) was selected on the basis of general suitability. The proposed landfall is located at National Grid Reference 325353E/221319N along a section of coastline which would be considered 'new' given the rate of coastal erosion. The solid bedrock geology is categorized as deep marine, slate, schist and minor greywacke. The quaternary or drift geology of comprises glaciofluvial sands and gravels, and tills, with gravels. The rapid rate of erosion is probably due to the lack of any substantial aggregate material within the sub-stratum at sea-level which is 4-5m deep. In order to minimise any impacts on existing ecology in the intertidal region it is intended that the last section of the offshore cable route will be completed by directional drilling from a location c. 50m beyond low tide under the beach and cliff face to a point within the park.

2.3.8 Onshore Grid Connection

From the cable landfall, the connection of the project to the National Grid will be completed by means of an underground cable to the ESB Substation at Carrickmines, Co. Dublin approx. 6.5km north west of the landfall location (Figure 2.7). The cable route will cross Shanganagh Park along a route which has been subjected to both an archaeological and a terrestrial ecological assessment and then be routed along public roads to the connection point at Carrickmines Substation. The Developers have already had discussions with Dunlaoghaire Rathdown Co. Co regarding necessary licensing agreements with the relevant roads authority along this route to facilitate the installation of the cable, refer to correspondence in Volume 3 Appendix A.

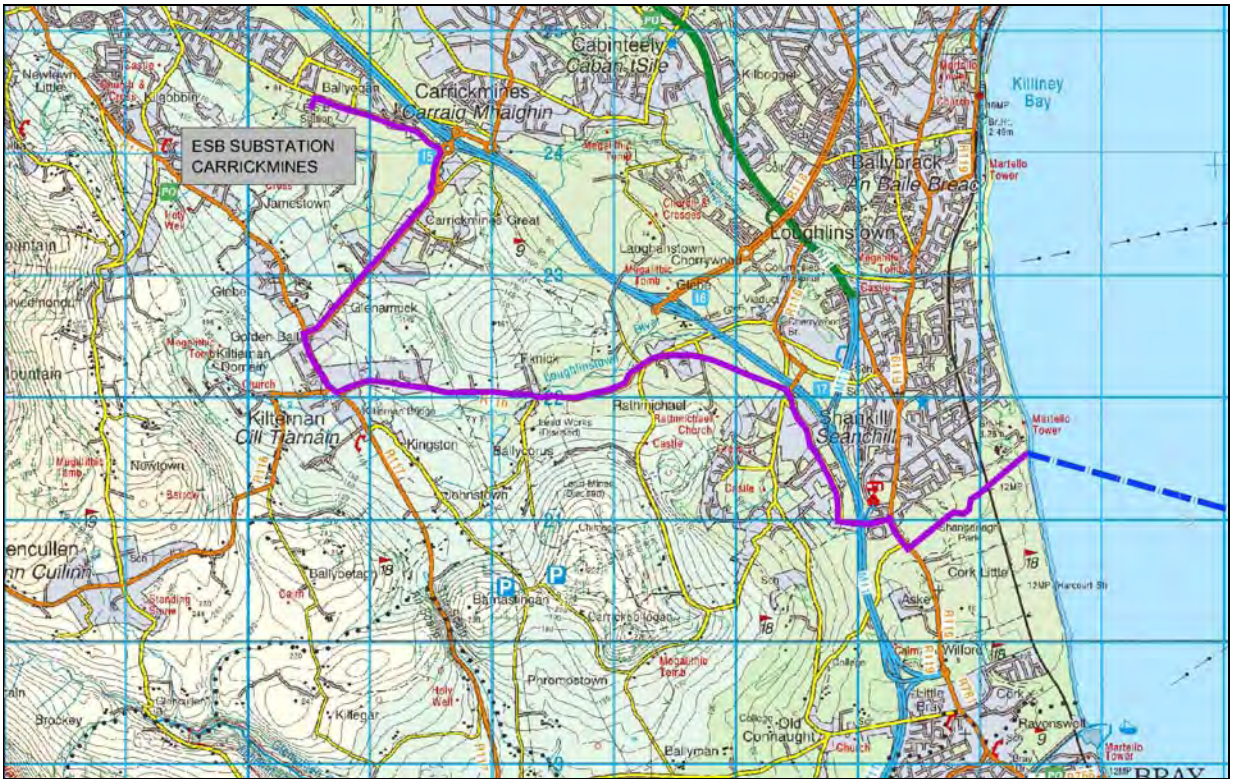


Figure 2.7 Landfall and Indicative Onshore Cable Route to connection point to National Grid

(OSI License No. EN0034812)

2.4 Construction Phase Onshore

2.4.1 Construction Operations Onshore

During construction of the wind farm a number of construction activities will need to take place onshore and it is envisaged that the Developers will lease space from Dublin Port to facilitate these operations. The facilities that would be required would include the following:

- Storage for major turbine components such as towers and rotors;
- Storage and assembly areas for piled foundation sections and transition pieces
- Covered area for dry working;
- Berths for construction vessels;
- Other temporary storage facilities;
- Fuel storage facilities; and
- Staff offices and canteens.

Given the intention to use monopile foundations for the Dublin Array the extent of onshore construction operations is significantly less than if a gravity (steel or concrete caisson) or multi-pile foundation solution had been adopted.

2.4.1.1 Foundation Construction / Assembly

The steel monopile foundations would be manufactured in a remote location. However, for ease of transport, they may be delivered in sections to Dublin Port, and so a dedicated hardstanding area would be required at the port to facilitate their fabrication to the required lengths for installation at each turbine location prior to loading on to a vessel for transfer to the Dublin Array site. The transition pieces to be fitted to the top of the piles will also be manufactured remotely and are likely to be delivered to Dublin Port for offloading and storage, prior to loading on to a vessel for transfer to the Dublin Array site prior to installation.

2.4.1.2 Turbine Assembly

An area will be required for the assembly of major turbine components. All major components would be manufactured remotely and delivered either directly to the Dublin Array site or to Dublin Port for pre-assembly as appropriate. Some degree of turbine component pre-assembly is likely to take place on shore within a dedicated port area. From the port area assembled components would be transferred onto vessels for delivery to site. Final turbine assembly would be conducted offshore using specialist vessels. Offshore wind turbines are typically installed from a jack-up barge. Vessel choice would depend on the water depth, vessel availability and cranage capability, which would need to be capable of assembling the wind turbines at sea.

It is estimated that approximately 50,000 m^2 of space is likely to be required onshore to facilitate the delivery, offloading, storage and pre-assembly of the wind turbine components. This would consist of approximately 15,000 m^2 of hardstanding area for construction / component assembly and 35,000 m^2 for storage. As well as the areas that would be required for storage, construction and assembly of major components, an area would be required for allowing construction vessels to berth. In addition a site would need to be provided for project site offices, canteens and sanitary facilities. It is envisaged that the Developers will lease the necessary space from the Dublin Port Company to facilitate their requirements in this regard, refer to correspondence in Volume 3 Appendix A.

2.4.2 Impacts of Onshore Construction Operations

2.4.2.1 Traffic

Almost all major turbine components (towers, blades, nacelles, hubs and piled foundations) would be delivered from a remote manufacturing location by sea either directly to the Dublin Array site or to Dublin Port for offloading and storage as appropriate. Onshore construction traffic resulting from the delivery of these major components would therefore be much less than would be experienced on the construction of an onshore wind farm.

The proposed use of mono-pile foundations to support the turbines will involve significantly less construction traffic than would be the case if a concrete caisson solution was to be adopted as this would have involved significant deliveries of construction materials including concrete, reinforcement, etc. as well as the traffic associated with construction personnel engaged in the prefabrication of the caissons onshore. The only significant traffic likely to be associated with the construction stage of the project is likely to be that associated with the delivery of the rock armour material for use in scour protection around the base of the mono-piles. This is likely to be sourced from a quarry in the region and delivered to the port for loading onto a special side tipping stone vessel for delivery to and placement on site at the Dublin Array.

2.4.2.2 Waste and Emissions

Wastes and emissions generated during the onshore construction stage of the project could comprise the following:

Solid Waste: There should be no significant source of solid waste associated with the construction stage of the project onshore. Any construction waste requiring disposal will be sorted and removed for disposal/recycling by an approved licensed contractor.

Atmospheric Emissions: The operation of mobile plant and equipment associated with the onshore operations during the construction stage of the project will give rise to minor emissions to atmosphere of exhaust gases containing combustion gases, sulphur dioxide, oxides of nitrogen and particulates. All such plant and equipment will be required to comply with relevant legislation in this regard.

Noise: The operation of mobile plant and equipment associated with the onshore operations during the construction stage of the project will give rise to noise emissions. These will be consistent with existing port operations. All such plant and equipment will be required to comply with relevant legislation in this regard.

Waste Water: There will be no significant source of wastewater associated with the onshore construction activities outside of the normal domestic wastewater associated with canteen and welfare facilities for the construction personnel which will be discharged directly to the port’s foul sewer network.

Hazardous Materials: The only hazardous materials associated with the onshore construction activities would be fuel, lubricating and hydraulic oils used by plant and equipment. These will be subject to the relevant statutory requirements and best practice regarding the delivery, storage, refuelling and spillage of same.

2.5 Construction Phase Offshore

2.5.1 Construction Operations Offshore

The following are the main construction activities that would take place offshore:

- Preparation of the seabed for turbine, offshore substation and meteorological mast foundations
- Installation of monopiles and transition piece including grouting of transition piece
- Installation of scour protection for foundations
- Installation of turbine towers, nacelles and rotors
- Installation of offshore substation
- Installation of array cables between turbines and offshore substation
- Installation of export cable between offshore substation and landfall site
- Final connection of cables and commissioning.

2.5.1.1 Preparation of the Seabed for Foundations

Given the likely use of monopiles as the preferred foundation solution for the Dublin Array, minimal preparation of the seabed would be required. Major obstacles such as boulders would need to be removed from the area under the footprint of the pile.

2.5.1.2 Installation of Foundations

The monopiles will be installed using specialist jack-up installation vessels which comprise a deck with extendable legs which are used to raise the vessel out of the water in order to create a stable platform from which to lift the pile using a large crane mounted on the vessel and to drive the pile into the seabed to the required depth of embedment. Once the pile is installed the crane will then lift the transition piece and mount it on top of the pile prior to grouting it in position.

2.5.1.3 Installation of Turbine Towers, Nacelles and Rotors

It is envisaged that the turbines will be shipped by the turbine supplier to Dublin Port where they will be offloaded and transferred to specialist installation vessels and taken to the Dublin Array site. The turbines will be installed using a large installation crane located on a specialist jack-up vessel.

The assembly of turbines in the offshore environment can be achieved in the same order as on land i.e. the tower can be installed in sections, followed by the placement of the nacelle on top of the final tower section and then the assembly of the rotor. The three blades of the rotor can be attached to the hub before lifting the entire assembly in place, or blades can be individually lifted into place and attached to the hub. The contractor would choose the method of assembly.

2.5.1.4 Installation of Scour Protection for Foundations

As outlined in Section 2.3.4, scour protection will most likely consist of rock armour that will be transported to the site using a specialist side tipping stone vessel from which it will be tipped onto the seabed in accordance with the detailed design for each turbine.

Figure 2.8 Typical Jack-Up Vessels used for foundation and turbine installation

2.5.1.5 Installation of Cables

Cables would be installed to connect turbines to the offshore substation and to connect the wind farm to the electrical gird onshore. The Developers intend to bury all cables in the seabed. The cables will be buried using a plough system or water jetting system. Some preparation of the seabed may be required prior to burying the cable trench.

2.5.2 Impacts of Offshore Construction Operations

2.5.2.1 Shipping Traffic

There is likely to be an increase in shipping traffic in the vicinity of the proposed development associated with the delivery of the turbine and foundation components and associated construction materials to Dublin Port and the Dublin Array site.

The impact of the construction of the wind farm on marine navigation is addressed in Section 5.2 of this Environmental Impact Statement.

2.5.2.2 Sediment Disturbance

Sediment disturbance would arise from the preparation of the seabed for the turbine foundations, cable laying operations and piling. The limited quantities of sediment disturbed by the piling operations would settle in the same way as occurs with sediment disturbed by normal energetic wave or tidal action on the banks. The likely use of driven hollow steel monopiles also minimises the extent of sediment displaced during the installation of the piles compared to drilled or bored piles as would be required in harder strata, and again the limited quantities of sediment disturbed by the piling operations would be quickly dispersed by the fast underwater currents in the vicinity of the banks.

2.5.2.3 Waste and Emissions

Wastes and emissions generated during the offshore construction stage of the project could comprise the following:

Solid Waste: There should be no significant source of solid waste associated with the construction stage of the project offshore. Any construction waste requiring disposal will be sorted and removed for disposal/recycling by an approved licensed contractor.

Atmospheric Emissions: The operation of vessel based plant and equipment associated with the offshore operations during the construction stage of the project will give rise to minor emissions to atmosphere of exhaust gases containing combustion gases, suphur dioxide, oxides of nitrogen and particulates. All such plant and equipment will be required to comply with relevant legislation in this regard.

Noise: The only source of noise associated with the offshore operations likely to be audible on shore during the construction stage of the project is that associated with the installation of the mono-pile foundations. However, given the distance from the coastline and subject to the appropriate monitoring and mitigation measures detailed in Section 5.1 of this Environmental Impact Statement it is not envisaged that the impact will be significant. The use of soft-start piling techniques will be used to minimise the impact of noise from the piling operations on birds and marine mammals.

Waste Water: There will be no significant source of wastewater associated with the offshore construction activities. Any domestic wastewater associated with canteen and welfare facilities for the vessel based construction personnel will be discharged to storage tanks on the vessels for subsequent disposal in accordance with statutory regulations.

Hazardous Materials: The only hazardous materials associated with the offshore construction activities would be fuel, lubricating and hydraulic oils used by the vessels and vessel based plant and equipment and grouting material used to fix the transition piece to the monopile foundation.

These use of fuel, lubricating and hydraulic oils will be subject to the relevant statutory requirements and best practice regarding the delivery, storage, refuelling and spillage of same in a maritime environment.

Grouting operations will be accurately controlled to avoid any potential spillages. Approximately 12 to 15 m^3 of grouting material is required to secure the transition piece to the top of the monopile foundations. Discharge of grouting material would result in increased pH in receiving waters. In order to mitigate this, all shuttering and form works would be efficiently sealed to prevent leakage (using inflatable or wiper seals with minimum 100% redundancy) and all grouting operations would be carefully monitored. It is important to ensure that only partial grouting is allowed and that completion of grouting does not occur until partial hardening has taken place to avoid excessive pressure on seals causing them to fail. It is also expected that the dilution effect, due to the high volume of water passing through the development area with each tidal cycle, would be such that the impact of spillages would be insignificant.

2.6 Operational Phase

During the lifetime of the project the wind turbines will require routine maintenance (one major and one minor service per year) as well as repair of unplanned faults. Electrical equipment will require inspection on an ongoing basis. Inspection of cable routes, support structures and scour protection around the turbine foundations will be required on an ongoing basis. Ongoing surveillance and maintenance of the scour protection will take place. The only requirement for access to the turbines will be for the maintenance and repair operations. Throughout their lifetime the wind turbines will be monitored and controlled 24 hours a day from a remote location through a supervisory control system.

2.6.1 Operational Activities

2.6.1.1 Regular Maintenance and Fault Repairs

To ensure that optimum availability of the wind turbines is achieved (> 95%), the turbines require regular maintenance. Modern offshore wind turbines, of the type that would be used in the proposed development, are designed to require one major and one minor service per year. Unplanned repair of faults that would arise would, of course, also be required. Local service crews would be required to perform these operations. The crew would be based onshore close to a port and would access the wind farm by boat. Scheduled maintenance operations would be undertaken during periods of favourable weather. It is expected that most regular maintenance would take place during summer months when access by sea is most favourable. For a treatment of the how safe access onto the turbines would be achieved, see Section 5.11 on Health and Safety.

2.6.1.2 Remote Operation

Modern offshore wind turbines are designed to operate under minimal supervisory control. Control systems within the turbine monitor and control the turbine automatically, to minimise the need for manual intervention. For instance, the wind turbine can be restarted automatically if it trips out due to voltage variations on the electrical grid. Each wind turbine is connected to a Supervisory Control and Data Acquisition System (SCADA). This system gathers and stores operational data, such as wind speed and power output, from each turbine in the wind farm. This system allows the turbines to be monitored and controlled from a remote location.

The wind farm would be operated in accordance with international best practice.

2.6.2 Impacts of Operational Activities

2.6.2.1 Navigation and Fishing Restrictions

Fishing trawlers do not operate on the banks because of the shallow nature of the sand banks in the area of the proposed development. Recreational vessels will be able to navigate in the area of the wind farm though they would be prohibited from making fast to the turbines. Notices would be placed on the turbine bases outlining the restrictions in place. Information boards placed at nearby ports would display the layout and location of the turbines and outline the restrictions that are in place. The wind farm will be fitted with navigational aids to be agreed with the Commissioners of Irish Lights. For a treatment of how the wind farm will be marked to aid marine navigation, see Section 5.2 on Shipping and Navigation.

2.7 Decommissioning

Modern wind turbines have a design lifetime of in excess of 20 years, though after this time turbines may be upgraded or replaced to extend the lifetime of the wind farm. Decommissioning is the requirement to return the wind farm site to the condition it was in before the construction took place, when it is decided to cease the operation of the wind farm.

The disposal of offshore installations is governed by the Oslo and Paris Convention (OSPAR) which covers the North East Atlantic and North Sea. In 1998 a new decision, 98/3, was made called the Sintra Statement. Signed by the environmental ministers of the EU and Norway, it is the current regulatory framework that governs disposal of offshore installations at sea.

Decommissioning is essentially the reverse of construction, with removal of the turbines using equipment similar to that deployed during construction. Almost all of the materials that are used in the construction of a wind farm (steel, aluminium, copper and concrete) are recyclable, with the possible exception of the material from which the blades are made. During decommissioning all of the components of the wind turbines (tower, nacelle and rotor) would be dismantled using a large crane vessel and taken ashore for recycling. Submarine power cables would be disconnected and pulled or reeled in from their trenches. If monopile foundations are in place, they would be cut where they meet the seabed surface, and removed. The Sintra Statement allows for the remaining part of the pile to be left in the seabed. Multi-pile foundations would be treated in a similar way. The Developers would ensure that best industrial practice be followed to ensure minimal environmental impact during decommissioning.

3 ALTERNATIVES CONSIDERED

Prior to selecting the project described in Chapter 2 of this Environmental Impact Statement the Developers considered several options in relation to potential site locations, site layouts, offshore wind turbine and foundation technologies, onshore and offshore cable routes, etc.. The options considered and the basis for selecting the preferred option are outlined in this Chapter of the Environmental Impact Statement.

3.1 Alternative Locations/Sites

Two key parameters currently govern the selection of appropriate sites for the development of offshore wind energy projects in the Irish offshore area which incorporates all Irish waters from the Mean High Water Mark out to the 200m water depth contour off the west and south west coast of Ireland and the Irish Exclusive Economic Area (EEZ) off the north, east and south east coast of Ireland. The two parameters to be evaluated on the basis of technical constraints are the wind resource at the site (min. mean annual wind speeds in excess of 7 m/s) and water depth (current monopile/turbine foundation technologies limit the current deployment of offshore wind turbines to water depths up to 40m below chart datum (CD).

A study of the theoretical wind energy resource indicates significant potential with predicted mean annual wind speeds of between 7 and 11 m/s at 100m height above mean high water springs (MHWS) in the vast majority of the area for which data is available. Generally, wind speed is predicted to increase with distance from the coast and the areas off the west and south west coast would be predicted to have the greatest wind resource as they face the prevailing westerly winds unconstrained by land as they arrive at the continental shelf from Atlantic weather systems.

As noted, current offshore wind turbine foundation technology constrains the economic development of projects to maximum water depths in the order of 40m below chart datum and this has generally precluded locations off the west and south west coasts where water depths increase rapidly with distance from the shore. The Irish Sea however forms a shallow basin with water depths in the range of 20-135m and with several coast parallel sand banks identified on the Admiralty Charts for the area approx. 5 to 10 km off the east coast. Given the relatively shallow water depths over these banks they have formed the primary focus of Developers when considering options for potential offshore wind energy developments in the Irish offshore area. The alternative sites considered on this basis include the following:

3.1.1 Codling Bank

The Codling Bank is located approximately 13 km east of Greystones and Wicklow Head and extends for approximately 5km in an east west direction. The Admiralty Chart indicates water depths over the bank of 2 to 9m below chart datum with water depths of below 20m extending over a much larger area in excess of 25 km in a north-south direction and 20 km in an east-west direction. Wave and tidal climates are similar to those of the Kish and Bray Banks with the exception that the Admiralty Chart predicts overfalls in poor weather on the Codling Bank, the SEAI Wind Atlas indicates 100m wind speeds in the order of 9m/s. Given the extent of the bank and the favourable water depths and wind speeds, the Codling Bank would offer an adequate alternative location for the development proposed on the Kish and Bray Bank. However, it was considered by the Developers that the Kish and Bray banks offered a better choice of location because of the disposition of the banks at right angles to the prevailing winds and the assessment that the Kish and Bray Banks offer a better wave/tidal environment. Subsequently, Codling Wind Park Ltd. have successfully obtained consent for the construction of 220 turbines on the Codling Bank in September 2005 providing up to 1100MW of installed capacity at this location.

3.1.2 India Bank

The India Bank is a significantly smaller bank than the Codling Bank and is located approximately 7.5 km to the south of same, approximately 10km off the Wicklow Coast. It extends for approximately 4 km in the north south direction and less than 1 km east west. Water depths are in the range 3.5 to 7.8m below chart datum. The area of the bank would not be large enough to accommodate an offshore wind energy project of the scale of that proposed on the Kish and Bray Bank.

3.1.3 Arklow Bank

The Arklow Bank is located 13 km east of Arklow off the Wicklow coast. It extends for approximately 27km in a north-south direction and is approximately 2.5 km wide. Water depths are in the range 0.6 to 4.0 m on the bank increasing rapidly to 20-30m on both sides. Wave and tidal climates are similar to those for the Kish and Bray Banks and the SEAI Wind Atlas indicates 100m wind speeds in the order of 9m/s. Given the extent of the bank and the favourable water depths and wind speeds, the Arklow Bank would have offered an adequate alternative location for the development proposed on the Kish and Bray banks. However, it was considered by the Developers that the Kish and Bray Banks offered a better choice of location because of the disposition of the banks at right angles to the prevailing winds, the proximity to the energy demand of Dublin and the assessment that the Kish and Bray Banks offer a better wave/tidal environment. Subsequently, GE Energy and SSE Renewables (formerly Airtricity) installed 7 no. 3.6 MW turbines on the bank in 2005 and have plans to install up to 200 further turbines providing up to 500MW of installed capacity at this location.

3.1.4 Blackwater Bank

The Blackwater Bank is located approximately 5km east of the Wexford Coast. It extends for approximately 17km in a north-south direction and is approximately 3 km wide. Water depths are in the range 10 to 15 m on the west of the bank increasing to in excess of 30m on the eastern side. Wave and tidal climates are similar to those for the Kish and Bray Banks and the SEAI Wind Atlas indicates 100m wind speeds in the order of 9m/s. Given the extent of the bank and the relatively favourable water depths and wind speeds, the Blackwater Bank would have offered an adequate alternative location for the development proposed on the Kish and Bray Banks. However, it was considered by the Developers that the Kish and Bray Banks offered a better choice of location because of it disposition at right angles to the prevailing winds, the proximity to the energy demand of Dublin and the assessment that the Kish and Bray Banks offer a better wave/tidal environment. The Blackwater Bank is now held under licence by another intending developer.

3.2 Alternative Cable Routes/Land Falls and Connection Points to National Grid

Two potential landfall locations were considered at locations just North of Bray, Co. Wicklow (see Figure 2.1.).

3.2.1 Landfall A

Position NGR: 326 353E/221 319N. Near Townland of Shanganagh, Co. Dublin

The coastline in this location is "new" because of the rate of coastal erosion. The solid bedrock geology of both landfall sites is categorized as slate, schist and minor greywacke. The quaternary or drift geology of Landfall A comprises glaciofluvial sands and gravels, and tills, with gravels.

Landfall A was selected as the preferred option on the basis that it provided the optimum solution in terms of accessibility and coastal geomorphology.

3.2.2 Landfall B

Position NGR: 326 750E/219 407N. Near Townland of Ravenswell, Co. Wicklow.

The landfall location is currently occupied by a breakwater constructed from large limestone boulders. The surface geology of Landfall B is limestone sands and gravels, and alluvial deposits. The location is next to a gradually sloping area, the cliff face proper beginning 20 m to the north. The cliff face here contains a basal layer similar to the substratum described above for Landfall A. It is clear from the survey that the area was formerly a refuse landfill.

As noted above, Landfall A was subsequently selected as the preferred landfall site.

3.3 Alternative Turbine Layouts

The layout of the proposed turbines on the Kish and Bray Banks was dictated by the following parameters:

Inter-turbine spacing: In order to eliminate potential wake effects and associated impacts on energy yields, wind turbines need to have a spacing of approximately four to five rotor diameters between turbines. For the size of turbine being proposed for this development with rotor diameters in the order of 100-130m a minimum separation distance of c. 500m between turbines is required.

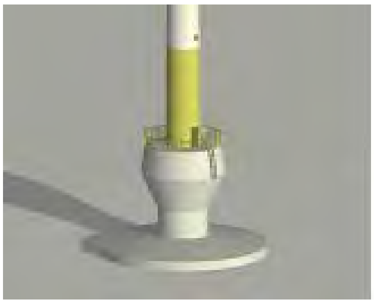
Water Depth: Current fixed foundation technology for offshore wind turbines limits their deployment to water depths of up to 40m and on this basis an assessment as to the feasibility of a site for an offshore wind farm development needs to consider existing water depths over the area of the site. The turbines locations for the Dublin Array were restricted to locations within the 30m water depth (below chart datum) on this basis and these depths were subsequently confirmed by the Bathymetric Survey.

Visual Impact: The layout comprises a series of straight lines of turbines aligned on the central axis of the banks, approximately parallel to the coastline. Additional regularity is assured through the regular spacing of turbines both within and between rows, which are to be separated by 500 m. The linear layout is in keeping with the parallel coastline and is dictated by the shape of the banks. An alternative linear or clustered array would not be possible for this reason. The Dublin Array would appear to occupy a wider extent of the seascape when viewed from most points along the coast than the proposed Codling Bank wind farm. Correspondingly, the distribution of turbines along the Kish and Bray Banks would appear to be less dense than that of the Codling Bank wind farm.

3.4 Alternative Turbine Manufacturers

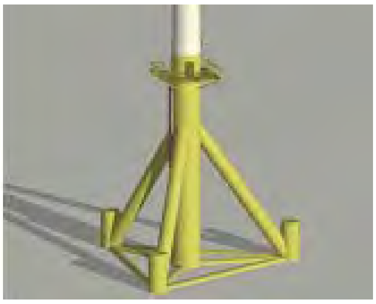
Given the continuing and rapid evolution in offshore wind turbine technology, as manufacturers continue to develop and refine their turbines for use in the offshore environment, and the Developer's intention to install the latest available technology once it comes to commencing construction of the Dublin Array, a final decision on the choice of turbine and associated manufacturer has not been made at this stage. The turbine spacing and layout has been designed to allow for flexibility in the final choice of turbine to be used.

3.5 Alternative Foundation Types



(A)

(B)



(C)

(D)

Figure 3.1 Offshore Wind Turbine Foundations

Gravity Caisson (Steel or Concrete) (A), Monopile (B) and Tripod (C) Foundations (courtesy Vestas Wind Systems A/S), Universal (Suction Pile) Foundation (D) *(courtesy Harland and Wolff Heavy Industries Limited).*

There are several types of offshore turbine foundation in use today (see Figure 3.1). These include:

- Gravity Foundation - Concrete Caisson
- Gravity Foundation - Steel Caisson
- Piled Tripod Foundation
- Monopile Foundation
- Universal Foundation (Suction Pile)

3.5.1 Gravity Foundations - Concrete Caisson

Vindeby (1991), the world's first offshore wind farm, and the Tunø Knob (1995) and Middlegrunden (2000) offshore wind farms used concrete gravity caisson foundations. The caisson method was also used in the installation of the Kish Lighthouse. Concrete gravity caisson foundations may take many different shapes but generally comprise of a hollow base with a large plan area and a central tower onto which the turbine is bolted (see Figure 3.1A). Such foundations rely on their inertia and ballast material (sand, gravel, iron ore or olivine), which is placed in the hollow base of the foundation, to resist the forces applied to the structure. Usually these foundations would be constructed in a dry dock, or at a land location in close proximity to a suitable harbour, and would be floated or transported by barge to site. These have a large self weight and require a large crane for installation.

Using conventional structural engineering design techniques for marine structures, each base is designed to withstand the loads applied to the foundation (including static and dynamic loads from the turbine and wave, tidal, currents and buoyancy loads on the base itself) and safely transfer these to the supporting seabed. The applied loads and resulting foundation size increase as water depth increases. At 5 m depth the foundation diameter is typically 17.5 m with 900 metric tonnes of concrete while at depths of 15 m the foundation diameter can be as large as 24 m with up to 2,200 metric tonnes of concrete being used. The cost of the completed foundation is approximately proportional to the square of the water depth. The water depths at Vindeby and Tunø Knob offshore wind farms vary from 2.5 to 7.5 m. At these sites each concrete foundation has an average weight of approximately 1,000 metric tonnes. Concrete caissons tend to become prohibitively heavy and expensive to install at water depths in excess of 10 m.

Figure 3.2 Concrete Gravity caisson foundations being fabricated for the Middelgrunden Project in Copenhagen Harbour.

Photo courtesy Middelgrundens Vindmøllelaug (www.middelgrund.com).

A high degree of site preparation is also usually required for this type of foundation, in order to eliminate any irregularities in the base onto which the foundation is placed. The foundation is usually placed on a pre-prepared bed of compacted crushed stone on the seabed. The extent of seabed preparation required will depend on the size of foundation and may involve excavation to depths of up to 4m to facilitate the placement of the layer of compacted crushed stone to receive the foundation. Concrete gravity foundations are also liable to scour and will require scour protection (see Section 2.3.4).

Given water depths up to c. 30m at many of the proposed turbine locations the use of concrete caisson gravity foundations is unlikely to be a viable solution for the support of the turbines on the Dublin Array.

3.5.2 Gravity Foundations - Steel Caisson

Steel caisson foundation technology adopts a similar methodology to that of the concrete gravity caisson. Rather than being constructed of reinforced concrete, steel is used as the primary construction material in these foundations. This construction is considerably lighter than concrete foundations with the steel structure weighing some 80 to 100 tonnes for water depths between 4 and 10 m. These relatively low weights relative to the concrete option allows barges to transport and install many foundations rapidly, using the same lightweight crane used for the erection of the turbines. Typically, the base of a foundation of this type has an area of 14 m by 14 m (or a diameter of 15 m for a circular base) for water depths from 4 to 10 m. Steel gravity foundations are filled with olivine, a high density mineral, which gives the foundations sufficient weight to withstand combined wind and wave loading during storms.

The advantage of the steel caisson solution is that the foundation is easier to produce, transport and install; waste material is low; no welding or grouting is required offshore and this foundation type may be used on all types of seabed although, as for their concrete equivalent, seabed preparation and scour protection are required. Additionally, the cost penalties associated with using this type of foundation in greater water depths are not as onerous as the traditional concrete caisson foundation option. To date the concrete solution has been preferred but on sites with increased water depths the steel solution may prove a more viable option.

Similar to the concrete caisson option, given water depths up to c. 30m at many of the proposed turbine locations the use of steel caisson gravity foundations is unlikely to be a viable solution for the support of the turbines on the Dublin Array.

3.5.3 Monopile Foundations

Steel monopile foundations have been used as the preferred foundation structure at the majority (c. 75%) of offshore wind farms constructed to date including Lely (1994), Dronten (1996) and Egmond aan Zee (2007) offshore wind farms in the Netherlands, at Bockstigen-Valar (1997) and Utgrunden (2000) in Sweden, at Blyth (2000), North Hoyle (2003), Scroby Sands (2004), Kentish Flats (2005), Barrow (2006) and London Array (2011) in the UK and at Arklow Bank (2004) in Ireland. The monopile foundation is a simple structure that can be constructed at almost any near shore location and can be towed by tug or carried by barges to the wind farm construction site. The foundation consists of a steel pile with a diameter in the range 3.5 to 5.5 m and wall thickness of 60 to 80 mm. The mass of the pile tends to be between 350 and 500 tonnes. Where soil conditions allow, piles are driven or vibrated into the seabed to a depth of between 20 and 40 metres by a large special purpose ship or rig; see Figure 2.5.

Figure 3.3 Installation of a steel monopile

Installation of a steel monopile at the Prinses Amalia Wind Park (formerly called Windpark Q7) above and installation of steel transition piece on top of monopile below (www.prinsesameliawindpark.eu)

Minimal seabed preparation is required and the hydrodynamic load on this foundation type is low. Driving the pile is the most cost-effective method and results in the least sediment disturbance, but where very stiff soils, rocks or other obstacles are encountered, making it unsuitable for pile driving, it is possible to remove such obstructions by drilling or water jetting. Alternatively, the monopiles can be placed in pre-drilled holes and grouted into position. Piles can be installed by cranes operating from either a jack-up or a floating barge. The monopile foundation effectively extends the turbine tower under water into the seabed. Once the steel monopile is installed in the seabed, a steel transition piece (Fig. 3.3) is then fitted to the top of the pile and grouted in place.

The turbine tower is bolted onto a flange on top of the transition piece, at a point high enough above mean sea level to be above the highest wave crest. The length of the pile varies depending on the actual soil/rock conditions and water depths at the site.

Heavy duty piling equipment would be necessary to install the piles into the seabed and these operations may pose a potential source of noise pollution. However, subject to the appropriate monitoring and mitigation measures and given the distance of the proposed development on the Kish and Bray Banks from noise sensitive receptors onshore, it is not envisaged that the noise impacts associated with the piling operations on this project would be significant. Furthermore, soft start piling would be used to provide an early warning to marine mammals in the vicinity of the foundations.

Scour protection is not essential for monopile foundations and allowances for scour may be made in the pile design. Where scour protection is used, regular inspection and possible maintenance of the protection is required; however, where scour protection is incorporated into the pile design, inspection is only required after heavy storms. The advantages of monopile foundations over other foundations include reduced wave loading and less obstruction to tidal flow.

Given water depths up to c. 30m at many of the proposed turbine locations and the nature of the sandy substrata to suitable depths on the Kish and Bray Banks it is likely that monopile foundations will be adopted as the preferred foundation solution on the Dublin Array.

3.5.4 Tripod Foundations

The tripod foundation draws on the experiences with lightweight and cost efficient three-legged steel jackets for offshore fields in the oil industry. The foundations consist of 3 piles driven or vibrated to a depth of up to 20 m into the seabed depending on sea conditions and predicted wind/wave loads. The piles are up to 1.5 m in diameter. The tripod consists of a central steel column of 4.5 to 6 m diameter. Tubular steel members emanate from the central column and are braced to each other giving the foundation its tripod shape. The tripod is connected to the pile sleeves. It must be firmly connected to the sleeves and may require grouting. The turbine tower is bolted to a flange on top of the central tower. Construction of the tripod foundations is done at a suitable onshore location. Piles are driven in a similar way to that used for the monopile foundations. To control the exact location of the piles, a template is applied to keep the piles in position during driving or vibration. The material thickness of the column, members and piles is 20 to 90 mm and the total mass of a tripod, including anodes and access ways is in the range of 420 to 470 tonnes. The weight of the 3 piles is in the region of 115 tonnes.

Tripod foundations are suitable for wind turbines located in larger water depths. Minimal seabed preparation is required and the hydrodynamic load on this foundation type is reduced. Also, the corrosion allowance required in the wall thickness of the pile is reduced because the diameter of the pile is less. However, this type of foundation is not suitable at water depths of less than 6 to 7 m since at low water depths vessels could be obstructed by the steel frame structure when approaching the turbines. As with the monopile foundation design, scour protection may need to be employed around the base of the tripod foundation. With respect to obstruction of water flow, the tripod concept, with and without scour protection is considered a solution midway between gravity and monopile foundations.

Given the shallow water depths at many of the proposed turbine locations on the Kish and Bray Banks it is unlikely that tripod foundations will be adopted as the preferred foundation solution on the Dublin Array.

3.5.5 Suction Pile (Universal) Foundations

The Universal Foundation is a relatively new design concept for offshore wind turbine foundations, which has been developed over the past decade combining the main aspects of conventional monopiles, described in section 3.5.3 above, and suction buckets previously used in the offshore oil and gas industries. Following a number of prototype installations for both met masts and turbine foundations, the Universal Foundation is now being promoted for supply to the commercial offshore wind market by Harland and Wolff Heavy Industries Limited based in Belfast. However, given the fact that it represents relatively new technology in the support of offshore wind turbines its use is not currently being seriously considered for the foundation structures to the wind turbines and met masts at the Dublin Array.

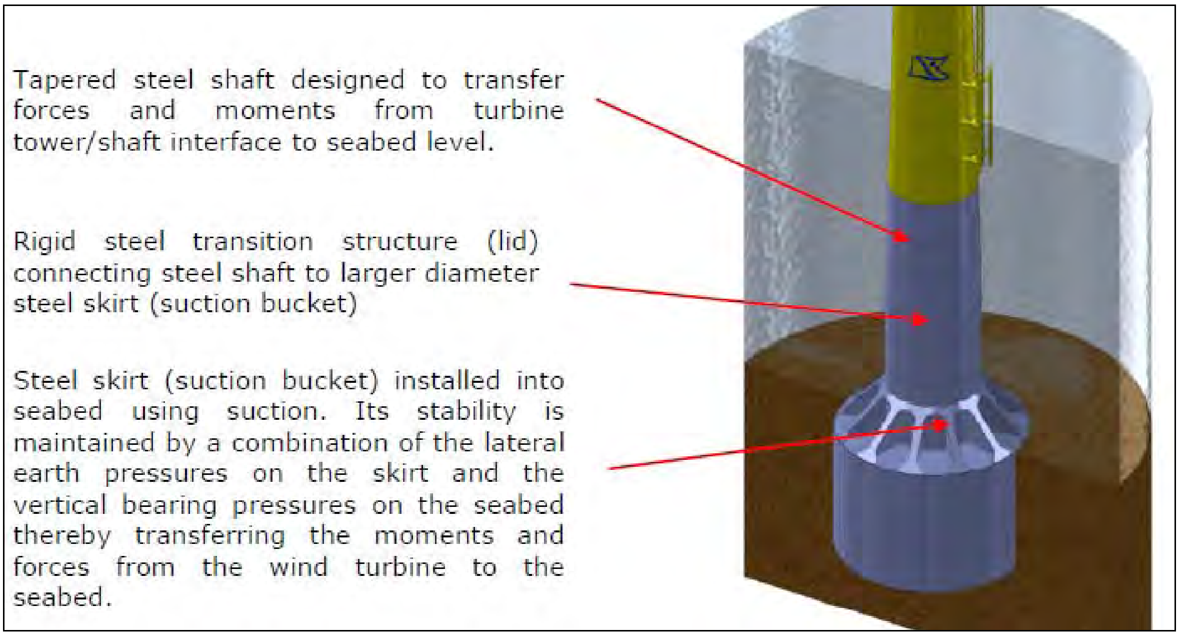


Figure 3.4 Universal Foundation

(Harland and Wolff Heavy Industries Limited)

The Universal Foundation design is illustrated in Figure 3.4 and comprises three main components, a small diameter steel pile (or shaft) rigidly connected at its base via a steel transition structure (the lid) to a larger diameter steel skirt (the bucket). The wind turbine tower sections are bolted directly to the shaft using conventional bolted flange the tower/shaft interface to seabed level.

3.6 Alternative Methods of Scour Protection

There are five common types of scour protection used to protect the seabed from scouring associated with the action of waves and currents following the installation of turbine foundation structures:

3.6.1 No Protection – Allow for Scour in the Pile Design

In some cases, it may be possible to avoid putting scour protection in place around foundation structures such as monopiles if provision is made for scour in the design. However, in a high energy seabed environment such as exists on the Kish and Bray Banks it is unlikely that local scour protection can be avoided through pile design considerations alone.

3.6.2 Rock Armour

All forms of scour protection involve placing obstacles of some kind in the vicinity of the pile to reduce the current velocity around the pile. Rock armour consists of large rocks that are placed around the pile. There are three methods of deploying rock armour:-

Placement of rock armour followed by piling: Using this method, the rock armour is placed on the seabed floor prior to piling. The piles are then driven through the rock armour and into the seabed.

Piling, followed by immediate placement of rock armour: This method involves placing the rock armour protection around the pile immediately after the pile has been driven into the seabed.

Piling, followed by placement of rock armour after the scour hole has been given some time to develop: Using this method, the pile is put in place and the local scour hole allowed some time to develop around it. The rock armour is then deployed, some of it being placed within the scour hole. In a high-energy environment with sandy seabed conditions, it would be possible to place the rock armour in the scour hole after a few hours. This method has the advantage that the scour protection causes less disturbance to the hydrodynamic flow than would be caused if the scour were placed on the seabed immediately after piling, thereby reducing secondary scour effects. This is the method of scour protection that was used on the Arklow Bank wind farm.

It is likely that rock armour will be selected as the preferred method of scour protection for the Dublin Array. The final design and selection of armour size, extent and timing of placement relative to monopile installation will be subject to further detailed geotechnical investigations and design specific to water depths at the location of each turbine.

3.6.3 Solid Apron or Collar

Similar to the rock armour method, a solid apron or collar consists of precast concrete blocks that are placed around the pile, for instance in the shape of two half-moons.

3.6.4 Concrete Filled Geosynthetic Mattress

Geosynthetic mattresses are much like large sandbags that are filled with concrete to form a flexible concrete mattress. While suitable for environments with a mild wave climate, this method of scour protection is difficult to deploy and is unlikely to be used on the Dublin Array.

3.6.5 Energy Flow Reduction Systems

Energy flow reduction systems consist of artificial seaweeds that are placed on the seabed to reduce the hydrodynamic flow velocity. It has been found that these systems have a low tolerance in extreme environments and are unlikely to be used on the Dublin Array.

4 PHYSICAL ENVIRONMENT

The Irish Sea, off the eastern coast of Ireland, takes the form of a fairly shallow basin with water depths generally ranging from 20-135m. It is connected with the Atlantic Ocean via the North Channel to the north and to the Celtic Sea via the St George's Channel to the south. The water masses of the region have different origins and distinguishable temperature and salinity characteristics. Due to Ireland's protecting effect, wave-energy in the Irish Sea is only approximately 20% of that on the Atlantic coasts.

The site of the proposed offshore wind farm on the Kish and Bray Banks, lies in a region of the Irish Sea which is characterised by a series of coast-parallel north-south trending offshore banks. These banks, which occur in a punctuated line along the east coast of Ireland, with breaks maintained by strong current activity and sediment movement, stand in shallow water and in places rise to within a few metres of the surface. The banks serve an important role in offering wave protection to the coast and controlling tidal flow in the region. The overall bank structures are stable in nature, whereas surface sediments exist in dynamic equilibrium with tidal and current conditions.

This chapter of the EIS describes the existing physical environment within and around the proposed Foreshore Lease Area and along the cable route to shore including underlying bedrock geology, sedimentology, bathymetry, hydrology and coastal morphology and examines the potential impacts of the proposed wind farm development on these environments during the construction and operational phases of the project.

Saorgus Energy commissioned Prof. John R. Graham, Department of Geology, University of Dublin, Trinity College to carry out an impact assessment for the proposed development on the physical environment. A copy of his report titled ***Geological Report on the Environmental Impact of the Proposed Kish & Bray Banks Wind Farm Development*** is presented in full in Volume 3, Appendix B of this Environmental Impact Statement. In order to supplement existing geological, bathymetric and hydrological data for the site, Saorgus Energy commissioned the following additional surveys for the proposed development:

- Bathymetric and geophysical survey of Kish and Bray Banks was undertaken by Hydrographic Surveys Ltd between June and September 2008. A copy of their report titled ***Kish and Bray Banks, Proposed Turbine Location Feasibility Study, Hydrographic and Geophysical Report of Survey, Volume 1, June – September 2008, PN 18/08*** is included in full in Volume 3, Appendix B.

- Geotechnical investigations comprising three exploratory boreholes by cable percussion methods, sampling, insitu and laboratory testing were undertaken by Glover Site Investigations Ltd. in September 2008. Copy of their report titled ***Proposed Kish & Bray Banks Offshore Windfarm, Preliminary Site Investigation, Report No: 08-0585*** is included in full in Volume 3, Appendix B.

4.1 Description of Existing Environment

4.1.1 Bathymetry

Existing bathymetric data for the area is represented on Admiralty Chart No. 1468 and was acquired between 1843 and 1911, using traditional sounding (lead-line) and navigations systems. The published chart indicates water-depths of 2-26m (Chart Datum) within the region of the proposed site with shallower depths (~ 1m) being observed towards the northern end of the site.

More recent bathymetric data (Wheeler *et al.* 2000) show that the Kish and Bray Banks lie in 10-30m of water and rise in places to within two metres of the surface towards the centre of the axis that runs north-south along the banks. A comparison of this data with that presented on the Admiralty Charts for the area reveal a close correlation between the two data sets for the deeper isobaths but less so in the shallower waters and on the crest. While it is noted that the changes may suggest some migration of the banks in historical time, the authors also note the markedly different technologies and techniques used in the generation of the datasets and formulation of isobaths limits their usefulness as "time-series". On this basis it is concluded that while the Admiralty Charts reliably locate the banks, the difference in crestal elevations make the charts unsuitable for across-bank navigation.

In 2008, Saorgus Energy Ltd. commissioned Hydrographic Surveys Ltd. to undertake a hydrographic and geophysical survey of the area of the proposed site and a copy of their report and associated survey drawings are included in Volume 3, Appendix B. A key element of their survey involved the plotting of 115 preplanned bathymetric profiles crossing the Kish and Bray Banks at 150m intervals. The survey was completed between 13th June and 11th September 2008 using a digital single-beam echo sounder, with positioning provided via Differential GPS and an on-shore tide-gauge facilitating reduction to chart datum.

The improved sounding and track density provided by this survey has enabled accurate water depths to be determined for each proposed turbine location as set out in Table 3.1 as well as facilitating more detailed descriptions of the surface morphology of the entire site. Additionally, the availability of the survey data in digital format enabled Digital Elevational Models (DEM's) to be derived thereby easing visualisation and interpretation of the survey data.

Immediately apparent from these digital representations was that the bank complex is more sinuous that the representation provided on the Admiralty Chart for the area and that there was good correlation with the 10m isobaths derived from the more recent bathymetric data (Wheeler et al. 2000) referred to above.

An analysis of the distribution of surface slopes over the proposed site indicated that slopes are steepest on the western face of the banks towards the north of the site. Going south, the slope on the western face of the banks reduces while that on the eastern face becomes more prominent. Further south, the slope of the eastern face decreases while that of the western face increases, leading to a more symmetrical appearance. In this region a broad shoal is evident in the digital representations derived from the survey data, but is poorly reflected on the Admiralty Chart or Wheeler *et al.* (2000) isobaths. To the very south of the proposed site, the bank complex remains symmetrical but the crest narrows substantially.

Turbine No.	Depth m CD	Turbine No.	Depth m CD	Turbine No.	Depth m CD
T1	17.7	T51	20.8	T101	16.5
T2	3.7	T52	14.5	T102	3.6
T3	12.6	T53	10.0	T103	13.4
T4	17.4	T54	7.5	T104	27.8
T5	26.7	T55	26.5	T105	27.1
T6	17.6	T56	22.0	T106	20.8
T7	5.0	T57	16.5	T107	8.5
T8	12.1	T58	11.0	T108	8.8
T9	17.0	T59	8.0	T109	23.6
T10	26.0	T60	26.0	T110	22.1
T11	19.1	T61	21.3	T111	7.0
T12	4.7	T62	17.0	T112	8.3
T13	9.9	T63	11.0	T113	23.5
T14	16.5	T64	8.8	T114	23.7
T15	25.6	T65	22.0	T115	19.0
T16	20.0	T66	>20.0	T116	5.0
T17	7.0	T67	17.0	T117	14.0
T18	5.5	T68	11.0	T118	28.7
T19	14.6	T69	9.0	T119	24.3
T20	25.8	T70	23.1	T120	11.8
T21	20.0	T71	>21.0	T121	5.8
T22	8.0	T72	17.3	T122	23.2
T23	5.8	T73	13.3	T123	23.4
T24	15.3	T74	7.9	T124	12.0
T25	26.1	T75	24.6	T125	8.4
T26	20.0	T76	>20.0	T126	26.4
T27	8.0	T77	16.1	T127	23.1
T28	6.2	T78	11.2	T128	18.2
T29	16.6	T79	4.8	T129	5.6
T30	26.5	T80	21.0	T130	23.8
T31	20.2	T81	15.0	T131	21.3
T32	9.7	T82	8.0	T132	17.8
T33	6.0	T83	10.4	T133	7.4
T34	13.7	T84	21.9	T134	20.8
T35	25.8	T85	14.0	T135	20.5
T36	23.0	T86	7.0	T136	20.0
T37	10.0	T87	16.0	T137	17.5
T38	7.0	T88	23.3	T138	3.0
T39	11.0	T89	14.0	T139	18.7
T40	25.4	T90	7.5	T140	18.5
T41	21.0	T91	16.8	T141	19.3
T42	12.0	T92	21.3	T142	17.3
T43	7.8	T93	12.5	T143	9.5
T44	6.2	T94	2.0	T144	17.5
T45	26.2	T95	23.6	T145	18.1
T46	25.4	T96	21.0		
T47	15.7	T97	12.5		
T48	11.2	T98	2.0		
T49	8.1	T99	22.4		
T50	14.4	T100	23.6		

Table 4.1 Depth to seabed (m CD) at Turbine Locations

No evidence of rock exposure is evident on the bathymetric data presented.

4.1.2 Hydrography

4.1.2.1 Wave Environment

Wave heights experienced in the Irish Sea are generally not as high as those experienced on the more exposed Atlantic coast, due to the protection afforded to the Irish Sea by the land mass of Ireland. In general, there is a reduction in wave height as water depth decreases although waves may become focussed by refraction as they pass over the shallow areas of the Kish and Bray Banks. Wave heights are likely to be further reduced due to the influence of seabed friction and wave breaking as they pass over the very shallow areas of the banks.

Analysis was carried out on wave data for the period 3rd May 2001 to 30th September 2004, obtained through Met Eireann, for a nearby Marine Institute operated data-buoy (Data-buoy M2 – 53^0 28.8'N, 5^0 25.5'W). This data consisted of hourly wave height, wave period and wind direction readings. Additional data, derived from the UK Meteorological Office wave model was included in the analysis for comparison purposes.

The data indicated, as expected, that the larger waves in the area originate predominantly from the south and southeasterly directions with some input from the northeast. This is consistent with the concept that waves arriving from the south are a result of channelling from the Atlantic, whereas those from other orientations are a result of the relatively short fetch of the Irish Sea.

Though wave conditions experienced closer to the proposed development are likely to be influenced by bathymetric and coastal factors, the close approximation between both datasets used in the analysis, suggest that the data provides an accurate proxy for conditions experienced by the Kish and Bray Banks site.

While the wave environment on the Kish and Bray Banks is quite vigorous, and it is expected that breaking waves would be experienced on the banks, it is benign in relative terms and is not anticipated that the wave environment would have an adverse effect on the construction or operation of the windfarm.

4.1.3 Tidal Amplitude

The Admiralty Chart No. 1468 indicates a mean high water spring tide level for the area of 4.1m above chart datum. This correlates well with tidal data presented in the Environmental Impact Statement for the Offshore Wind Farm at Codling Bank (Natural Power, 2002) which indicated a 1 in 50 year return period extreme high water level of 5.32m above chart datum. This can be extended to the proposed development on the Kish and Bray Banks.

4.1.3.1 Tidal Flows

The proposed site on the Kish and Bray Banks experiences approximately a southern flow direction during the Ebb tide and a northern flow direction during the Flood tide as shown on Admiralty Chart No. 1468. Data presented on the chart (tidal Diamond C – $53^0$19'3N $5^0$44'5W) shows a maximum tidal velocity of 2.2 knots (1.13 m/s) with an approximately North-South flow orientation. Further tidal flow markers located along and adjacent to the Kish Bank indicate a more NNE-SSW orientation.

More detailed evidence of local flow conditions can be elucidated with reference to the geological bedforms observed during the hydrological and geophysical survey of the site undertaken by Hydographic Surveys Ltd. on behalf of the Developers in 2008 as part of the Environmental Impact Assessment for the project. Analogue modelling has been used to determine the flow conditions necessary to generate a range of bedforms for sediments of a given size. For sediments with a grain size of approximately 0.5mm, as would apply to the medium sand encountered on the banks, sand waves (dunes) are observed to form under flow velocities of approximately 0.6m/s and gradually change to high-energy planar bed features at velocities above 1 m/s (Leeder, 1999). Under flow velocities of less than 0.6 m/s, such sediments are observed to form ripples. As a result, the pattern of bedforms observed on the banks suggests that the strongest tidal flow conditions are found closest to the banks, due to the acceleration of tidal flows around the obstruction which the banks present.

4.1.4 Geology

Seabed sediments, and the marine sedimentary processes of erosion, transport and deposition that control their distribution, character and thickness are very relevant to the design of foundation structures required to support the turbines. The current seabed landscape is a relict of the underlying bedrock geology and the actions of several glacial periods when large volumes of material were eroded and deposited on the seabed. The morphology and distribution of surficial sediments in the region has resulted largely from glacial deposition/scour processes combined with reworking and redeposition as a result of riverine input and tidal processes.

The geological environment can generally be divided according to the main groupings of materials based on age and geological processes as follows:

- Bedrock geology – these are rocks older than 1.8 million years old formed before the last ice ages.
- Drift (Quaternary) geology – these are rocks and semi-consolidated material deposited since the start of the last ice age and are from 1.8 million to 10,000 years old.
- Seabed sediments – these represent the youngest materials and were formed from reworking of either the solid or quaternary material, river inputs of sediments or the creation of new materials such as biogenic shells.

The 1:1,000,000 scale Solid and Quaternary geology maps of the area (British Geological Survey, 1991 and 1994) show Permian-Triassic rocks overlain by Quaternary glacial deposits of sand (>50% sand, <5% gravel) belonging to the Late Pleistocene to Early Holocene periods.

Sediment mapping, based on both sampling and sonar techniques indicate that the upper parts of the banks are composed of extensive thicknesses of sand-to-gravel sized material, with coarser gravel material located towards the crest of the banks and evidence of sediment fining towards the north of the bank. The soils encountered in the three boreholes undertaken by Glover Site Investigations, to their maximum depth of 20m, were marine sand deposits, loose/medium in the upper layers, soil of medium density down to 12m and very dense soil 12m and greater below the sea-bed.

Wheeler *et al.* (2000) concluded, on the basis of the bathymetric comparisons referred to in Section 3.1.1, that the banks were quasi-stable over time, probably maintaining their position due to the interaction between wave and current regimes. Their research defined, on the basis of side-scan sonar characteristics reflecting differences in bedforms and bottom types, five separate echo-facies covering the area of the proposed development on the banks. These comprised:

Stippled Bank Crest Facies – This area occurs towards the north of the proposed development on the crest of the Kish Bank. It represents a transition from sandwave dominated sediments on the bank margins, to environments dominated by planar beds with scattered patches of more highly reflective sediments which were interpreted to represent more gravel rich deposits. The morphology of the sandwaves observed in this echo-facies was interpreted to indicate a northwardly transport direction of sediment over the bank.

Bank-crest Facies – This echo facies occurs on the crest of the Bray Bank and is described as being similar in character to the pevious unit but lacking the patches of increased reflectivity.

Stippled Sandwave Facies – This unit occurs on the margins of the Kish Bank and represents areas dominated by sandwaves but also displaying areas of increased reflectivity interpreted to mean more gravel rich deposits.

Sandwave Facies – This unit describes a highly mobile seafloor environment occurring on the margins of the bank complex. The facies is characterised by widespread sandwaves and other bedforms, with bedform development decreasing with distance from the bank complex. Again, bedform morphology implies a northerly net transport of sediment, with stronger tidal flows adjacent to the banks.

Stable Seabed Facies – The final facies is found at greater distances from the bank complex and represents regions where no bedforms were imaged. This unit is interpreted to represent a stable or non-mobile seafloor. Where no bedforms are imaged, small scale ripples below the resolution of the sonar instrument may exist.

As expected, the additional sidescan data acquired for this development by Hydrographic Surveys Ltd. in 2008 shows a similar distribution of bedforms to those identified above, though additional small scale bedforms are observed on the bank crests.

4.2 Potential Impacts of the Proposed Development on Physical Environment

4.2.1 Construction Phase

During the construction and decommissioning stages of the project, appropriate engineering plant and support vessels will operate at the location of each of the turbines for a relatively short period of time in order to prepare the seabed, install the turbine foundations and support structure, scour protection and associated infrastructure including inter turbine and export power cables. Potential impacts on the physical environment associated with the construction phase of the project include:

- Disturbance and release of sediment into the water column during the preparation of the seabed to facilitate the installation of the turbine foundations. The extent of preparation required depends on the foundation type selected to support the turbines. Mono-pile foundations will require limited preparation involving localised levelling and removal of large clasts in the immediate vicinity of the pile whereas multi-pile or gravity foundations would require more intensive site preparation over a larger area with the potential for greater quantities of sediment to be released into the water column.

- Release of sediment into the water column during the installation of piles for turbine foundations. Again the extent of sediment released will depend on the foundation solution adopted. The use of augered piles would involve the release of significantly greater volumes of sediment than driven steel mono-piles.

- Release of sediment into the water column during the installation of power cables in the seabed between the turbines, offshore substation and the landfall site on shore.

4.2.2 Operational Phase

Following the installation of up to 145 turbines and associated foundations and infrastructure including offshore substation, met masts and cabling the potential impacts of these structures on the physical environment in the vicinity of the Kish and Bray Banks include:

- Localised scour and sediment dispersal in the immediate vicinity of the turbine foundations.
- Modification of tidal regimes and wave conditions associated with the obstacles provided by the turbine foundations.
- Impact on coastal stability and erosion along the Dublin and Wicklow coastline associated with potential changes in wave, tidal or sedimentary conditions following construction of the wind farm.
- Impact on potential utilisation of the banks as a source of material for the aggregates industry.
- Impact on the potential future development and extraction of petroleum resources in the vicinity of the banks.
- Impact on the potential future development and extraction of coal resources in the vicinity of the banks.
- Potential risk of damage to cables due to inadequate embedment, particularly along the cable route between the wind farm site and the landfall site where it could be susceptible to damage from fishing trawlers or vessels anchoring.

4.3 Mitigation and Enhancement

The following mitigation measures will be considered and adopted as appropriate to minimise the risk of potential negative impacts on the physical environment during the construction, operation and decommissioning phases of the project.

4.3.1 Site Preparation and Foundation Emplacement

Monopile foundations will be adopted in preference to gravity or multi-pile foundation types due to their reduced footprint and associated reduction in the extent of seabed which needs to be prepared and levelled prior to emplacement.

Subject to detailed site investigations, it is envisaged given the nature of the sediments on the site, that driving rather than augering will be used for the emplacement of monopiles, due to the smaller volumes of sediment potentially released.

4.3.2 Cable Laying

Established methodologies will be used to bury the power cables beneath the seabed using a plough which forms the trench, lays the cable and backfills the trench in a single operation. These will minimise sediment disturbance and burial depths will be of sufficient magnitude to account for sediment mobility. Planned and achieved burial depths will be measured from troughs of identified sandwaves, rather than crests, due to the mobility of such features over time.

4.3.3 Scour Protection

Scour protection will need to be deployed around turbine foundations to compensate for the local scour effects to be experienced in the immediate vicinity of the turbine foundations. Although further studies will be undertaken to facilitate the detail design of optimal scour protection measures for this site, it is envisaged that rock armour will be adopted as the preferred solution. Monitoring following emplacement of the first turbines will allow the effectiveness of deployed scour protection measures to be assessed and modified if required.

4.4 Actual Impacts of the Proposed Development on Physical Environment

4.4.1 Site Preparation and Foundation Emplacement

The preparation of the seabed to facilitate the installation of the turbine foundations, installation of piles and cable installation will lead to the release of sediment into the surrounding environment. This would lead to local increases in suspended sediment concentrations. Such increases would be temporary and spatially limited. The high energy conditions experienced at the proposed site would lead to rapid reworking and dispersal of such sediment into the natural sedimentary regime of the banks. Installation of such structures would have minimal environmental impact with regard to sedimentation. Indeed, the scale of the project would be such that only a portion of the overall works will take place at one time, so the impact will be lesser than it would be if the whole project were completed in one construction stage.

4.4.2 Effects of Tidal Dynamics on Proposed Wind Farm

Turbine foundations and any free lying cables would provide limited obstructions to tidal flows. This could lead to localised scouring around such structures, though this may be prevented through the deployment of scour protection measures. The relatively small size of the turbine structures and the large spacing between structures is sufficient to prevent interaction of scour from individual foundations. The overall effect of the proposed development on tidal flows, apart from in the immediate vicinity of the site, is deemed to be insignificant.

The proposed wind farm would provide a limited obstruction to waves, potentially leading to changes in height and orientation. The relatively small size of the turbine structures and the large distance between turbine locations implies that such changes would be very limited in magnitude. This conclusion is supported by modelling that has been carried out for a number of adjacent wind farm developments. The overall effect of the proposed development on wave conditions, apart from in the immediate vicinity of the turbines, is deemed insignificant.

4.4.3 Effects of Proposed Wind Farm on Tidal Dynamics

Any structure located in a tidal stream will, necessarily, have an impact on the tidal flow and wave patterns in the area. Intuitively, the effect is dependent upon the size of the obstruction to the flow. In the case of the proposed development, the diameter of the turbine tower would be of the order of 6m and the spacing between the turbines would be of the order of 500m, therefore, the effect on the profile of the area through which the tidal stream passes would be an obstruction of 1%, which is negligible. Locally, the water will accelerate around each obstruction and waves will rebound, in a circular fashion, off each turbine. The effect on the regional tide will not be appreciable, but locally, scour patterns may form at the point at which the turbine tower penetrates the surface of the Bank. The effect of scour is seen in the figure below (Figure 4.1.) and its effect is offset by placing armour, or protective support such as large rocks which have large inertia, at each turbine base to prevent the sand (which has low inertia) from removal by flowing water.

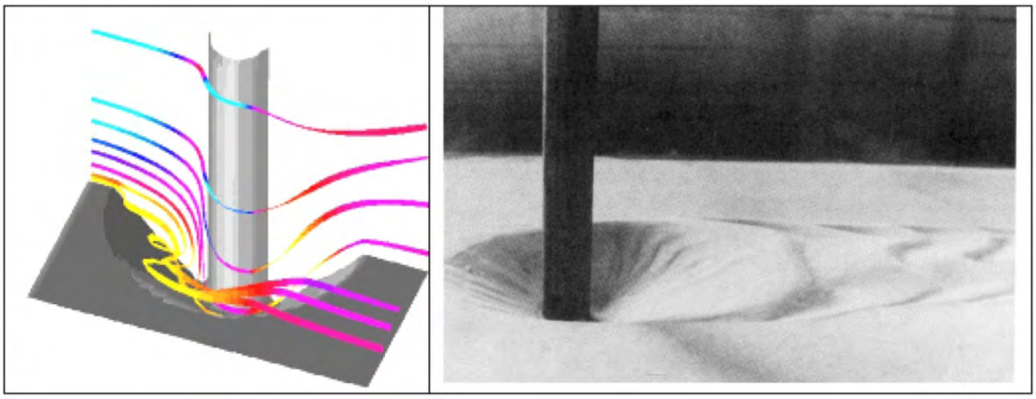


Figure 4.1 Flow Displacement and Scour Pattern as a result of a cylindrical tower placed in a sand structure subject to a tidal flow

(Source: Geological Report for EIS. Graham J.R. 2009)

4.4.4 Effects on Bank

The proposed wind farm development would have a limited impact on the site's natural sedimentary processes. The site's sediments exist in quite a high-energy state, and the development is not likely to obstruct or alter the banks sediment pathways. The slight local changes in flow conditions would cause some modification of sedimentary conditions, but the overall activities of the bank and its interaction with the shoreline are not likely to be significantly affected. The wind farm would not destabilise the banks or have a negative impact on the coastline.

4.4.5 Effects on Sub-Surface, Extractable Material

The Kish and Bray Banks have long been identified as a potential source of material for the aggregates industry. Their location and the shallow depths observed over the banks makes them ideal for this purpose. However, there are currently no plans for offshore aggregate extraction. The utilisation of the banks as a site for offshore wind farms is not compatible with their usage for aggregate extraction, as this may lead to the potential destabilisation of turbine foundations. The environmental impact of the proposed wind farm development is considered to be far less than the potential impact of wholesale aggregate extraction.

The existence of coal bearing strata has been recognised in the Kish Bank Basin since the 1970's, though extraction is unlikely to be economically viable in the current climate. The proposed wind farm site is not envisaged to cause any significant obstruction in the future development and potential extraction of this resource. In addition, the environmental impact of the proposed wind farm site is considered to be significantly less than that likely to result from any future development of the Kish Bank Basin coal deposits.

Providence Resources PLC has a licence to drill exploratory wells for gas and or oil in the Kish basin. The proposed wind farm is not envisaged to cause any significant obstruction in the future development and potential extraction of this resource.

5 HUMAN ENVIRONMENT

This section of the Environmental Impact Statement addresses the potential impacts of the proposed Dublin Array Offshore Wind Farm development on the Kish and Bray Banks on human beings with a view to ensuring that they experience no significant diminution in their quality of life as a consequence of the construction, operational and decommissioning phases of the project. Many of the effects of the proposed project on the environment have the potential to impact on human beings either directly or indirectly. Accordingly, the impact of the development on human beings is addressed not just in this section of the Environmental Impact Statement but throughout the document under separate headings which deal with each of the other appropriate aspects. Aspects which will be specifically addressed in this section of the EIS include:

- Noise
- Shipping and Navigation
- Submarine Cables and Pipelines
- Aviation
- Military Use of Area
- Electromagnetic Broadcast Signals
- Minerals, Oil and Gas
- Socio-Economic Effects
- Recreational Activities
- Traffic
- Health & Safety

5.1 Noise

The potential impact of noise associated with the construction, operation and de-commissioning of the proposed Dublin Array Offshore Wind Farm development on the Kish and Bray Banks on human beings will primarily be associated with potential impacts on existing noise levels at noise sensitive locations on shore along the Dublin and Wicklow coastline approximately 10 km west of the wind farm. Given the limited use of the banks by recreational craft and for angling it is not anticipated that any increase in noise levels in the immediate vicinity of the banks will have a significant impact on human beings. The potential impacts of noise in the vicinity of the banks on commercial fisheries, marine mammals and birds is addressed in the relevant sections of this Environmental Impact Statement.

5.1.1 Existing Noise Environment

The existing noise environment in the vicinity of the Kish and Bray Banks will be made up of noise from a number of sources including those from natural sources such as wind, waves, rain and birds and those from anthropogenic sources such as shipping, fishing and aircraft. The existing ambient noise levels due to the natural sources will vary considerably depending on wind speed and weather conditions with rain likely to have a significant contribution to ambient noise levels particularly during the winter months. Noise levels from intermittent sources such as shipping will vary depending on the level of activity within the area at any one time.

Existing ambient noise levels on shore along the Dublin and Wicklow coast are likely to vary significantly depending on the time of day, proximity to urban areas, sources of industrial noise, roads, railway lines and the shore and weather conditions at the time. Typically urban areas will have an ambient noise level in the range of 50 to 70 dB (A) during the daytime and from 45 to 55 dB (A) at night while quiet rural areas (with little traffic noise) are likely to have ambient noise levels in the range of 30 to 40 dB (A).

5.1.2 Impacts of the Proposed Development

5.1.2.1 Construction Noise

The primary noise sources associated with the construction of the wind farm would be pile driving and noises resulting from any shipping activity associated with vessels used for the transportation and installation of turbine components and construction materials. Given the distance of the proposed wind farm from the shore (c. 10km) the pile driving is the only noise source likely to potentially be audible onshore. Published measurements from the San Francisco-Oakland Bay Bridge piling project suggest that driving of piles similar to those used for offshore wind turbines would have a maximum sound power level in air at source of 137 – 165 dB(A) (Ward & Healy, 2002), measured using impulse measurement time weighting. Measurements performed during the construction of the offshore wind farm in Rodsand indicate that noise levels due to the driving of a monopile of 3.5 m diameter were 150 dB(A) at source. At a distance of 8 km from the source, the noise level was measured as 42 - 53 dB(A) (Sure Partners Limited (2001)) and on this basis are likely to be below 40 dB(A) at distances in excess of 10km which will apply in the case of the Dublin Array.

There are no statutory limits for noise emissions resulting from construction activities in Ireland. However there are two standards that provide an indication of what noise levels would be acceptable from industrial and construction activities. These are the Environmental Protection Agency *Guidance Note for Noise* and the *International Standard ISO 1996 Parts 1, 2 & 3 – Description and Measurement of Environmental Noise*. According to the EPA guidance notes, industrial activities are permitted to have noise levels of 40 - 45 dB(A) at night and 50 - 55 dB(A) during the daytime, at the nearest residence.

On the basis that the turbines of The Dublin Array will be located at a distance in excess of 10 km from the coastline, it is predicted that noise levels from piling activities associated with construction of the wind farm will be below the threshold levels recommended by the EPA for industrial activities when measured at the closest residences onshore. The impacts on humans, in terms of nuisance associated with noise from piling operations during the construction of the wind farm, are therefore likely to be insignificant.

5.1.2.2 Operational Noise

Noise resulting from operational wind turbines arises due to the movement of the blades through the air (aerodynamic noise) and the consequent transmission of power and momentum to the nacelle that could result in noise from the major components, such as the gearbox and generator, located within the nacelle (mechanical noise). The impact of noise is dependent upon the level and character of the noise emitted, the distance from the turbines to potential sensitive receivers, wind direction and background (ambient) noise levels.

Detailed guidance in relation to permissible noise levels considered appropriate to provide protection to neighbours of proposed wind farm developments are given in the Wind Energy Planning Guidelines for Local Authorities published by the Department of Environment, Heritage and Local Government (2006).

The "Guidelines" recommend separate daytime and night-time limits as follows:

- In general, a lower fixed limit of 45 dB(A) or a maximum of 5 dB(A) above background at nearby noise sensitive locations. The guidelines recommend a slightly lower limit of 35-40 dB(A) in very quiet areas where background noise levels are less than 30 dB(A).

- At night-time it is recommended that the lower fixed limit is reduced to 43 dB(A) to protect sleep inside properties at night.

While the above guidelines were not developed specifically for offshore wind farms they provide a firm basis on which to measure the potential impact of operational noise from an offshore wind farm on onshore noise sensitive locations.

In order to facilitate an assessment of potential noise levels that would result from the operation of the proposed offshore wind farm on the Kish and Bray Banks, the Developers commissioned a study by Vestas, one of the world's leading wind turbine manufacturers, and a company that has considerable experience of measurement of operational noise from wind turbines. Calculations were performed on the basis of an overall sound power level at source of 109.4 dB(A) on the basis of a reference wind speed of 8m/s at 10m above sea level excluding meteorological correction factors. This would be typical of offshore wind turbines in the capacity range being considered for this project. The calculations were based on the international norm "ISO 9613-2, Acoustics – Attenuation of sound during propagation outdoors". A sound intensity contour map detailing the noise levels arising from the proposed development on the basis of the modelling undertaken by Vestas is included in Figure 5.1. The model indicates that operational noise levels from the proposed wind farm will be substantially below the threshold limits specified in the Department of Environment, Heritage and Local Government Guidelines by the time it reaches the Dublin/Wicklow coastline and are unlikely to be audible to human beings on land on the basis that they will be well below typical ambient noise levels even in typical rural environments. On this basis it is concluded that there will be no significant impact on human beings associated with operational noise from the turbines.

The noise level predictions show that the resultant 40 dB(A) sound contour occurs approximately 2.5 km from the centre of the proposed development and approximately 7.5 km from the nearest point onshore. The 30 dB(A) sound contour occurs approximately 5 km from the nearest point onshore. On this basis operational noise levels from the turbines are likely to be significantly less than existing ambient noise levels by the time they reach the Dublin/Wicklow coastline and will therefore not be perceptible to any onshore receivers. On this basis it is concluded that operational noise levels from the turbines will not have a significant impact on human beings.

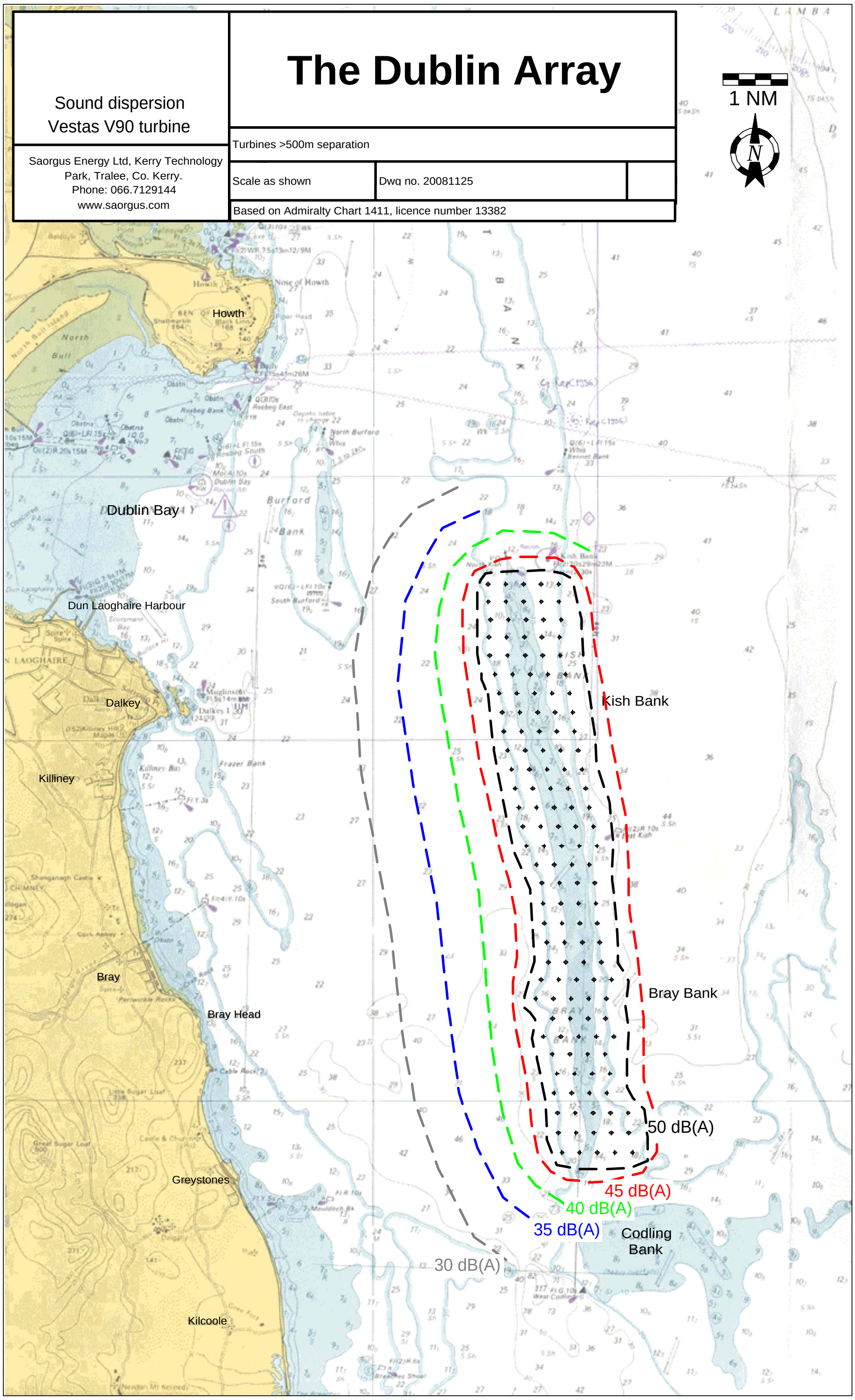


Figure 5.1 Noise intensity profile for the operation of The Dublin Array (for typical offshore wind turbine)

5.1.3 Mitigation Measures

5.1.3.1 Construction Noise

Baseline noise measurements will be undertaken at agreed noise sensitive locations onshore prior to construction. Noise levels will be monitored at these locations during the piling operations relative to the permitted threshold levels recommended in the EPA guidance. In the event that noise levels associated with the installation of the piles are found to exceed the recommended threshold levels, a cushion would be placed on the hammerhead to reduce the impact of construction noise.

5.1.3.2 Operational Noise

On the basis that the predicted noise levels associated with the operation of the turbines are unlikely to exceed existing ambient levels onshore, even in quiet rural environments, it is not anticipated that any mitigation measures will be required to reduce the impact of operational noise from the turbines.

5.1.4 Cumulative Impacts

On the basis that the predicted noise levels associated with the operation of the turbines on the Dublin Array are unlikely to exceed existing ambient levels onshore, even in quiet rural environments, it is not anticipated that any cumulative impact will occur in combination with other proposed offshore windfarm developments.

5.2 Shipping and Marine Navigation

With several large commercial ports in the vicinity (Dublin, Liverpool, Milford Haven, Clyde, Belfast and Manchester) there is significant shipping activity in the Irish Sea. The flow of traffic is in both the north-south direction between the western approaches and the northern channel and the east-west direction with vessels from ports along the east coast of Ireland accessing ports in the UK and mainland Europe. Traffic operating in the western sector of the Irish Sea is well established with approximately 40,000 ship movements per annum shared by ports on the east coast of Ireland. The ports of Dublin and Dun Laoghaire alone handle approximately 15,650 ship movements per annum. The majority of the trade is dominated by the ‘regular users’, namely ferry operators, RoRo operators and Container Feeder vessels. The increasing interest in offshore renewable energy has the potential to lead to a further increase in shipping traffic in the study area.

The potential impact of the construction and operation of the proposed Dublin Array Offshore Wind Farm development on the Kish and Bray Banks on shipping and navigation is addressed in this section of the Environmental Impact Statement. This will include effects both on safety and effects on issues related to economics, such as journey times and distances, and trade.

In order to facilitate this assessment, Arcadis UK Limited were engaged by the Developers to undertake an assessment of the potential impact of the proposed Dublin Array Offshore Wind Farm on shipping and marine navigation. The UK DTI document “Guidance on the Assessment of the Impact of Offshore Wind Farms – Methodology for Assessing Marine Navigational Safety Risks of Offshore Wind Farms” was used as a reference for compiling their assessment. The scope of their study, which included both the construction and operational phases of the development, was to:

- Identify the existing shipping traffic in the area
- Assess the impact of the proposed development on shipping collision
- Identify any mitigation measures that may be deemed necessary

A copy of Arcadis UK Limited’s report entitled ‘Dublin Array Offshore Wind Farm Marine Navigation Impact Assessment’ is included in Volume 3, Appendix C.

In order to compliment the above Marine Navigation Impact Assessment, the Developers engaged QinetiQ to undertake a study of the potential impact of the proposed development on the operation of both ship and shore based radar systems. A copy of QinetiQ's report entitled 'Kish and Bray Banks Wind Farm Radar Impact Assessment' is included in Volume 3, Appendix C.

5.2.1 Existing Marine Environment

5.2.1.1 The Kish and Bray Banks

The Kish and Bray Banks together extend for a distance of approximately 10 nautical miles north-south and have an average width of approximately 0.5 nautical miles over which the water depth is less than 10m below chart datum. To facilitate safe marine navigation in the vicinity of the banks, their northerly extent is marked by the North Kish (**N**orth **C**ardinal **M**ark). The northerly extremity is further marked by the Kish Bank Lighthouse located some 1km (half a nautical mile) ENE of the North Kish (NCM) and some 0.5km ENE of the bank. The southernmost extremity of the banks is found at 53° 08.8'N 005° 54.5'W and is unmarked by navigation buoys. The eastern extremity of the bank is marked by a Red Can Buoy (East Kish). The westerly edge of the bank is unmarked by any navigational buoys. The location of buoys in the vicinity of the Kish and Bray Banks are detailed in Table 5.1.

Buoy / Light	**Latitude**	**Longitude**	**Characteristics**	**Mark**
North Kish	*53° 18.5'N*	*5° 56.4'W*	Very Quick Flashing (VQ) Painted Black and Yellow (BY)	**N**orth **C**ardinal **M**ark
Kish Bank Lighthouse	*53° 18.7'N*	*5° 55.3'W*	Flashing [(2)20s29m22M] Horn (2)30s Racon (T)	
Red Can Buoy (East Kish)	*53° 14 3'N*	*5° 53.6'W*	Flashing [(2)R.10s]	

Table 5.1 Navigation Aids in the Vicinity of the Kish and Bray Banks

5.2.1.2 General Traffic Flow within the Irish Sea

As noted, the Irish Sea is a major hub of international shipping connecting the large commercial ports on the east coast of Ireland and the west coast of the UK to each other as well as continental and world wide ports. The northbound traffic in the Irish Sea emanates from St. George's Channel through the main arteries known as Traffic Separation Schemes (TSS) off 'The Smalls' in the east and 'Tusker Rock' in the west. The ship sizes/types using these TSS vary from large tankers/bulk carriers to coastal tankers/bulk carriers. Northbound vessels rounding 'The Smalls' and destined for a port in the United Kingdom generally stay to the east heading for the Traffic Separation Scheme off Anglesey and thence north-west to ports in the United Kingdom. Vessels destined for ports further north, such as Glasgow, Belfast and Larne invariably pass to the west of the Isle of Man passing approximately 2.5 miles east of The Codling Bank Lanby Buoy, and thence approximately 15 miles east of Kish Bank. Northbound vessels destined for ports on the east coast of the Irish Republic and north of Arklow and Wicklow have the option of passing the Codling Bank Lanby Buoy approximately 2.5 miles to the east and thence on to their various destinations or, if proceeding to Dublin then via India North-NCM and India South-SCM or West Codling and South Codling-SCM.

The volume of southbound traffic entering the Irish Sea from the North Channel, north of Belfast Lough is, in general, considerably lower than the numbers entering from the south. The size and type are similar to the northbound traffic but their numbers probably in the region of 20% of the northbound total. The southbound flow is therefore greater than the northbound total as it consists of both the southbound traffic entering from the North Channel as well as the returning northbound traffic.

The east/west traffic in the Irish Sea is dominated by the established Ferry Services, the Container Feeder Services and Coastal Bulk (Liquid and Dry).

Commercial vessels do not cross the Kish and Bray Banks since the water is too shallow (< 2 m in places). A detailed sector analysis of traffic within the Irish Sea is presented in the Marine Navigation Impact Assessment prepared by Arcadis UK Limited on behalf of the Developers and included in Volume 3, Attachment C of this Environmental Impact Statement.

5.2.1.3 Routing Rationale

Vessels destined for Dublin Port from the North will approach via the TSS north of Burford Bank at reporting point '**Charlie**'. Similarly those departing Dublin and destined North will do so via '**Delta**'. They will have little impact on marine navigation in the vicinity of the banks.

Vessels destined to Dublin from the south have the option of proceeding towards the TSS South of Burford Bank at reporting point '**Alpha**' either along a route on the outside of the Kish and Bray Banks via East of the Codling Lanby Buoy and east of Kish Bank Light or alternatively along a shorter route referred to locally as the 'inside channel' on the inside of the banks via c. 1.8km west of North Arklow Buoy and c. 1.1km west of India South and 1.1km west of West Codling. Similarly, vessels departing Dublin to the South can depart via departing point '**Bravo**' along either route. The aforementioned 'inside channel' from Tuskar Rock to South Burford is primarily used by coastal vessels with local knowledge drawing 4/5m of water.

5.2.1.4 Recreational Traffic

There are several marinas catering for leisure craft and yachts in the immediate vicinity of Dublin Bay, namely Dun Laoghaire, Clontarf Yacht & Boat Club, Malahide, Howth, Poolbeg and Dublin (City Moorings). Most of these craft restrict their movements to areas where they can return to their mooring by nightfall and rarely venture south of Killiney Bay or north of Howth. On this basis recreational traffic in the form of pleasure craft is not considered a hazard and the numbers which currently cross the Kish/Bray Bank are few.

Angling is very popular along the southeast coast but there is limited activity on the Kish and Bray Banks themselves due to the distance offshore and the effects of tidal currents on small pleasure craft. What angling activity takes place is limited to inshore areas to the west of the bank in way of Dublin Bay (South), Scotsman's Bay, Dalkey Island, Killiney Bay and south along the Wicklow coast. Recreational Traffic is not considered a hazard.

5.2.1.5 Commercial Fishing

Commercial fishing on and around the Kish and Bray Banks is much reduced in recent years due in the main to the depletion in fish stocks. In addition, due to the shallow nature of the banks, the banks themselves tend not to be fished. It may be summarised as to say that commercial fishing on the Kish / Bray banks is negligible. There is however, a thriving inshore industry in the fishing for whelks that does extend to a lesser degree to Kish / Bray banks. The impacts of the proposed development on commercial fishing are treated in detail in Chapter 7.

5.2.1.6 Ports and Harbours

Ports and harbours along the east coast of Ireland that contribute to traffic flow in the vicinity of the banks are listed in Table 5.2, along with estimates of the number and types of vessel using the ports in 2010. The ports and harbours that are closest to the area of the proposed development are highlighted in bold in the table below.

Port	Liquid Bulk	Dry Bulk	Container	Specialised	General	Total
Arklow	-	-	-	-	-	0
Wicklow	**-**	**8**	**-**	**-**	**45**	**53**
Dun Laoghaire	**-**	**-**	**-**	**-**	**243**	**243**
Dublin	**437**	**375**	**1529**	**185**	**5053**	**7579**
Drogheda	34	12	27	-	107	180
Dundalk	3	37	-	-	-	40
Greenore	6	72	-	-	48	126
Total						**8221**

Table 5.2 Estimated Number and Types of Vessel Arrival for 2010
(based on data from CSO)

5.2.1.7 Commercial Shipping Traffic

A summary of shipping traffic associated with each of the main ports along the East coast including vessel numbers, origin/destination, direction and proportion likely to use the 'inside passage' to the west of the banks, is included in Section 8.0 of the Marine Navigation Impact Assessment prepared by Arcadis UK Limited in Volume 3, Attachment C.

The traffic operating to the western sector of the Irish Sea is well established with approximately 40,000 ship movements per annum shared by the ports on the east coast of Ireland. The majority of the trade is dominated by the 'regular users', namely ferry operators, RoRo (Roll-on/Roll-off) operators and Container Feeder vessels.

Dublin Port/Dun Laoghaire Harbour ship movements amount to 15,645 per annum which translates into 43 movements per day, consisting of:

- 30 Ferry/Roll-On-Roll-Off (RoRo) movements per day (including seasonal adjustments)
- Approx. 8 regular runners (Container Feeder Ships, Car Carriers etc)
- Approx. 5 unscheduled.

The trans-Irish Sea Ferry/RoRo vessels account for 71% of traffic entering and departing Dublin Bay. Approximately 33% of this traffic, namely that traffic to Holyhead, enter/depart Dublin Bay through the Kish/Bennet channel i.e. that channel between the Kish Bank Lighthouse and the Bennet Bank Buoy. The remaining 67% enter/depart Dublin Bay some several miles north of Bennet Bank Buoy.

Liner Services (regular runners) amount to approximately 4 vessels per day (1,460 per annum). Approximately 10% (the northerly element) arrive/depart through reporting points at the Bailey TSS. Approximately 60% (the Southerly Element) arrive/depart via reporting points at the South Burford TSS. Approximately 30% (the non regular and larger ships) enter through the Kish/Bennet Channel.

Unscheduled traffic amounts to approximately 2.5 vessels per day (913 per annum). Approximately 10% account for the northerly element, with approximately 60%

accounting for the Southerly Element and approximately 30% entering through the Kish/Bennett Channel.

On the basis of a Directional Analysis for the ships using the ports along the east coast, the following disposition of vessels navigating the waters around the Kish and Bray Banks was identified:

North Kish: Approximately 6,935 vessels navigating to the north of the Kish Bank annually (38 ship movements per day).

South Kish: Approximately 1,848 vessels navigating to the south of the Kish Bank annually (10 ship movements per day).

East Kish: Approximately 1,751 vessels navigating to the east of the Kish Bank annually (10 ship movements per day).

West Kish: Approximately 1,899 vessels navigating to the west of the Kish Bank annually (10.5 ship movements per day).

The above ship movements are illustrated in the Sector Analysis included in Section 9.0 of the Marine Navigation Impact Assessment prepared by Arcadis UK Limited in Volume 3, Attachment C. It is to be noted that this analysis identified no commercial routes traversing the Kish and Bray Banks, due to the shallow nature of the banks.

5.2.2 Potential Impact of Proposed Development on Shipping and Marine Navigation

Given the significant level of shipping activity in the seas around the proposed Dublin Array Offshore Wind Farm the construction and operation of the development has the potential to impact on this activity should it have an effect on safety or on economic issues such as journey times and distances, and trade.

An assessment of the potential impact of the proposed offshore wind farm development at the Kish and Bray Banks on shipping in the vicinity is included in the 'Dublin Array Shipping and Marine Navigation Impact Assessment' prepared by Arcadis UK Limited on behalf of the Developers. This study assessed the potential collision risk of the proposed development to shipping as well as the impact of the construction and operation of the wind farm on marine navigation. A copy of the report 'Dublin Array Shipping and Marine Navigation Impact Assessment' prepared by Arcadis UK Limited on behalf of the Developers is included in Volume 3, Appendix C of this Environmental Impact Statement.

On the basis of recommendations included in the Arcadis UK Limited report, a further study was commissioned by the Developers to investigate the likely impact of the wind farm on marine radar signals in the vicinity of the wind farm. The Radar Impact Assessment was undertaken by QinetiQ and a copy of their report 'Kish and Bray Banks Wind Farm Radar Impact Assessment' is included in Volume 3, Appendix C of this Environmental Impact Statement

5.2.2.1 Construction Stage Impacts

Potential impacts during the construction stage of the proposed Dublin Array Offshore Wind Farm on shipping and marine navigation include:

Increased Journey Times and Distances: During construction of the development an exclusion area will be identified and imposed around the area of activity from which vessels not directly associated with the construction activities therein will be excluded. In the event that such an exclusion zone involved vessels taking an alternative route this could involve an increase in journey time and distance with associated increase in fuel use and costs for the shipping operator as well as increased carbon emissions. However, based on the analysis undertaken by Arcadis UK Limited, vessels do not currently navigate across or close to the banks where the majority of the construction activities will take place. The only activities likely to take place in the vicinity of routes currently used by commercial shipping will be the installation of the subsea cable between the offshore substation and the shore which will cross the 'inside channel' route used by ships navigating to the west of the banks. However, this activity is only likely to last for a limited duration (c. 10 days) and is unlikely to have a significant impact on shipping using this route. On this basis it is unlikely that commercial shipping vessels will need to alter their routes to avoid exclusion zones imposed during the construction of the wind farm and there should therefore be no increase in journey times or distances for commercial shipping associated with the construction of the Dublin Array Offshore Wind Farm.

Reduced Trade Opportunities: Any potential restriction on access to ports and harbours during construction of the wind farm could have an effect on trade and supplies. However, based on the analysis undertaken by Arcadis UK Limited, the exclusion zones imposed during the construction of the wind farm are unlikely to restrict access to existing ports along the East coast.

Reduced Visibility: The presence of installation vessels, jack-up rigs and other construction vessels/equipment has the potential to obstruct views of other vessels and navigation features such as lights and buoys, etc. in the vicinity of the construction operations. However, based on the analysis undertaken by Arcadis UK Limited, since vessels do not currently navigate close to or directly across the banks, and as no construction activity associated with the construction of the wind farm will take place between established shipping lanes and existing navigation features such as lights and buoys it is unlikely that there will be any impact on visibility associated with the construction of the wind farm.

Collision with Construction Vessels and Turbine Foundations: The presence of slow moving or stationary installation vessels and equipment and newly installed turbine foundation structures could affect the probability of close quarter encounters or collisions with both vessels moving under power and drifting vessels. However, as already noted, an exclusion zone will be established around each zone where construction activity is taking place and given the fact that commercial shipping routes do not currently traverse the banks the risk of such a collision is considered unlikely. The presence of construction activities and associated exclusion zones also has the potential to cause small craft and recreational vessels which might otherwise cross the banks to use areas transited by larger vessels. However, as previously noted most recreational craft restrict their movements to areas where they can return to their mooring by nightfall and rarely venture south of Killiney Bay or north of Howth. On this basis recreational traffic in the form of pleasure craft is not considered a hazard and the numbers which currently cross the Kish/Bray Bank are few.

Impacts on Search and Rescue Operations: The planning of any search and rescue operations using helicopters and boats in the vicinity of construction works will need to take account of installation activities.

5.2.2.2 Impacts during the Operational Phase

Potential impacts during the operational stage of the proposed Dublin Array Offshore Wind Farm on shipping and marine navigation include:

Increased Journey Times and Distances: Given that vessels do not currently transit the area of the Kish and Bray Banks on which the proposed Dublin Array Offshore Wind Farm will be located, there should be no requirement for vessels to alter their route in order to avoid the wind farm.

Reduced Trade / Supply Opportunities: As the proposed development will not obstruct any established access routes to existing ports along the east coast for commercial vessels there should be no reduction in trade or supply opportunities associated with the operation of the proposed wind farm.

Reduced Visibility: The presence of offshore wind turbines has the potential to obstruct the view of other vessels, navigation features such as lights and buoys and the coastline. This could at least in theory, present a hazard to other vessels in areas where visibility is particularly important for navigation.

Collision: Section 10.3 of the Dublin Array Offshore Wind Farm Marine Navigation Impact Assessment prepared by Arcadis UK Limited on behalf of the Developers includes a comprehensive assessment of the potential collision risk to marine traffic following construction of the wind farm. Their conclusions are summarised below:

Commercial Traffic:

- East/West Transit of Banks: Commercial vessels do not cross the Kish and Bray Banks because of the shallow water depth, and routes for commercial traffic are well documented as avoiding the banks. On this basis the assessment concludes that the risk of collision with turbine towers due to commercial vessels crossing the banks is remote and would be confined to human errors in navigation or to operational error that may arise in GPS navigational systems caused by close proximity to wind turbines. It notes that there is no evidence at present to support such errors as a result of interference by turbines.

- North Kish: The traffic flow to the north of the Kish Bank is well monitored. Vessels arriving and departing from Dublin Port and Dun Laoghaire maintain contact with the Dublin Port Vessel Traffic Service (VTS) that monitors all traffic and advises vessels of traffic in their immediate vicinity. The North Kish is also well marked by the Kish Lighthouse and the North Kish Buoy, and tidal streams are well documented. The flow of traffic to the north of the bank is well ordered. Ferry/RoRo traffic account for approximately 87% of traffic in the vicinity of the North Kish. Of this, only 7% (Stena Holyhead – Dun Laoghaire) operate in close proximity (200-400m) to the Kish Bank Lighthouse / North Kish Buoy. In addition there are approximately 5 passages per day (accounting for the remaining 13% of traffic) of scheduled and unscheduled traffic destined for Dublin. Of these five, approximately 1.5 passages per day will round the Kish (the remainder will favour the Bennet Bank Buoy). The assessment concludes that while care must be exercised when navigating the waters around the North Kish, the risk of contact with turbines in this well monitored, well ordered and well marked sector is remote.

- South Kish: The Dublin traffic, which consists of approximately 10 passages per day, would pass within one nautical mile of its southern extremity en-route to the West Codling Buoy. The report concludes that the risk of contact with turbine structures following the installation of the appropriate navigational lights will be remote.

- East Kish: In total there are approximately 13 passages per day destined for ports on the east coast of Ireland that pass to the east of the Kish Bank. Of these 6 passages are allocated to Belfast and as such have a closest point of approach to the Kish Bank (Bray Bank in the south) of approximately 9 nautical miles. Given the distance, the proposed development would not pose a risk to these passages.

Approximately 4 passages per day are apportioned to Dundalk, Drogheda, Greenore and Warrenpoint ports. The route takes the vessels to and from Codling to the Rockabill. The closest point of approach for these vessels would not be less than 4 nautical miles and, in addition, they have good navigation marks, both visual and as a radar target in the Kish Bank Lighthouse. Again, given the distance and navigation aids, the proposed development would not pose a risk to these passages.

The balance of 3 passages per day is attributed to vessels destined for Dublin. These vessels have a closest point of approach of approximately 4.5 nautical miles in the south in way of the southern extremity of the Bray Bank. The closest point of approach along the eastern side of the bank averages 1.5 nautical miles. This area of the bank is well marked by the presence of the East Codling Red Can Buoy, the East Kish Red Can Buoy and the Kish Lighthouse. The assessment concludes that the risk of collision will be remote for the existing Dublin traffic navigating off the East Kish Buoy in relatively open deep water with the appropriate navigation lights fitted to the turbines.

- West Kish: The traffic operating to the west of the Kish Bank consists of approximately 12.5 passages per day. Of this total, 10 passages per day originate from Dublin. This traffic has a closest point of approach of 1 nautical mile at the southern extremity of the bank, while the remaining traffic maintains a distance of between 1 and 2 nautical miles from the western side of the banks. The assessment concludes that the risk of collision with structures in this area would be remote following the installation of the appropriate navigation lights on the turbine structures.

Trawlers: The Marine Navigation Impact Assessment notes that trawling on the Kish/Bray banks is negligible and once the wind farm is operational, bottom trawling on the banks would be discouraged. According to the Dun Laoghaire Harbourmaster, local fishermen fishing for whelks typically confine their activities to the Dublin Bay area, though this does extend to a lesser degree to the area around the Kish/Bray banks. There is no whelk fishing on the bank itself. On this basis it is considered that following the installation of the appropriate navigation lighting on the turbines, the risk of collision with the turbines by trawlers will be remote.

Recreational Traffic: Consultation with the various sailing clubs in the region has revealed that the majority of boats and dinghies favour inshore sailing within 3 kilometres of the shore and when engaged in racing do so in a well defined area within Dublin Bay. For those craft engaged in offshore or coastal racing (e.g. Round Ireland Race), the Irish Sailing Association (ISA), in consultations that were conducted as part of the Shipping Collision Risk Assessment study, indicated that the development would not cause concern for navigation, provided the development was adequately buoyed as per recommendations from the Commissioners of Irish Lights. Indeed it could act as an aid to navigation, given its size and location on a substantial underwater hazard.

Radar: In order to assess any consequential impacts for the safety of marine navigation the Developers commissioned QinetiQ Ltd to undertake a detailed assessment of the potential impact of the proposed development on ship and shore based radar systems. As part of the assessment a number typical ship based radar systems representative of the type normally used by the shipping traffic which had been identified in the Arcadis UK Ltd. report were analysed as well as the vessel traffic service (VTS) system operated by Dublin Port. The conclusions reached by QinetiQ in their assessment are based on modelling evidence provided by computer simulations of the impact of the development on generic S-Band and X-Band vessel based radar installations and on the X-Band VTS radar installation operated by Dublin Port which is based at the Bailey Lighthouse in Howth, approximately 10km northwest of the proposed development. A number of effects were investigated as part of the assessment including shadowing, probability of detection, receiver saturation and false plots. The assessment concluded as follows:

- It was found, given the number of turbines and their layout, that the effects of physical shadowing were likely to significantly degrade the detection performance of both the vessel and shore based radar systems of vessels on the opposite side of the wind farm. However, with relatively large gaps between the turbines where no such shadowing would occur, it was concluded that intermittent detection would be expected.
- On the basis of the above it was concluded that the Dublin Port VTS radar would experience a loss of detection for vessels to the south and east of the proposed wind farm. However, the Developers have consulted with the Dublin Port Company regarding the potential impact of this loss of detection on the operation of their VTS and they have confirmed that it will not be an issue for them. A copy of their correspondence confirming same is included in Appendix VI of the Arcadis UK Limited Report (Volume 3 – Attachment C).
- It was concluded that any radar systems operating in the area will detect the turbines out to the full range of the radar but that this is unlikely to be detrimental to the performance of the radar.
- It was also concluded that turbines in close proximity to each other are unlikely to cause false plots on a ships radar display. It further concluded that although unlikely, if any false plots were to occur, they would be contained within the region of the wind farm. The consequence of this event is that there may appear to be more turbines on a vessels radar display than actually exist but this would only be an issue for vessels trying to navigate through the wind farm itself. As previously noted, commercial vessels do not currently traverse the banks given the shallow water depths and such false plots are unlikely to be an issue on this basis.

A complete copy of QinetiQ's report entitled 'Kish and Bray Banks Wind Farm Radar Impact Assessment is included in Volume 3, Attachment C.

5.2.3 Mitigation Measures

The Developers will adopt the following mitigation measures identified by Arcadis UK Limited in their Marine Navigation Impact Assessment to address any potential risk to the safety of shipping and marine navigation associated with the construction and operation of the proposed Dublin Array Offshore Wind Farm.

5.2.3.1 Construction Stage Mitigation Measures

Design: The wind turbines will be spaced at a minimum of 500m apart in both the north south and east-west directions thereby rendering marine traffic in the area visible and detectable. As recommended in Section 11.4.4. of the Marine Navigation Impact Assessment prepared by Arcadis UK Limited, visibility of marine traffic at the four corners of the site will be enhanced by chamfering through the relocation of four turbines to less critical areas of the site as recommended by the Marine Survey Office.

Exclusion Zones: During the construction of the wind farm, designated work areas will be established around the area in which construction operations are taking place at a particular time and an Exclusion Zone implemented and marked in accordance with the IALA MBS (Maritime Buoyage System). The exclusion zone and associated construction activity will cover approximately 10% of the proposed wind farm site area at any one time and will be moved as the works are progressed. Implementation of the Exclusion Zone will be arranged through the Commissioners of Irish Lights and promulgated through Notices to Mariners.

Notification of Responsible Bodies: At least three months in advance of the erection of the wind turbines the following information will be made available to both the Irish Aviation Authority (IAA) and the Commissioners of Irish Lights (CIL):

- Estimated position of each turbine/structure to be erected.
- Estimated maximum elevation of each turbine/structure.
- Lighting details for each turbine/structure.
- Marking details for each turbine/structure.
- Conspicuity details (Radar Enhancer/Transponder/Reflector/AIS).
- Spacing between turbines/structures
- Estimated earliest date of erection
- Any other relevant information which may impact on air or marine navigation as appropriate

5.2.3.2 Operational Stage Mitigation Measures

Promulgation of Information: The positions and markings of the turbines and substations would be disseminated to all makers of navigation charts and coastal almanacs, such as UK Hydrographic Office, Imray and Reeds Almanac and will include general information to be agreed with the Commissioners of Irish Lights in relation to passing distances and warnings against mooring alongside structures and identifying any radar impacts where appropriate. Co-operation with all Irish ports and sailing associations along the east coast to promote a safety and awareness culture amongst Mariners and recreation craft owners navigating in the vicinity of the Dublin Array Wind Farm. Information provided will include a layout of the wind farm showing the numbering of the units and their position (Latitude and Longitude).

Marking of Wind Farm: The proposed development will be marked so as to be conspicuous by day or night giving due regard to prevailing visibility and traffic. The layout of the proposed wind farm is such that will facilitate the designation of specific turbines as **Significant Peripheral Structures** (SPS) representing the periphery of the wind farm for the purposes of installing the appropriate lighting and other navigational aids necessary to define the wind farm as identified below. The following additional marking requirements will apply to all turbines:

- High visibility yellow form high water mark to the specified level of the marine navigation protection lights.
- Double yellow bands as specified.
- Fog signals <u>may</u> be required to be fitted on Significant Peripheral Structures – this requirement will be agreed with the Commissioners of Irish Lights.
- Each turbine will be numbered with appropriately sized numerals conspicuously positioned.
- Notice boards would be placed on each turbine structure at a height clearly legible to all, forbidding the practice of mooring to the turbines. Such notice boards would also indicate the minimum safe distance at which a vessel should pass.

Lighting Requirements to Protect Marine Navigation Safety: Yellow navigation lights will be fixed to all wind turbines at a level above the Highest Astronomical Tide (HAT) but below the lowest point of rotation of the turbine blades. The lights will be visible throughout 360^0 in azimuth and for a distance of at least 5 nautical miles with a minimum availability of 99%. Turbines selected to represent the periphery of the wind farm, and be designated as Significant Peripheral Structures as noted above, will be spaced at intervals not exceeding 3 nautical miles. The lighting on these turbines will have a distinctive flashing characteristic and an increased visible range of 10 nautical miles.

Lighting Requirements to Protect Air Navigation Safety: High intensity aviation warning lights will be fixed at the highest point practicable on all designated Significant Peripheral Structures. Lights will comply with International Civil Aviation Organisation (ICAO) requirements.

Radar Enhancers/Reflectors: Significant Peripheral Structures may be required to be fitted with Radar Enhancers, Transponders, Reflectors and/or Automatic Identification Systems (AIS) as determined by the Commissioners of Irish Lights and the Irish Aviation Authority in order to facilitate marine and air navigation as appropriate.

Dublin Port – Vessel Traffic Service: Dublin Port operates a Vessel Traffic Service (VTS) which, by definition, is a service implemented by a competent authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service has the capability to interact with traffic and respond to traffic situations developing in the VTS area. Dublin Port VTS operators monitor and control traffic in the vicinity of the Kish / Bray bank and in this respect the existence of this VTS can be considered a mitigating factor in collision reduction.

5.2.4 Actual Impacts on Shipping and Navigation

Given the location of the proposed wind farm on the Kish and Bray Banks over which commercial shipping vessels do not currently navigate due to the shallow depths of water over same and subject to the adoption of the mitigation measures detailed in Section 5.2.3 above, it is not envisaged that the proposed construction of the Dublin Array Offshore Wind Farm will have a significant impact on shipping and marine navigation.

5.3 Submarine Cables and Pipelines

Given that Ireland is an island state, it is connected by several existing and proposed submarine power and telecommunications cables and gas pipelines to the UK, continental Europe and the USA. The operation, maintenance and development of these key utility connections is vital to the economic development of the state and it is important therefore that offshore wind farms and other renewable energy developments are located away from active and proposed cables and pipelines in order to enable utility owners access for any necessary maintenance and repairs.

5.3.1 Existing Environment

The Kingfisher Cable Awareness Chart (Irish Sea) (Fig. 5.2) identifies two active submarine telecommunications cables that landfall in Dublin Bay, namely ESAT2 and Hibernia 'D'. Two further active submarine telecommunications cables landfall to the north of Dublin Bay, Hibernia 'C' and Sirius South. There is also a redundant submarine telecommunications cable (BT-TE1) which also landfalls to the north of Dublin Bay. All of the above cables with the exception of Hibernia 'D' connect Ireland to the UK and are routed in a north easterly direction from their landfall site, well away from the proposed Dublin Array Offshore Wind Farm development on the Kish and Bray Banks. The Hibernia 'D' telecommunications cable passes to the north and east of the Kish and Bray Banks and runs in a southerly direction parallel to the east coast towards St. George's Channel.

The electrical interconnector currently being constructed by Eirgrid between Ireland and the UK landfalls at Rush in north Co. Dublin and runs in an easterly direction towards Barkby Beach in north Wales, again well away from the proposed Dublin Array Offshore Wind Farm development on the Kish and Bray Banks. There are two gas interconnectors, Interconnector 1 and Interconnector 2, connecting the Bord Gais network to the gas network in the UK. These come ashore at Gormanstown and Loughshinniy, both to the north of Dublin, well away from the proposed Dublin Array Offshore Wind Farm development on the Kish and Bray Banks (Fig. 5.3) and cross the Irish Sea in a north easterly direction towards Brighouse Bay on the west coast of Scotland.

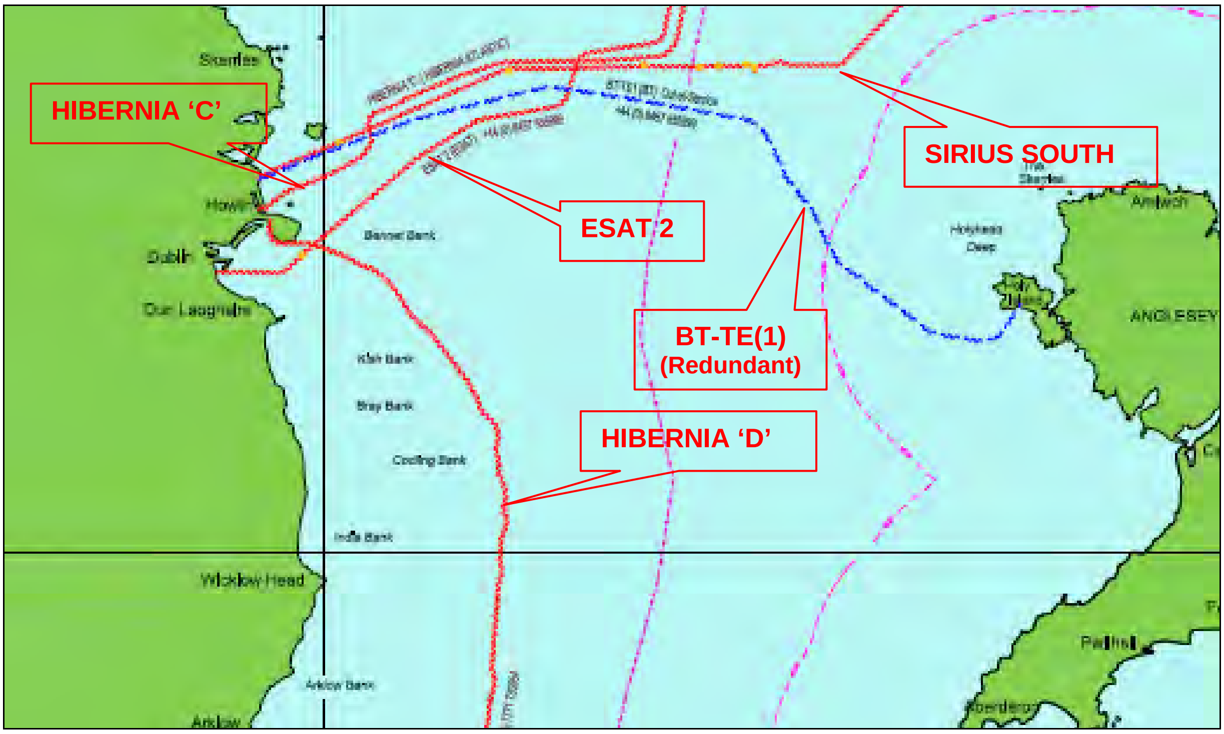


Figure 5.2 Submarine Telecommunications Cables
(Extract from Kingfisher Cable Awareness Chart (Irish Sea))

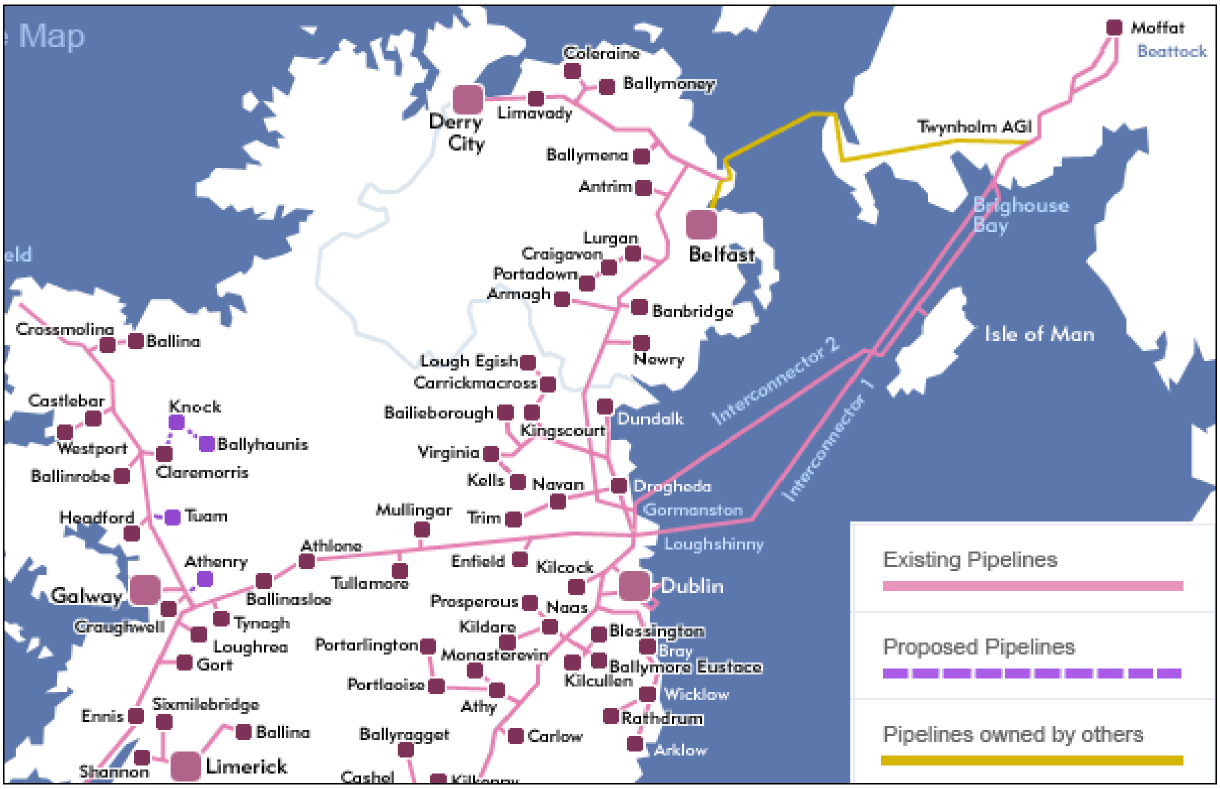


Figure 5.3 Gas Pipelines
(Bord Gais)

On the basis of the above it is concluded that there are no active submarine telecommunications cables, power cables or pipelines in the vicinity of the proposed Dublin Array Offshore Wind Farm development. Similarly, the proposed submarine cable between the wind farm and the proposed land fall site near Bray will not cross any existing such utilities.

5.3.2 Potential Impacts on Submarine Cables and Pipelines

Potential impacts on any submarine cables and pipelines in the vicinity of the proposed development could include:

- Direct damage caused by physical interaction with the cable or pipeline by anchors, jack-up vessels or during the preparation for and installation of turbine foundations and cables during the construction stage of the project.
- Reduced access to existing pipelines and cables for maintenance and repair activities during both the construction and operational stages of the project.
- Serious or fatal injury in the event of electrocution as a result of damage to existing power/telecommunications cables.
- Disruption to international communications as a result of damage to communications cable.
- Disruption to power supplies as a result of damage to power cable.
- Hazard to the environment associated with damage to gas or oil pipeline.

5.3.3 Mitigation Measures

The following mitigation measures have been adopted to avoid any adverse effects on cables and pipelines:

- The Developers have consulted the UK Hydrographic Office (UKHO) digital charted data, the Kingfisher Cable Awareness Chart (Irish Sea), Bord Gais, Eirgrid and international telecommunication providers (ESAT, Hibernia Atlantic, Virgin Sirius, etc.) regarding the location of existing power and telecommunications cables and pipelines in the vicinity of the proposed development.
- International Cable Protection Committee (ICPC) guidelines recommend that offshore wind energy developments should avoid existing cables and other such infrastructure by a minimum of 500m. No foundations structures to turbines and other associated infrastructure such as the offshore substation will be installed within 500m of any existing power or telecommunications cable.

5.3.4 Actual Impacts on Submarine Cables and Pipelines

Given the lack of existing submarine power and telecommunications cables and pipelines in the immediate vicinity of the Kish and Bray Banks it is not envisaged that the proposed Dublin Array Offshore Wind Farm will have any impact on the integrity of these utilities.

5.4 Aviation

5.4.1 Existing Environment

There are a number of licensed aerodromes and radar installations on the east coast in the vicinity of the Kish and Bray Banks as detailed in the table below:

Name	Facility	Location	Distance from Dublin Array
Casement	Military Aerodrome	South Co. Dublin	33.6 km
Dublin	Civil Aerodrome & Radar	Co. Dublin	25.3 km
Weston	Civil Aerodrome	South Co. Dublin	36.7 km
Newcastle	Private Aerodrome	Greystones, Co. Wicklow	12.6 km

Table 5.3 Aerodromes and Radar Installations on East Coast

5.4.2 Potential Impacts of the Proposed Development on Air Navigation

Given the significant height of the wind turbines above sea-level (max. c. 160m) the potential impacts of the proposed offshore wind farm development on air navigation are as follows:

- Interference with landing and takeoff procedures at the above aviation facilities.
- Physical obstruction to low level aircraft manoeuvres in the immediate vicinity of the proposed development including search and rescue and military operations and training.
- Interference with the operation of the navigation/radar facilities located at Dublin Airport.

5.4.3 Mitigation Measures

As part of the EIA consultation process details of the proposed development including turbine co-ordinates and max. blade tip heights were submitted to the Irish Aviation Authority (IAA) to enable them to evaluate the impact of the development on air navigation including take off and landing procedures at relevant aerodromes, radar installations and search and rescue operations and training. A response was received from the IAA stating that it had no objections to the proposed development. A copy of this response is provided in Volume 3, Appendix A.

As required by the IAA, the turbines would be lighted with aviation lights in accordance with OAM 09/02 "Offshore Wind Farms Conspicuity Requirements". These will comprise high intensity flashing white lights fitted at the highest point practicable on the turbine. The fittings will be effectively cut-off so that practically no light is emitted below the horizontal. As required under the Obstacles to Aircraft in Flight Order, S.I. 215 of 2005, notification of the erection of turbines would also be provided to the IAA.

5.4.4 Actual Impacts on Air Navigation

On the basis of the response from the IAA it is not envisaged that the proposed development will have a significant effect on the safety of air navigation.

5.5 Military Use of Area

5.5.1 Existing Environment

There are a number of Military Practice and Exercise Areas (PEXA) within Irish Territorial Waters used by the Defence Forces (Army, Navy and Air Corps) to practise manoeuvres, test armaments and to conduct other general exercises. The principal charted areas for this purpose are off the northwest and the south coasts and there are none in the vicinity of the proposed development.

There are three permanently defined areas off the Irish Coast used by the Department of Defence (DOD) as gunnery, bombing or firing ranges. These Danger Areas are located off the coast of Gormanstown, Co. Meath, Galley Head, Co. Cork and west of Bantry, Co. Cork. There are no such areas in the vicinity of the proposed development.

The Irish Naval Service is based on Haulbowline Island in Cork Harbour. The fleet comprises of a helicopter patrol vessel, five offshore patrol vessels and two coastal patrol vessels. Fishery protection patrols are undertaken on a daily basis throughout Irish Territorial Waters.

5.5.2 Potential Impacts on Military Use of the Area

Given the absence of designated Military Practice and Exercise Areas and Danger Areas in the vicinity of the proposed development and the shallow depth of water over the banks it is not envisaged that there should be any significant military use of the waters in the vicinity of the proposed development and there should be no associated impacts on this basis.

5.5.3 Mitigation Measures

As part of the consultation process for the EIA, the Department of Defence was informed of the proposed development and invited to comment on it. The Department provided confirmation that they have no objection to the proposed development. A copy of this correspondence is provided in Volume 3, Appendix A.

5.5.4 Actual Impacts on Military Use of the Area

On the basis that the Department of Defence has confirmed that it has no objection to the proposed development there should be no impact on military use of the area.

5.6 Television Reception and Broadcast Signals

5.6.1 Introduction

This section addresses the potential impacts of the proposed Dublin Array offshore wind farm development on the Kish and Bray banks on television reception and broadcast signals in areas that could be affected by the proposed development.

In order to examine the potential impacts of the proposed development on television broadcast services the Developers engaged GTech Surveys Ltd., a UK Midlands based broadcast and telecommunications consultancy, to conduct an impact assessment on their behalf. A copy of GTech's report entitled 'Television Reception Desktop Study & Broadcast Service Impact Assessment' is included in Appendix L, Volume 3 of this EIS.

The Developers also consulted with the main mobile phone network operators regarding any potential impacts of the proposed development on their networks. Copies of relevant correspondence are included in Volume 3, Appendix A.

5.6.2 Existing Environment

5.6.2.1 Television Broadcast Services

The GTech report provides an outline of television broadcast signals currently available in the study area. These include:

Analogue Terrestrial Television: Although analogue transmissions are still currently available in the study area it is noted that such signals are due to be switched off prior to the commencement of array operations. The proposed switch off of these signals is scheduled for October 2012 and is currently being communicated to the public in Ireland via a detailed advertising campaign in the print and broadcast media. Full details of the proposed switch to digital only television services is provided on Saorview's website (http://www.saorview.ie).

Digital Terrestrial Television (DTT): The areas around Dublin and north Wicklow are served by DTT transmissions from transmitters located at Three Rock, Kippure and Greystones. Depending upon their locations, residents in these areas are expected to receive interference free DTT reception from one of these transmitters. It is considered unlikely that such terrestrial transmissions will be available in the immediate vicinity of the proposed development location on the banks due to antenna tilt (used to minimise interference to coastal parts of UK), transmitter powers and the distance from the transmitters.

Digital Satellite Television (Freesat and Sky): Freesat and Sky digital satellite television services are provided by geostationary earth orbiting satellites positioned above the equator. For the reception of the 28.2E ASTRA satellite cluster, dish elevations of 21.4 degrees are required at this latitude. Optimal receive dish azimuths are 139.5 degrees with respect to true north.

5.6.2.2 Mobile Phone Transmissions

Although the advertised coverage for the main mobile phone networks does not extend to the area around the Kish and Bray banks it is possible that intermittent coverage may be received.

5.6.2.3 Marine Radar, Communications and Navigational Systems

Other potential telecommunications signals in the vicinity of the proposed development could include marine radar, communications and navigational systems. The potential impacts of the proposed development on such systems is addressed in section 5.2 of this chapter of the EIS.

5.6.3 Potential Impacts on Television Reception and Broadcast Signals

5.6.3.1 Mechanisms of Interference on Broadcast Services

The GTech report provides a description of the mechanisms of interference on broadcast signals. These include:

Analogue Television Interference: On the basis that analogue television services are scheduled to be switched off in the study area prior to construction of the Dublin Array, there should be no potential interference on analogue television reception associated with the construction and operation of Dublin Array.

Digital Terrestrial Television (DTT) Interference: The digital television broadcast platform offers many advantages over older analogue broadcast technologies. Due to the way picture signals are encoded and broadcast, digital television offers a much more resilient platform against the types of interference encountered by analogue television broadcast networks. The construction of digital signals ensures that they are much more impervious to the effects of interference from indirect secondary reflections, which consequently ensures good quality and coherent data stream integrity at the receiver, resulting in an interference free picture. Digital signals are also more robust to the interference effects created by moving wind turbine blades. Again, the structure of the signal ensures that the data stream is much less susceptible to the interference mechanisms wind turbines can generate for analogue services.

The GTech report noted that the BBC is currently investigating and quantifying the effects wind turbines have upon digital television signals and that although at the time of writing, this work was still ongoing, it is widely accepted that DTT is much more resilient to the effects of wind turbine generated television interference. It is also understood that wind turbine generated interference can reduce the reliability of DTT services if signal levels are low and bit error rates (BERs) are high. However, due to the structure of the digital signal (specifically relating to the 'guard interval' – a technical description of which is included in the Appendix to the GTech report), interference to DTT signals is almost practically impossible.

Digital Satellite Television Interference: Digital satellite services are provided by geo-stationary earth orbiting satellites positioned above the equator. To ensure good reception of satellite services, satellite receiver antennas (satellite dishes) are normally positioned away from trees and other clutter and are orientated to face the southern (south southeast) skies. Disruption to satellite television services is normally caused by an obstruction on the line of sight from the satellite to the receiver antenna e.g. a tall building or tall trees. Adverse weather can also influence reception and further details of weather based interference are detailed in the Appendix to the GTech report (Volume 3, Appendix L).

In the UK, Freesat and Sky services come from the 28.2 degrees east ASTRA 2A, ASTRA 2B and ASTRA 2D satellites. These three satellites occupy the same space and are collectively called the Astra Cluster. The transmission footprints of these satellites can be found in the Appendix to the Gtech Report (Volume 3, Appendix L). The report notes that while the exact satellite which Saorsat services will be broadcast from has not been revealed at the time of writing, it will have the ability to direct the signal beam over the island of Ireland, and only the island of Ireland.

Figure 5.4 below shows typical clearance distances and obstruction heights for interference free satellite television reception.

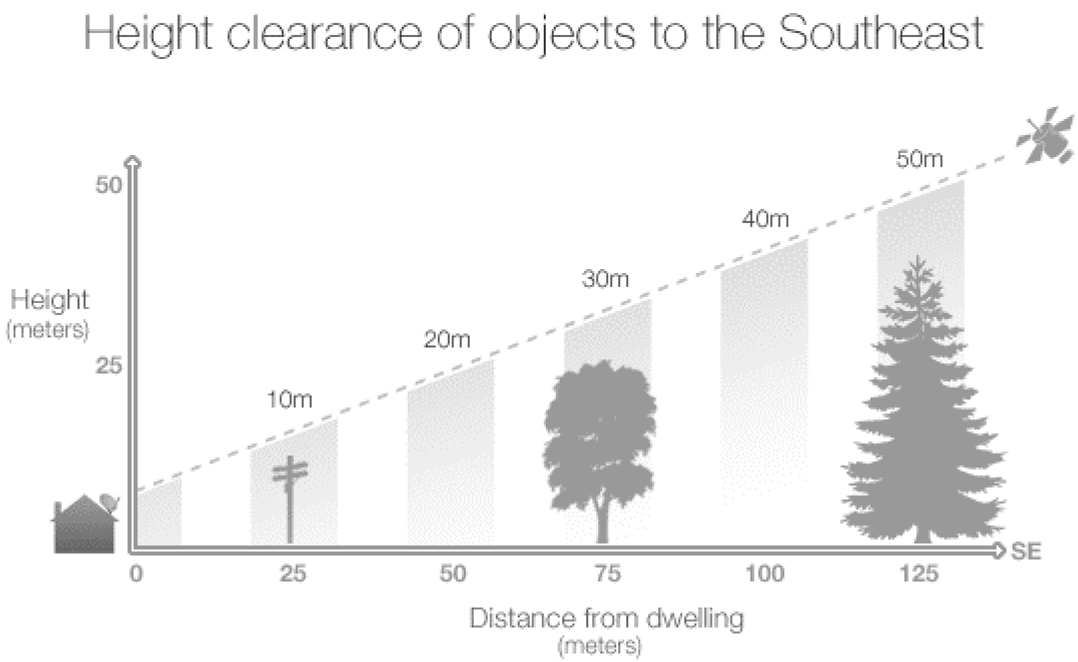


Figure 5.4 Typical Clearance Distances and Obstruction Heights for Interference Free Satellite Television Reception

Radio Frequency Scattering and Signal Reflections: Wind turbines can cause signal scattering from reflections and refractions caused by the rotating turbine blades and the actual structure. The magnitude of these unwanted reflections is dependent upon several factors – the angle of the incoming wanted signal to the orientation of the turbine blade, the amplitude of the incoming signal, the electrical 'reflectivity' of the structure, the frequency of the incoming signal and the speed of blade rotation. Consequently, accurate modelling is complex. With respect to television transmissions, two scatter zones are defined. The forward scatter zone is the area beyond the turbine with respect to the transmitter and the backscatter zone is the area between the wind turbine and the transmitter. Figure 5.5 shows these two zones.

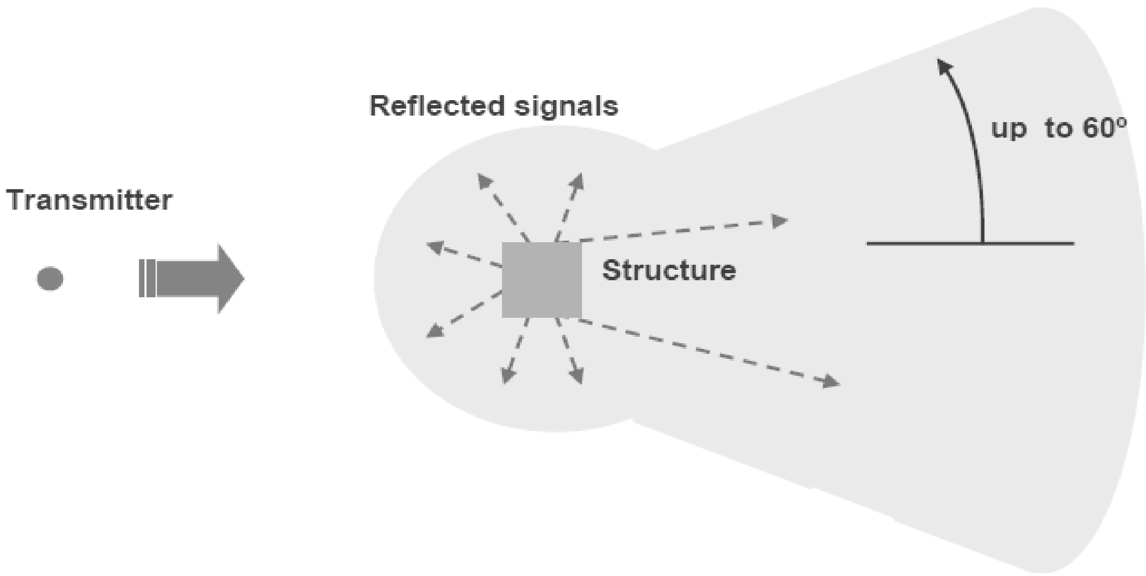


Figure 5.5 Scatter Zones Created by Reflecting and Refracting Surfaces

Consider Figure 5.6 below, the direct signal travels a distance P1 to the viewer, whilst the signal reflected from the structure travels slightly further, distance (P2 + P3). Although travelling at the speed of light, the different path lengths can mean that one signal arrives with a significant delay relative to the other.

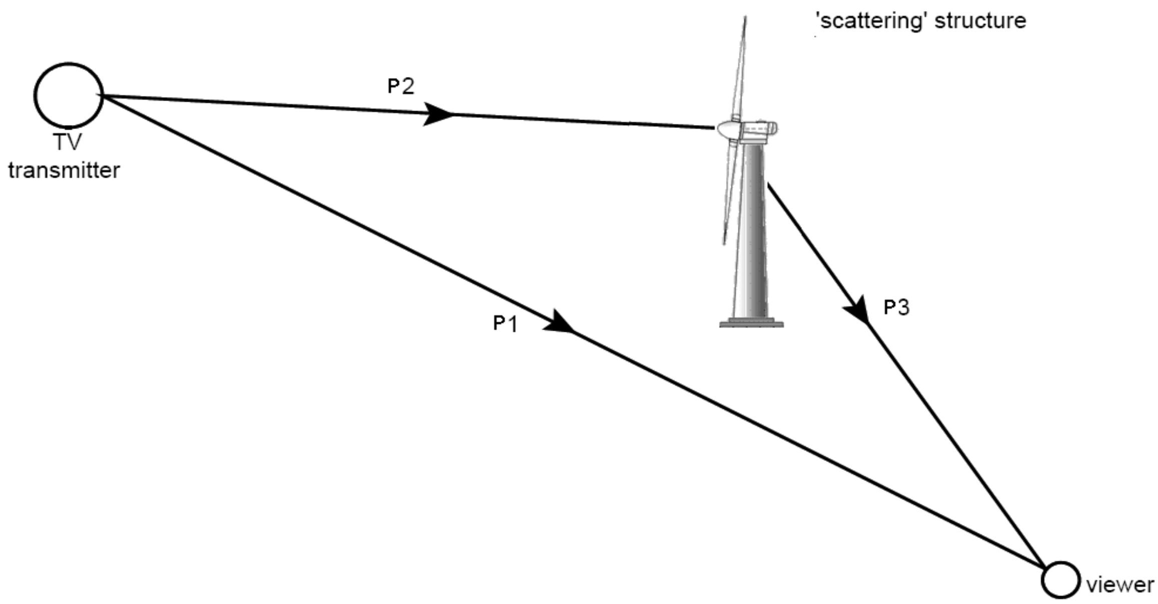


Figure 5.6 Direct and Indirect Signal Paths

To avoid interference it is necessary to ensure that the ratio of wanted signal along the direct path (P1) to the unwanted signal along indirect paths (P2+P3) is sufficiently high. Domestic Yagi type TV receiving antennas generally have a significant directional response to incoming signals, which means that the antenna may discriminate against interfering signals that arrive on significantly different bearings. This can result in an increase in the ratio of wanted to unwanted signal, as presented to the television receiver. Very little unwanted signal is received off bearing with a Yagi type TV antenna. This is shown in Figure 5.7

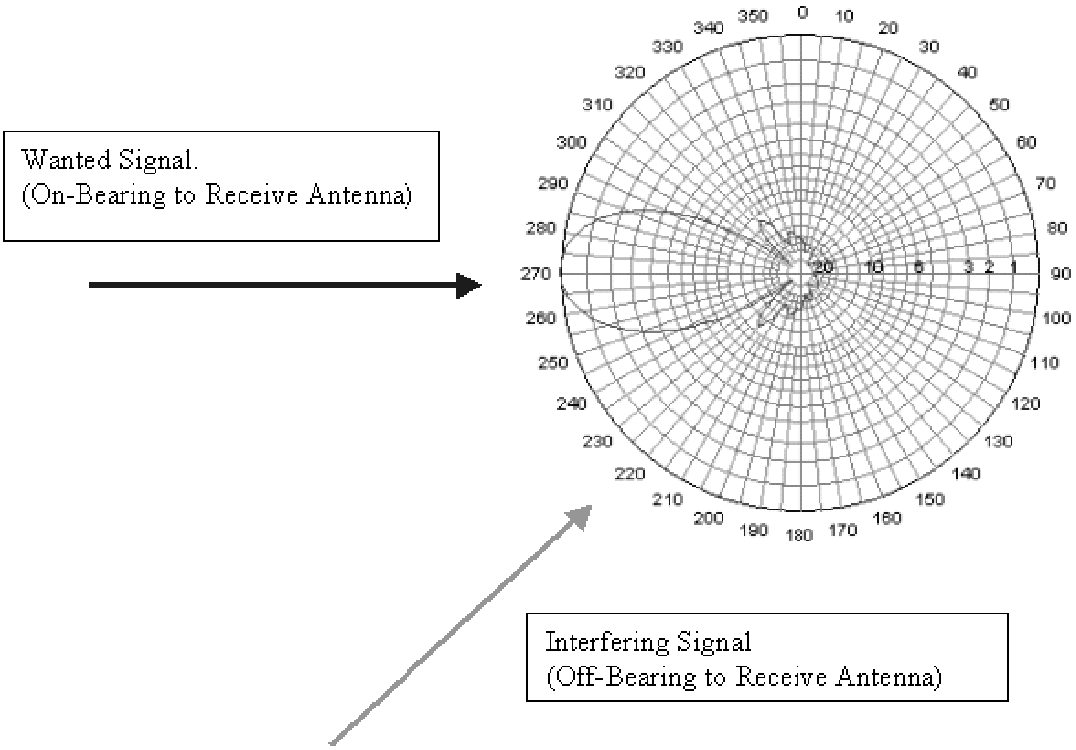


Figure 5.7 Domestic Yagi Receiver Antenna Response

5.6.3.2 Predicted Effects of Dublin Array on Broadcast Services

As part of the impact assessment carried out by Gtech, the potential impacts posed by Dublin Array on broadcast services were modelled (this modelling is further described in the Appendix to the GTech report – Volume 3, Appendix L). The predicted effects of the development on broadcast signals, as identified by this modelling were as follows:

Analogue Terrestrial Television: Given the scheduled switch to digital only television services, analogue signals will no longer be available once the wind farm is operational and consequently interference with analogue television broadcast signals by the proposed development would not be possible.

Digital Terrestrial Television (Saorview): Digital services are much less affected by signal reflections from moving wind turbine blades and the modelling undertaken by GTech indicated that DTT services are not at risk from signal interference generated from the development. They concluded that this is due to the proposed development's offshore location, the good coverage provided by the serving transmitters and the favourable proximity of residents with respect to the proposed development.

Digital Satellite Television (Freesat and Sky): Tall buildings and wind turbines can disrupt satellite reception by causing obstructions on the line of sight to the receiver dish from the serving satellite. Using the mathematical tangent function and based on the heights of the proposed wind turbines and the angle and orientation of the incoming satellite signals, interference to satellite reception could occur up to 540m in a northwesterly direction (320 - 330 degrees with respect to true north) of each turbine. However, as no satellite signal receiver dishes are located in these areas, GTech concluded that no interference to satellite television reception can occur.

5.6.3.3 Potential Impacts on other Mobile Phone Transmission Signals

Interference with mobile phone transmission has not been a problem resulting from onshore wind farms. Indeed mobile phone transmission operators have installed mobile telecommunications equipment at operating wind farms.

As noted above, the Developers also consulted with the main mobile phone network operators regarding any potential impacts of the proposed development on their networks. Copies of relevant correspondence are included in Volume 3, Appendix A.

5.6.3.4 Potential Impacts on Marine Radar, Communications and Navigational Systems

The potential impacts of the proposed development on such systems are addressed in section 5.2 of this chapter of the EIS.

5.6.4 Mitigation Measures

The GTech report concludes on the basis of the lack of predicted interference with television broadcast signals in the study area, that no mitigation measures are required.

The Developers have provided an undertaking to RTE, in the form of a standard protocol agreement that in the unlikely event of interference with television signals broadcast by RTE associated with the operation of Dublin Array that they will take the appropriate measures to address same. A copy of this Agreement is included in Volume 3, Appendix A.

5.6.5 Actual Impacts on Television Reception and Broadcast Signals

The GTech report (Volume 3, Appendix L) concludes on the basis of the desktop study undertaken by them on behalf of the Developers to assess the possible effects of the proposed Dublin Array offshore wind farm on the Kish and Bray banks on the reception of television broadcast signals that the actual impacts on the three television platforms that could possibly be affected will be as follows:

5.6.5.1 Analogue Terrestrial Television

As analogue transmissions in the area will be switched off prior to the development of the wind farm, it will not be possible for Dublin Array to have an impact on terrestrial television reception.

5.6.5.2 Digital Terrestrial Television (DTT)

The report concludes on the basis of the modelling (no viewers are located in any areas where interference could occur) and analysis of current likely reception conditions that the proposed development will not have any effect upon the reception of DTT services.

5.6.5.3 Digital Satellite Television

Due to the location of the proposed development relative to potential satellite signal receiver dishes, it is concluded that the proposed development cannot have any effect upon the reception of digital satellite television services such as Freesat or Sky.

5.7 Minerals, Oil and Gas

The potential impacts of the construction and operation of the proposed Dublin Array Offshore Wind Farm on the Kish and Bray Banks on aggregates and coal extraction and on oil and gas exploration are addressed in Chapter 4 of this Environmental Impact Statement.

5.8 Socio-Economic Effects

The potential Socio-Economic effects of the proposed development will be assessed in this Sub-Section of the Environmental Impact Statement under the following headings:

- Employment and Investment
- Tourism
- Fuel

The impact of the proposed development on Commercial Fisheries is addressed in a later Chapter of this Environmental Impact Statement.

5.8.1 Employment and Investment

5.8.1.1 Existing Environment

The Irish Economy is currently undergoing a significant recession with substantial increases in the level of unemployment in recent years. However the 'green economy' and in particular the significant energy resource associated with potential wind, wave and tidal energy projects within the Irish EEZ has been identified as a key potential contributor to Ireland's economic recovery.

5.8.1.2 Potential Impact on Employment and Investment

Positive impacts on the local, regional and Irish economy would result from the construction, operation and decommissioning of The Dublin Array.

A report commissioned by the National Offshore Wind Association of Ireland (NOW Ireland), completed by the leading international economic research agency, Indecon, in September 2008, estimated that the number of full-time jobs that result as a consequence of the installation of wind-energy is of the order of 5 jobs per installed 8 MW of capacity (based on 627 jobs for a hypothetical 1000MW wind farm studied). This is the estimated number of staff required to construct and service the wind farm and operate spin-off companies. This figure is lower than the corresponding figure for the wider EU area, because the manufacturing base for the wind-turbines is in Central Europe. A report by Deloitte in 2009 estimated the number of jobs to be created during both the construction and operation stages of wind energy projects in Ireland at more than 1 job per MW during construction and 0.5 jobs per MW for the lifetime of the wind farm. These jobs would primarily be local jobs and would, therefore, result in a boost to the local economy. Furthermore, these jobs would be technical, skilled jobs and jobs that could not be out-sourced to a cheaper part of the world, given the requirement for the operational staff to be local to the site.

5.8.1.3 Construction Stage Impacts

The design, construction and commissioning of Dublin Array would result in an investment in the region of € 2 billion, depending on the total capacity to be installed. The construction phase would involve a diverse range of business activities drawn from civil, marine, turbine and electrical engineering, as well as legal services, banking, environmental consultancy and support services. It is estimated that the construction phase of the project would employ over 600 people (2009 Deloitte & Touche) both onshore and offshore during the construction period. The local economy would benefit from the influx of construction workers during this construction period. Direct employment would also be created through the provision of support services such as shipping, transportation, rental of port facilities, environmental monitoring and plant hire.

5.8.1.4 Operational Impacts

The operational period would involve direct employment of a significant number of turbine and electrical technicians, operations and management staff in the local area throughout the lifetime of the wind farm. In addition there would be investment related to monitoring of the civil works and marine environment, including environmental surveys. A number of full-time turbine and electrical technician crews would be needed for maintenance purposes, along with teams for management and administration support. The technicians would be stationed onshore in close proximity to the wind farm and close to a harbour. The majority of these technicians would be recruited locally. In addition to the above employees, the technicians would need a boat and crew for transportation to and from the wind farm. The wind farm would also require operations staff to monitor and control the wind farm on a daily basis.

Indirect and ancillary jobs would also form part of the created employment resulting from the wind farm's installation. Jobs in supporting services to the technicians involved in monitoring (software, parts, shipping of hardware), administrative work (legal, recruitment services, ongoing banking), infrastructure operation & maintenance and upgrade (Irish Electricity Grid) would all be supported by the existence of a large project in full-time need of monitoring and human input.

It is estimated that over 250 full time jobs would be created for the lifetime of Dublin Array (2009 Deloitte & Touche).

5.8.1.5 Decommissioning

This would result in significant contracts to civil, turbine and electrical engineering contractors. The benefits to the local economy during the decommissioning phase would be similar to those of the construction phase.

5.8.2 Tourism

5.8.2.1 Existing Environment

Irelands coastal waters constitute a significant element of the country's attraction as a tourist destination for both domestic and overseas visitors and water based recreational activities generate significant benefits for the Irish economy. The Dublin and Wicklow coastlines have a well developed tourist infrastructure and numerous coastal attractions which include coastal walks, watersports, sea angling, recreational beach use and wildlife watching. Landscape, seascape and visual amenities, which are intrinsic to the areas ability to attract tourists are addressed in Chapter 11 of this Environmental Impact Statement.

5.8.2.2 Potential Impacts of Development on Tourism

On the basis that the marine environment, seascape and resources play an important role in many tourism and recreation activities, any impact on the coastal or marine environment through the construction or operation of the proposed offshore wind farm development on the Kish and Bray Banks has the potential to have an effect on the tourist industry and recreation. Potential effects are discussed below:

Noise: Noise generated during the construction of the wind farm could potentially have direct and indirect effects on recreation and tourism, although the effects will be limited to the duration of the construction works the noise detected onshore during construction will most likely be within the guidelines for urban areas. The main direct effect is related to disturbance that will be experienced by visitors to key coastal attractions/locations (e.g. beaches and coastal paths) and key coastal and marine recreational activities (e.g. golf, sailing, swimming and water-sports). The issue of noise associated with the construction and operation of Dublin Array Offshore Wind Farm is addressed in Section 5.1 of this Environmental Impact Statement.

Landscape and Seascape: The landscape, seascape and views along the Dublin and Wicklow coastlines are intrinsic to the area's ability to attract tourists and visitors. While the turbines would not be visible from many of the most popular visitor attractions in the area, such as much of the Wicklow Mountains, Glendalough and the Vale of Avoca, there would be distant views of the turbines from a number of elevated sites, such as the Great Sugar Loaf, and from much of the coastline. The potential impacts of the proposed development on the landscape and seascape are addressed in Chapter 11 of this Environmental Impact statement.

Water Quality: Any water pollution or impact on water quality associated with the construction of the wind farm could have an effect on tourism. Potential impacts on water quality are addressed in Chapter 12 of this Environmental Impact Statement.

5.8.2.3 Public Attitudes

A recent survey commissioned by Sustainable Energy Ireland, "Attitudes Towards the Development of Wind Farms in Ireland", indicates that there is a high level of support among the general public for the construction of more wind farms in Ireland, with two thirds of Irish adults favourably disposed to having a wind farm built in their locality. Among those living in proximity to an existing wind farm, over 60% were found to be in favour of a second wind farm or of an extension to an existing one. This represents a strong vote in favour of wind farm developments. It is especially important since it is voiced by those who know from direct experience about the impact of such developments on their communities. There was very little opposition found for reasons of scenic beauty or tourism. The 'Not in my back yard' effect appears not to be a major factor in the wind farm catchment areas. Indeed the positive effects of the wind farms are strongly endorsed by the local communities.

A survey undertaken by the Developers of an offshore wind farm at North Hoyle in the UK found that 50% of businesses surveyed believed that the development would encourage tourism and 40% believed that it would neither encourage nor discourage tourism.

Similarly, a MORI survey of tourists in Scotland (MORI Scotland, 2002) found that wind farms not only co-exist happily with tourism, but that they can have a beneficial effect, helping to promote a positive image of an area and encouraging repeat visitors. It implied that the majority of tourists would judge an area positively for using its resources to generate renewable energy. 43% thought the wind farms had a positive effect on the area, compared to only 8% who thought there was a negative effect (43% thought the effect was equally positive and negative). 80% of tourists said they would be interested in visiting a wind farm visitor centre.

There is no evidence to suggest that wind farms negatively affect tourism or that tourists would be discouraged from visiting any amenities due to the presence of a wind farm. In fact it is anticipated that the construction of an offshore wind farm would prove an attraction to visitors, with tourists being likely to travel to coastal areas or elevated positions to get a view of the development. Additional potential for tourism includes boat trip tours of the development.

5.8.3 Commercial Fisheries

The impact of the proposed development and the mitigation measures proposed to minimise the impact on commercial fisheries in the area is discussed in detail in Chapter 7 of this EIS.

5.8.4 Fuel Issues

5.8.4.1 Fuel Cost

The Indecon Report estimates the cost of fuel used to generate electricity in Ireland over the next 18 years (in which is contained the majority of the projected life of the proposed project). The findings are predicated on various growth-rates of, in particular, the economy. However, based on a combination of the possible growth-scenarios for the next two decades, the findings of the report indicate that the cost of primary electricity-generating fuels will increase by 225% over the period 2008-2026, which reflects a 35% increase, in real terms – accounting for the devaluing effect of inflation – of the price of fuel, and therefore, electricity.

The cost of the base fuel for wind-energy is static (at zero) and it is implausible that this will change. Therefore, by the end of the period analysed by Indecon, the fuel-cost of generating electricity by conventional means will increase by this factor, that of wind-energy will not have changed. Indeed, the Indecon report, for a range of different economic projections – both in terms of economic development and energy usage – estimates fuel cost savings over the lifetime of a generic 1,000MW offshore wind capacity to be in the range of €2.7bn to €4.1bn.

5.8.4.2 Security

The fuel supply is not dependent upon the international market but, rather, is a natural resource indigenous to Ireland. Therefore, the security of the energy supply is far superior to that of fossil fuels, which depends upon global demand and international relations at any given time. It is strongly in the national interest to move from unpredictable sources towards energy independence; to do so by displacing fossil fuels would help to secure the long-term energy future of Ireland as well as reducing the country's environmental impact.

5.8.4.3 Carbon & International Environmental Agreements

Analysis by the Developers indicates that the cost of Carbon, that would otherwise be generated by the use of fossil fuels to generate electricity, is of the order of €20million per annum. Based on SEI estimates of the future cost of Carbon production (which are conservative compared to Indecon's estimates), the cost of Carbon production will increase by 11% per annum more than the rate of inflation. The cost of the Carbon production, based on these estimates over the years 2013 to 2026, is likely to be in the region of €1.5billion. Put in the perspective of today's monetary value, this represents a real-cost doubling every five years based on an energy usage increase of 1.4% per annum. This cost-analysis is based on the purchase price of carbon production credits and ignores completely any costs associated with possible effects of climate change.

Finally, international agreements such as the Kyoto Protocol and, more recently, the EU 2020 targets – to reduce CO_2 emissions by 20% by 2020, on which Ireland is a signatory, state that Ireland must reduce its emissions of greenhouse gases to proscribed levels. These agreements are legally binding and Ireland is subject to penalties in the event that these targets are not reached. The proposed development would be a crucial step in the achievement of the targets, as it would provide 5-8% of the country's electricity needs, all from a non-carbon producing source.

5.9 Recreational Activities

The Kish and Bray Banks do not host much recreational activity. The activities that are known to take place on or near the banks are recreational sailing and possibly sea angling. The effects of the proposed development on recreational sailing have been considered in Section 4.2 of this EIS. Apart from a requirement on the part of recreational craft to avoid the safety zone during the construction phase of the project, there would be no adverse impact on recreational sailing. Indeed the wind farm may be viewed as a new attraction or curiosity for pleasure craft to visit. There would be no restrictions on sea-angling in the area of the development. Since there are no adverse impacts arising from the proposed development to recreational activities, no mitigation measures are proposed.

5.10 Traffic

The construction and operation of the proposed Dublin Array Offshore Wind Farm on the Kish and Bray Banks is likely to lead to an increase in both marine and road traffic. The potential impact of the proposed development on shipping and navigation is addressed in Section 5.2 of this Chapter of the Environmental Impact Statement. This section will address the potential impact of the proposed development on road traffic.

5.10.1 Existing Environment

Dublin Port, which is likely to be used as the base for most of the shore based activities associated with the construction and operation of Dublin Array Offshore Wind Farm, is well connected to the national road network and in particular the Dublin Port Tunnel, which was opened in 2006 and which provides fast and direct access to the strategic M50 and M1 routes within minutes of the Port. With over 13,000 HGV movements per day into and out of the Port, the Tunnel has assisted in removing congestion within the Port Estate and in the environs of the Port. In recent years the Dublin Port Company has also invested significantly in improving the road network within the Port itself to facilitate the efficient movement of goods to and from the various terminals and facilities in the Port. In addition to reducing congestion within the Port and reducing the impact of HGV traffic on the City Centre, the strategic investment in both the Dublin Port Tunnel and the upgrading of the M50 have both assisted in reducing the times involved in moving goods to and from the Port. Although the level of freight currently transported to and from the Port by rail is comparatively low compared to that by road, the Dublin Port Company has maintained and developed the main rail infrastructure within the Port and rail offers a viable alternative to the delivery of goods to the Port.

5.10.2 Potential Impacts of the Proposed Development on Traffic

Potential impacts of the construction and operation of Dublin Array on traffic include the following:

- Disruption to existing traffic flow associated with abnormal loads should the major turbine components be delivered by road to Dublin Port.
- Additional traffic associated with construction of concrete caisson foundations including concrete and reinforcement deliveries, construction personnel, etc. should this option be selected for the foundations to the turbines. As detailed in Section 3.6.1, given water depths in excess of 15m at many of the turbine locations, each foundation could involve volumes in excess of c.2500 m^3 of concrete and c.250 tonnes of steel reinforcement which would involve up to 750 traffic movements (c. 375 deliveries) per base associated with material deliveries alone.

- Additional traffic associated with delivery of rock armour to Dublin Port for loading onto specialist vessels for onward delivery to Dublin Array for use in scour protection around the turbine foundations. As outlined in Section 2.3.4. the final volume of scour protection required at each base will depend on further geotechnical investigations, water depth, scour protection method adopted and final detail design of same for each base. Given the likely use of monopiles with rock armour scour protection as detailed in Section 2.3.4 typical rock armour volumes are likely to be in the order of 250–600 m^3 of filter rock and 500–1000m^3 of rock armour per turbine. The material would be sourced from a quarry in the Dublin/Wicklow region and delivered to the site via the M50 and Dublin Port Tunnel. It would involve c. 50 to 150 articulated truck movements per turbine on this basis.

- Additional traffic associated with construction personnel travelling to and from the Port during the construction stage of the project.

- Additional traffic associated with maintenance personnel travelling to and from the Port during the operational stage of the project.

5.10.3 Mitigation Measures

The following mitigation measures would be adopted to limit the impact of the construction and operation of Dublin Array on vehicular traffic in the vicinity of Dublin Port and the Dublin Area.

- All of the major turbine components including towers, nacelle, generators and blades will be delivered by sea either directly to the wind farm site on the Kish and Bray Banks or to Dublin Port for offloading, storage, pre-assembly and loading onto specialist vessels prior to delivery to the site. This will avoid any abnormal loads associated with the delivery of such components by road to Dublin Port.

- Given the water depths at the proposed turbine locations on the Kish and Bray Banks and the nature of the sandy substrata it is likely that monopile foundations will be adopted for the proposed turbine foundations. Similar to the major turbine components, these components (including the steel transition piece) will be delivered by sea either directly to the wind farm site on the Kish and Bray Banks or to Dublin Port for offloading, storage, prefabrication to required lengths and loading onto specialist vessels prior to delivery to the site. The use of monopile foundations as the foundation solution on Dublin Array will avoid the substantial HGV traffic movements that would be associated with construction of concrete caisson foundations onshore prior to delivery to the site.

- A detailed Traffic Management Plan will be put in place for the construction stage of the project and agreed with the relevant authorities including the Dublin Port Company, Road Authorities and the Gardai prior to the commencement of the construction works.

- The Developers will follow any agreed constraints regarding the timing of deliveries of any abnormal or oversized loads to the Port.

5.10.4 Actual Impacts on Traffic

Given the fact that most major deliveries, including turbine components and foundations, associated with the construction of Dublin Array Offshore Wind Farm on the Kish and Bray Banks will be by sea either directly to the wind farm site on the Kish and Bray Banks or to Dublin Port for offloading, storage, prefabrication to required lengths and loading onto specialist vessels prior to delivery to the site, the main HGV deliveries to the Port will be those associated with delivery of rock armour for scour protection along with miscellaneous smaller quantities of other materials. It is not envisaged that the traffic movements associated with such deliveries (c. 50-150 traffic movements per turbine for rock armour) will have a significant impact on existing traffic movements at the Port or in the greater Dublin area given that the recent investment in road infrastructure including the Dublin Port Tunnel and upgrading of the M50 enables the Port to currently handle up to c. 13,000 HGV movements per day.

Similarly, it is not envisaged that the slight increase in passenger vehicle traffic movements associated with personnel travelling to and from the Port during both the construction and operational stages of the project will have a significant impact on traffic given that there are currently over 4000 people employed in the Port area.

The impacts on traffic during decommissioning would be similar to those experienced during construction with most major components being removed by sea rather than by road.

5.11 Health & Safety

The design, construction, operation and decommissioning of the wind farm would be carried out in accordance with the Safety, Health and Welfare Act at Work (Construction) Regulations 2006 and the Irish Wind Energy Association (IWEA), Best Practice Guidelines.

5.11.1 Construction

Potential risks to health and safety arising from the construction phase of the wind farm would be confined to the construction personnel, since the public would not be permitted access to the construction site. The main risks to construction personnel are:

- Traffic safety during the transportation of oversized loads;
- Working at heights;
- Use of cranes;
- Use of electricity;
- General construction safety; and
- Marine construction safety.

The potential risks to the health and safety of construction personnel would be addressed by ensuring that best practice in health and safety is followed. A site-specific health and safety statement would be prepared for the construction of the project in accordance with the Safety, Health and Welfare Act at Work (Construction) Regulations 2006. The procedures outlined in the health and safety statement would be enforced by the site manager.

5.11.2 Operation

5.11.2.1 Turbine Access

While the public would, ordinarily, not have access to the wind farm due to the offshore location of the turbines, access would be required for maintenance crews and for visitors to the wind farm. Vestas, the Danish wind turbine manufacturer, were consulted with regard to how best provide safe access onto the offshore turbines.

Safe access to the turbines would be provided through a landing platform located on the outside of the turbine tower that is clear from tides and the wave zone. Each turbine would be fitted with a ladder, protected by boat fenders, which would be used to gain access to the tower's landing platform. Depending on the length of the ladder, intermediate resting platforms may be installed. Typically, there is an intermediate rest platform located 8 metres above mean sea level. The main access platform is located a further 18 metres above the rest platform. The ladder, which would be used to gain access from the rest platform to the main access platform, would be fitted with a steel rope for the use of a personal fall arrest system. From this platform the inside of the tower can be accessed. The minimum requirements for the work platform at the tower door are as follows:

- A minimum surface of 3 m x 3 m in front of the door;
- A minimum bearing capacity of 20,000 kg;
- A hatch over the manhole to the access ladder, preventing personnel from falling from the platform;
- The manhole to the ladder must be at least 0.8 m x 0.8 m; and
- Sufficient railing.

Entry to the turbines from the access platform would be through a hatch door. This would be locked at all times. Should the weather conditions deteriorate rapidly once personnel are working on the wind turbine, it would be necessary for the crew to remain on the wind turbine until the conditions render it safe to exit. The wind turbines would be fitted with accommodation, drinking water and two means of communication (UHF and a dedicated mobile phone). In addition, all boats used to access the turbines would carry grab packs with emergency rations and equipment so that the crew could survive in relative comfort if necessary. From within the turbine, access to the nacelle would be provided by means of an internal ladder or an elevator lift.

Access to the wind turbines from onshore would be achieved either by boat or by helicopter. This access would be controlled by strict operational procedures to be put in place by the turbine manufacturer.

Vestas Danish Wind Systems provided a summary of the operational procedures that they use to gain access to their offshore wind turbines by boat. The procedures consist of the following:

Turbine Access Operational Procedures - Summary
It is ensured that all vessels used for wind turbine access are suitable for making safe personnel transfers. All vessels must be fitted with a crew finder beacon location device. The Operations and Maintenance Manager controls access to the turbines and all visits to the turbines have to be authorised by this person. Any access to the turbines is carried out by a team, such that there is a minimum of two people on a turbine at any given time. The actual number of people on the access boat is limited by the capacity of the boat. Typically, personnel are transferred from shore to the turbines using a ‘Man Over Board’ (MOB) boat. This type of boat allows for a close mooring to the turbine tower. Its specifications are as follows: Length 8-10 metres, width 2-3 metres, service speed at 25-30 knots; The boat transports up to 6 technicians; The boat is equipped with first aid facilities; and The boat is equipped with radio equipment. There are two levels of access to the turbines, *routine* and *visitor*.

Maintenance work is carried out under routine access.
In order to be allowed this type of access, personnel have to be competent as follows:
Be physically fit, in good health, and able to climb a ladder;
Have completed successfully a Marine Transfer Course; and
Have completed successfully an Induction Session provided by the turbine manufacturer.

The Marine Transfer Course would be run by locally experienced personnel or as part of a course to be run by the turbine manufacturer.

Visitor access is designed to allow persons not fully trained in marine access to visit the turbines during periods of good, calm weather. The company aims to minimise this type of access because of the inherent risks. To be allowed visitor access a person must be:
Physically fit, in good health, and able to climb a ladder;
Able to use personal protective equipment correctly; and
Accompanied by an authorised person.

The boat remains near the turbines for the duration of the visit.

Visitor Access Requests - Prior to the visit each person is required to fill in an access request form stating justification, time of visit, duration, and the personnel involved. A minimum team of two people is required for each visit. The weather conditions are checked and recorded on the access request, and access only permitted if weather conditions are deemed suitable. The personal protective equipment to be used is checked and recorded on the visit form.

Communications - Each work team on a tower must have two means of communication; UHF and a dedicated mobile phone. The transfer vessel must also have the same working frequency. The vessel master is responsible for maintaining the personnel transfer list that records all transfers and changes of location. The vessel master reports passengers' ID numbers on departure to the marine co-ordinator. This person is responsible for ensuring that the same people are on board when returning to shore as were present when going offshore.

All personnel must use the following personal protective equipment during the access procedure:

- Lifejacket
- Flotation Suit
- Head Protection
- Gloves
- Safety Footwear
- Fall Arrest System

The Developers would ensure that the procedures outlined above would be enforced to minimise the risk to health and safety of the public and maintenance personnel in gaining access to the wind turbines.

As is the case for personnel, equipment can be transferred to the wind turbine either by boat, or by helicopter should this means be available. Large equipment (such as gearboxes / generators) would typically be transferred using dedicated supply boats.
The transfer of equipment from the service boats to the turbines would be facilitated using cranes. For routine equipment transfer between the boat and the turbine platform, the turbine platform would be equipped with a 250 kg electrical hoist, which can hoist

directly from the deck of the boat onto the platform. From the platform, the equipment can then be hoisted to the nacelle by using the nacelle service crane, which can lift up to 800 kg. The nacelle crane can also hoist directly from the deck of the boat, which would allow for heavier loads to be lifted directly from the service boat. The Developers would require that contractors use best health and safety practice for working at heights and for use of cranes when transporting equipment to the wind turbines.

5.11.2.2 Storm Damage

The Developers plan to use only well-proven three-bladed turbines certified by agencies such as Germanischer Lloyd that have not suffered problems from storm damage. These turbines would be built with the potential for unusually high wind speeds in mind (up to 70 m/s). During such conditions (experienced less than once every 100 years on average) it would be extremely hazardous to be anywhere out of doors or at sea. Such hurricane conditions would result in widespread destruction of dwellings and infrastructure. Nevertheless, these wind turbines are designed to survive such winds.

5.11.2.3 Icing

In cold winter storm conditions, rime ice can build up on exposed structures. On wind turbines operating in these conditions the ice can fly off the tower, nacelle or moving blades with the risk of injury to anybody being struck by this ice. This is an issue for wind farms at high altitude or in cold countries and is not considered a potential problem for offshore wind farms or in temperate latitudes. In Ireland such rime ice rarely forms at altitudes below 600 m although it is frequent on stationary structures at altitudes above 800 m. The Kish and Bray Banks are at sea, reducing to negligible the possibility of such icing.

5.11.2.4 Wind Turbine Design

The components of a wind turbine are designed to last for 20 years and are equipped with a number of safety devices to ensure safe operation during their lifetime. The turbines are also fitted with lightning protection.

The rigorous safety checks imposed on the turbines during design, construction and commissioning would ensure that the risks posed to humans by the turbines are negligible.

5.11.2.5 Marine Vessels

It is not anticipated that the workings of the turbines would present any danger to any shipping, sailing or fishing activities in the area. The Maritime Safety Division of the relevant Government Department would be contacted regarding the production of a marine notice that would describe the works and give construction commencement and completion dates. The notice would be forwarded to the Maritime Safety Division at least four months prior to works commencing. The Developers would ensure that all vessels employed over the course of the development would comply with all statutory regulations. Vessels used to carry persons employed by the contractors to and from the site would have a passenger boat licence if carrying 12 persons or less and a passenger vessel certificate if carrying more than 12 persons. All the appropriate certificates would be forwarded to the Maritime Safety Division for review.

5.11.2.6 Aviation

The turbines would be fitted with navigational aids to ensure air navigation safety as discussed in Section 5.4 of this EIS. Lighting would be in accordance with the OAM 09/02 "Offshore Wind Farms Conspicuity Requirements" as provided and interpreted for the Kish and Bray Banks by the Irish Aviation Authority and the Commissioners of Irish Lights.

5.11.2.7 Electromagnetic Radiation

Electrical generators, located within the nacelle of the wind turbine, emit electromagnetic radiation. The levels of electromagnetic radiation that are emitted are no more than are emitted from a standard diesel generator. There is no evidence to suggest that electromagnetic radiation of the strength generated by wind turbines can be injurious to human health. Such fields are commonplace in built-up areas, factories and farms throughout the country and arise from standard substations, transformers, overhead lines and similar installations.

5.11.3 Visibility of Navigation Lights

Because these structures need to be lit at night for navigation safety purposes, there is a possibility that the view from the land of these lights at night could be viewed as light pollution. However, the development will take place in an existing environment of a busy shipping area with several existing static navigation lights, such as the Baily Lighthouse, the Kish Lighthouse and the East Kish buoy. In addition, it is proposed to vertically restrict the coverage of the lights in a westerly direction so that they have minimal, if any visibility, close to or on the coast.

6 CULTURAL HERITAGE/ARCHAEOLOGY

6.1 Introduction

Both the Kish and Bray Banks are areas of high potential for underwater archaeology, particularly in the form of shipwrecks as the banks have presented natural navigation hazards for several centuries and represent the final resting place of a large number of vessels that have foundered due to bad weather, grounded on the banks at low tide or a combination of both. Pre-development archaeological assessment of development in a marine environment, such as the proposed Dublin Array Offshore Wind Farm on the Kish and Bray banks, is required under the EU Environmental Impact Directives 85/337/EC and 97/11/EC.

Wrecks greater than 100 years old and archaeological objects found underwater are protected under the National Monuments (Amendment) Acts 1930 to 1994. The Act also allows the imposition of an Underwater Heritage Order to protect sites of historical, archaeological or artistic importance. This can include wrecks less than 100 years old (e.g. RMS Lusitania, sunk May 1915, was placed under such an order in 1995). Under the Merchant Shipping (Salvage and Wreck) Act 1993 the Director of the National Museum of Ireland (NMI) has a statutory role regarding dealing with notifications from receivers of unclaimed wreck and the retention on behalf of the state of unclaimed wreck if it is of archaeological interest.

As part of the consultation process for the Environmental Impact Assessment, the Developers consulted with the Development Applications Unit of the Department of the Environment, Heritage and Local Government (DoEHLG) and were advised that the area to be impacted should be subject to an underwater archaeological impact assessment, the scope of which was included in the written correspondence received from the Development Applications Unit, in advance of any works taking place.

The Developers engaged Hydrographic Surveys Ltd and Headland Archaeology Ltd to undertake an underwater archaeological assessment of the areas to be impacted which included the Kish and Bray Banks, the seabed for the cable route from the banks to the foreshore, the foreshore itself and immediate land areas selected for the proposed cable landfall. The scope of the assessment included the following:

- Detailed desk-based study undertaken by Headland Archaeology to examine the archaeological potential of the Kish and Bray Banks, the route along which the cable would pass en route to the shore and two potential landfall sites being considered at that stage. The desk-based study included:

    - Review of Sites & Monuments Record (SMR) and Record of Monuments & Places (RMP) in order to identify any recorded monuments in the vicinity of the proposed landfall sites.

    - Various literary and documentary sources were consulted including the Shipwreck Inventory of Ireland being prepared by the Underwater Archaeology Unit at the Department of Environment, Heritage and Local Government and Lewis' Topographical Dictionary (Lewis 1837). A full list of the references consulted is provided in the bibliography on pages 23/24 of the Archaeological Assessment prepared by Headland Archaeology Ltd. in Volume 3, Appendix D.

- Review of various records of shipwrecks including *Shipwrecks of the Irish Coast, Volumes 1,2 and 3* (Bourke 1993,1998 and 2000), *National Wreck Register* (OPW), and *www.irishwrecksonline.net.*

- Cartographic sources including 1st edition Ordnance Survey map, 1829-41(6”:1 Mile), 2nd edition Ordnance Survey map, 1887-1913(25”:1 Mile), Record of Monuments and Places map, Discovery Maps #50 and #56 and Admiralty Chart #1468.

- The Archaeological Excavations Bulletin, an annual fieldwork gazetteer for Irish Archaeology was checked for a record of any licensed archaeological investigations carried out within the townlands surrounding the proposed landfall sites between 1970 and 2004.

- Geophysical survey comprising a high-resolution side-scan sonar survey, magnetometry survey, sub-bottom profile survey and bathymetric survey of the area of the proposed wind farm on the Kish and Bray Banks was undertaken by Hydrographic Surveys Ltd. between the 13th June 2008 and 19th September 2008 under Licence from the Department of Environment Heritage and Local Government (Licence No. 08R113). A copy of their report is included in Appendix 9 of the Archaeological Assessment Report prepared by Headland Archaeology Ltd. in Volume 3, Appendix D of the EIS.

- Geophysical survey comprising a high-resolution side-scan sonar survey, magnetometry survey, sub-bottom profile survey and bathymetric survey of the proposed cable route from the wind farm to the shore was undertaken by Hydrographic Surveys Ltd. between the 13th June 2008 and 15th September 2008 under Licence from the Department of Environment Heritage and Local Government (Licence No. 08R113). A copy of their report is included in Appendix 10 of the Archaeological Assessment Report prepared by Headland Archaeology Ltd. in Volume 3, Appendix D of the EIS.

- The results of the above geophysical surveys were reviewed by Dr. Dan Atkinson of Headland Archaeology (UK) Ltd., in order to identify any targets which may be deemed to be of cultural heritage interest within the survey area. Sites and features of cultural heritage interest are those that represent activities, features or objects that indicate human activity or the remains of such that survive within the archaeological record. This might include relict prehistoric landscapes and evidence of past human occupation and activity, or features, objects or artefacts that relate to past historic activity; for example all forms of maritime losses and their artefacts such as vessels and aircraft and remains of maritime installations (e.g. docks, harbours, breakwaters, piers and jetties). A copy of Dr. Atkinson’s report is included in Appendix 11 of the Archaeological Assessment Report prepared by Headland Archaeology Ltd. in Volume 3, Appendix D of the EIS.

- The foreshore and terrestrial areas due to be impacted by the transmission cable landfalls onshore were subject to a metal detector survey, undertaken by Headland Archaeology Ltd. in October 2008. The survey was intended to assess the potential sub-surface archaeology at the two potential landfall sites being considered at that stage. A copy of Headland Archaeology’s report on the metal detector survey is included in 12 of the Archaeological Assessment Report prepared by Headland Archaeology Ltd. in Volume 3, Appendix D of the EIS.

This chapter of the EIS summarises the findings of the above assessments. The complete archaeological impact assessment report prepared by Headland Archaeology for the proposed development is included Volume 3, Appendix D.

Following the selection of Landfall A as the preferred location for the export power cable from the wind farm to come ashore, and having identified a potential cable route across Shanganagh Park to the public road network on the R119 Regional Road to the west of the Park, the Developers engaged Headland Archaeology Ltd. to undertake an Archaeological, Architectural and Cultural Heritage Impact Assessment of the proposed cable route across Shanganagh Park. A copy of their report entitled 'An Archaeological, Architectural and Cultural Heritage Impact Assessment of a Proposed Development Site Close to the Cable Landfall for Dublin Array' is included in Volume 3, Appendix D. A summary of the findings, as appropriate, are included within this Chapter.

Given the proposed routing of the export cable from the wind farm along public roads between the exit point from Shanganagh Park onto the R119 until the proposed connection point to the National Grid at Carrickmines Substation there should be no impacts on Cultural Heritage and Archaeology associated with that section of the cable route.

6.2 Existing Archaeological Environment

6.2.1 Kish & Bray Banks

The Kish and Bray Banks are part of a series of coast-parallel north-south oriented offshore banks in the western Irish Sea (Wheeler *et al*., 2000). They are situated about 10 km offshore and rise to within a few metres of the surface. The series of banks are broken by gaps maintained by currents and sediment movements. While they offer wave protection to the coast they also form a shipping obstruction and numerous shipwrecks have been recorded since the eighteenth century. This section identifies potential archaeological features within the vicinity of the proposed wind farm on the Kish and Bray banks.

6.2.1.1 Record of Shipwrecks

The review of records of shipwrecks undertaken by Headland Archaeology identified a considerable number of shipwrecks recorded in the general area of the Kish and Bray banks. A total of forty-four entries were identified which specifically refer to the Kish Bank and these are listed in Section 3.4 of Headland Archaeology's report. However, many of the other wrecks listed in the various surveys (Bourke 1998; Bourke 1994; National Wreck Register, etc.) have relatively vague details as to their exact location with many being listed as being 'near Dublin' or 'off Bray'. It is possible that some of these wrecks may be within the vicinity of the proposed development on the Kish and Bray banks and they are listed in the Appendices to Headland Archaeology's report on this basis. It is noted that several ships are listed as wrecked on the Wicklow Bank, a term which is not identified on the Admiralty charts and which is no longer in use. It is assumed it is an old name for one of the banks off the Wicklow coast but it is difficult to say to which bank it refers. Details of shipwrecks on this bank have been included in the Appendices to the Headland Archaeology report as they may potentially be impacted on by the proposed development.

6.2.1.2 Side Scan Sonar Survey Results

The side scan sonar survey data recorded by Hydrographic Surveys Ltd. (HSL) in the vicinity of the Kish and Bray banks is presented as a series of mosaics on charts HS:59A-1/08 to HS:59A-5/08 in Volume 3, Appendix D (Figures 5-9).

A brief background on this area as extracted from the Anglesey Sheet 1:250,000 series produced jointly by the British Geological Survey and the Geological Survey of Ireland describes the Kish and Bray banks as the largest sand bank located off the east coast of Ireland. The area is approximately 18 km long and is characterised by a strongly asymmetrical cross-section with a steep east facing slope.

The seabed sediments comprising this bank are broadly classified as sand of medium to low acoustic reflectivity. The following characteristics have been observed from the side scan records collected by HSL during the course of their survey.

At the northern limit of the survey area the top of the bank is found towards the western side of the area limits, while progressing southwards the top of the bank appears to migrate towards the east. The most obvious and dominant features found on the banks are sand waves. Wave lengths and heights vary from wavelengths of between 100 to 175m and heights of 1-4m towards the north of the banks to larger wavelengths and reduced heights of 1-1.5m moving south. Descriptive notes have been appended to the charts to give indications of the average wavelengths and heights observed while bathymetric contours have also been included to illustrate the asymmetrical nature of the bank.

6.2.1.3 Magnetometer Results

The results of the magnetometer survey recorded by Hydrographic Surveys Ltd. (HSL) on the Kish and Bray banks are presented on charts HS:59B-1/08 to HS:59B-5/08 in Volume 3, Appendix D (Figures 10-14).

A total of 23 targets (ref. Kish 1 to Kish 23) were identified by Hydrographic Surveys Ltd. which they considered could be of potential archaeological significance. These targets were annotated onto both the side scan sonar and magnetometer interpretation charts and listed in Table 1 of their report along with grid position, image and other descriptive information including proximity to and potential impact on proposed turbine locations. Five turbine locations were considered to fall within a nominal exclusion zone of c.100m around these targets.

6.2.1.4 Review of Geophysical Data by Archaeo-Geophysicist

The review and analysis of the side-scan and magnetometer data undertaken by Dr. Dan Atkinson of Headland Archaeology (UK) Ltd. identified a further nine possible targets (ref. KB24 to KB32) for consideration.

6.2.2 Cable Route to Shore

As part of the proposed development a cable route will extend along the sea-bed from the proposed offshore substation on the Kish Bank to one of two potential landfall points north of Bray, Co. Wicklow. Two potential landfall locations for the cable were identified, Landfall A at Shanganagh, Co. Dublin (NGR 326353/221319) and Landfall B at Ravenswell, Co. Wicklow (NGR 326750/219407). Similar to the banks, there is potential for impacts on submarine archaeological features along this route.

6.2.2.1 Record of Shipwrecks

As noted in section 5.2.1.1 above, a large number of shipwrecks have been recorded off the Dublin and Wicklow coast and are listed in the various surveys (Bourke 1998; Bourke 1994; National Wreck Register, etc.), but have relatively vague details as to their exact location with many being listed as being 'near Dublin' or 'off Bray'. It is possible that some of these wrecks may lie along or within the vicinity of the proposed cable route from the offshore substation to the shore. As noted previously, detailed lists of all shipwrecks identified in the desk-based study are included in the Appendices to the Headland Archaeology Ltd. report in Volume 3, Appendix D.

6.2.2.2 Side Scan Sonar Survey Results

The side scan sonar survey data recorded by Hydrographic Surveys Ltd. (HSL) along the proposed cable route is presented as a series of mosaics on charts HS:59A-6/08 to HS:59A-7/08 in Volume 3, Appendix D (Figures 21-22).

The following characteristics have been observed from the side scan records collected by HSL during the course of their survey along the proposed cable route to the shore.

The seabed to the east of Landfall A at Shanganagh, Co. Dublin is characterised by course deposits with rock outcrops and boulders present close to the shore. The interpreted boundary between these course deposits and a relatively smooth seabed dominated by finer deposits has been marked on HS:59A-6/08 and occurs approx. 1.5 km from the shore. The seabed closest to Landfall B at Ravenswell, Co. Wicklow appears smooth with some rock outcrops or potential targets. The seabed appears relatively smooth and featureless where the proposed route divides with sand waves occurring east of the divide. Wavelengths and heights of these vary ranging from 50-150m long and 1-3m high. Moving east towards the bank, the sandwaves decrease in size and the seabed in HS:59A-7/08 is dominated by ripples in the northern section with smoother and more featureless seabed towards the south. Bathymetric contours are included on the charts and indicate a generally gently sloping seabed with 5m contours 50-450m apart.

6.2.2.3 Magnetometer Results

The results of the magnetometer survey recorded by Hydrographic Surveys Ltd. (HSL) along the proposed cable route are presented on charts HS:59B-6/08 to HS:59B-7/08 in Volume 3, Appendix D (Figures 23-24).

A total of 11 targets (ref. Cable 1 to Cable 11) were identified by Hydrological Surveys Ltd. along the route of the cable which they considered could be of potential archaeological significance. These targets were annotated onto both the side scan sonar and magnetometer interpretation charts and listed in Table 1 of their report along with grid position, image and other descriptive information including proximity to and potential impact on proposed turbine locations. It should be noted that all of the targets identified were located towards the western end of the cable route close to the shore and that no significant targets were identified on a section approximately 8.3m long leading from the bank westwards towards the shore.

6.2.2.4 Review of Geophysical Data by Archaeo-Geophysicist

The review and analysis of the side-scan and magnetometer data undertaken by Dr. Dan Atkinson of Headland Archaeology (UK) Ltd. identified one further possible target (ref. KC12) for consideration.

6.2.3 Landfall A – Shanganagh, Co. Dublin

The proposed cable route from the wind farm will come to shore at one of two potential landfall locations north of Bray, Co. Wicklow. The first (Landfall A) is located in the townland of Shanganagh, Co. Dublin (NGR 326353/221319) and the second (Landfall B) is located at Ravenswell, Co. Wicklow (NGR 326750/219407). Along much of the coastline north of Bray, the Harcourt Street to Bray Railway formerly followed the cliff edge until its closure in 1958. Following its closure a new line was built further inland, a position it still occupies today. It is clear that this stretch of coastline has been subjected to rapid and extensive erosion which would have had a detrimental impact on any archaeology on or near the foreshore. The current foreshore was, until very recently, some distance inland and between 10 and 20m above existing ground level. The exact rate of erosion is difficult to determine accurately, but the present location of the old railway line in relation to the foreshore indicated the extent of erosion. Adjacent to Landfall A, the remains of the old line are still visible on the very edge of the cliff but are currently fenced off due to the risk of collapse. Here, the new line is some 400m inland from the beach. As a result of the erosion the current coastline is "new". The recovery of maritime artefacts deposited on the beach would be unlikely and any archaeological material identified along this coastline is more likely to have originated inland.

The following potential archaeological features were identified in the desk-based study and field survey undertaken by Headland Archaeology Ltd.

6.2.3.1 Sites & Monuments Record and Record of Monuments & Places

The Sites & Monuments Record (SMR) consists of Ordnance Survey 6" maps with annotated known and suspected archaeological sites that generally pre-date AD 1700. The SMR was collated from documentary sources; various editions of Ordnance Survey maps; aerial photography, historical and archaeological literature, the seventeenth century Down Survey and Civil Survey maps, eighteenth century estate maps and folklore/oral traditions. The National Monuments Act (1994) made provision for a Record of Monument & Places (RMP). The RMP is a revised set of SMR maps, on which newly discovered sites have been added and locations which proved not to be of antiquity have been de-listed by the National Monument Service.

There are no recorded monuments corresponding with the grid references provided for Landfall A at Shanganagh, Co. Dublin. However, there are a number of monuments within 500m of the proposed landfall site. These are listed in the RMP as follows:

Monument no.	Grid ref.	Townland	Description
DU026-055001	326354/221792	Shanganagh	Martello Tower
DU026-055002	326354/221795	Shanganagh	Defensive redoubt site

Table 6.1 Recorded Monuments within 500m of Landfall A

Additional monuments recorded within 1 km of Landfall A included a castle (DU026-120), a *fulacht fiadh* (DU026-116) and a series of ecclesiastical monuments; a church (DU026-054001), a graveyard (DU026-054-002), a cross (DU026-054003) and an additional building (DU026-054005).

6.2.3.2 Literary and Oral Sources

The proposed location of Landfall A is in the townland of Shanganagh, in the parish of Rathmichael, Co. Dublin. In Lewis' Topographical Dictionary (Lewis 1837) he refers to the parish of Rathmichael as a place that 'attained a considerable degree of importance in the early period' with the vicars choral of St. Patrick's, Dublin claiming as their ancient inheritance the town of Shanganagh. The wealth of archaeological remains within the parish was commented on as follows:

'The remains of a line of castles and entrenchments may be traced, commencing on the lands of Shanganagh...and continued over the mountain beyond Rathmichael to Ballyman; in such as yet exist, the vaults appear to have bee centred with wickerwork. There are also several Druidical relics in the neighbourhood; also the ruins of Puck's Castle and that of Shankill, said to have been besieged by Cromwell and near which have frequently been found human skeletons and coins of the reigns of Chas. I and Jas. I.'

6.2.3.3 Other Cartographic Sources

In addition to the SMR and RMP maps outlined above, other cartographic sources can also be important in tracing land use patterns within a proposed development site as well as providing important information on the topography and archaeological potential of an area. A number of maps were consulted for information about the area around Landfall A.

1st edition Ordnance Survey map, 1829-41, 6": 1 Mile

The Martello tower (DU026-055001) is listed on this edition of the map in Shanganagh townland. The defensive redoubt (DU026-055002) is not listed, however a line on the map to the west of the Martello tower running parallel with the shoreline may suggest its presence.

The nearby Shanganagh Castle (DU026-120) is listed on this edition of the map in Shanganagh townland. Kiltuck church is listed as being 'in ruins', its graveyard cross and associated ecclesiastical remains are not identified.

2nd edition Ordnance Survey map, 1887-1913, 25": 1 Mile

The Martello tower (DU026-055001) is listed on this edition of the map in Shanganagh townland. Again the defensive redoubt (DU026-055002) is not listed nor is it represented by any markings on the map.

The nearby Shanganagh Castle (DU026-120) is listed on this edition of the map in Shanganagh townland. Kiltuck church is listed as being 'in ruins', the crosses (DU026-054003) are also listed in this edition of the map. The graveyard and associated ecclesiastical remains are not identified.

Discovery Map # 50

Only the Martello tower (DU026-055001) is listed on this map.

6.2.3.4 Previous Archaeological Investigations

The Archaeological Excavations Bulletion was checked for a record of any licensed archaeological investigations carried out in the townlands surrounding Landfall A between 1970 and 2004. No recorded investigations were identified.

6.2.3.5 Metal Detector Survey

Headland Archaeology Ltd. conducted a metal detector survey of the two potential landfall sites in October 2008. The objective of the metal detector survey was to assess the archaeological potential of the landfall locations by looking for metal find concentrations deposited on the beach and immediately inland. It was considered that a metal detector survey of the beachfront from the high water mark to 25m inland over a width of c. 100m centred on the intended cable route would be sufficient to identify any areas of potential finds. The survey was carried out to the highest professional standards as laid out in *Geophysical Survey in Archaeological Field Evaluation, English Heritage Research and Professional Services Guideline No.1*(2nd ed.) (English Heritage 2008). A copy of Headland Archaeology Ltd's report on the results of the metal detector survey is included in Appendix 12 of their main Archaeological Assessment report (Volume 3, Appendix D).

Landfall A was found to be heavily eroded exposing clearly defined stratification on the cliff face which is immediately above the high water mark. Unfortunately the height of the cliff top above the beach level precluded detailed investigation, however on visual inspection Headland Archaeology considered the area to be archaeologically sterile. According to local sources the area was until recently under tillage and has since been purchased by Dun Laoghaire-Rathdown County Council and converted into an amenity area with planted trees, viewing benches, a pathway and lawn. Immediately adjacent to the edge of the cliff are the remains of the old railway line.

The results of the metal detector study from the amenity area show a spread of metal fairly evenly along the site with no obvious concentrations. On the beachfront itself the northern extent does contain a slightly greater number of hits than the southern extent but the entrance to the beachfront is immediately north of the survey. Therefore it is likely that concentrations of modern refuse will be higher in this area. It was apparent at the time of the survey that the level of non-archaeological debris on the surface was much higher in the north.

As there is no stable beach front the occurrence of artefacts was considered unlikely. The erosion of the cliff face and lack of deposition of material by the tides means that the metal detector hits are most likely associated with the dumping of modern materials and not of archaeological significance.

6.2.4 Landfall B – Ravenswell, Co. Wicklow

The second potential landfall site location for the proposed cable route from the wind farm to come ashore (Landfall B) is located at Ravenswell, Co. Wicklow (NGR 326750/219407). This area has undergone significant land disturbance in the relatively recent past, associated with the construction of the DART line, approx. 20m to the west in the early 1980’s. The landfall location is adjacent to a breakwater constructed from large limestone boulders in order to provide protection from coastal erosion to a complex of workshops and a storage compound on a level plateau above the shoreline.

The following potential archaeological features were identified in the desk-based study and field survey undertaken by Headland Archaeology Ltd.

6.2.4.1 Sites & Monuments Record and Record of Monuments & Places

There are no recorded monuments corresponding with the grid references provided for Landfall B at Ravenswell, Co. Wicklow. However, there are a number of monuments within 500m of the proposed landfall site. These are listed in the RMP as follows:

Monument no.	Grid ref.	Townland	Description
DU026-124	326638/219461	Bray Golf Links	Possible linear earthwork
DU026-070	326715/219835	Bray Golf Links	Martello Tower
DU026-068001	326181/219568	Corke Abbey	Abbey
DU026-068002	326181/219572	Corke Abbey	Graveyard
DU026-069	326179/219480	Corke Abbey	Holy Well

Table 6.2 Recorded Monuments within 500m of Landfall B

Landfall B is located approx. 70m southeast of the zone of potential of one of the above sites, the possible linear earthwork. It is recorded on the SMP as part of the Pale boundary, SMR 26:124, however other evidence suggests a possible connection with the nearby Corke Abbey to the north or Ravenswell House to the south.

6.2.4.2 Literary and Oral Sources

The proposed location of Landfall B is in the townland of Ravenswell, in the parish of Bray, Co. Wicklow. The Martello tower, DU026-070, is mentioned in the Ordnance Survey Namebooks for Co. Dublin as is the site of Corke Abbey DU026-06801.

‘In East of townland of Great Cork. A very fine looking house situate[d] on rising ground which is covered with ornamental trees. The seat of Col. Wingfield.’

The Ordnance Survey letters also mention the site of Corke Abbey and its graveyard, DU026-06802.

‘A little distance on the road to Dublin you turn to the right into Corke Abbey, the residence of Col .Wingfield. They say that the house is built on the site of the old Abbey the ruins of which were pulled down for that purpose some forty years ago, and they show the site of the old burial place a little south and west of the house. Head stones and bones have been often dug up here.’ Eugene Curry.

A site of architectural heritage is also known in the area however it is almost 500m west of the proposed landfall point and should not be impacted upon by the proposed development.

6.2.4.3 Other Cartographic Sources

In addition to the SMR and RMP maps outlined above, other cartographic sources can also be important in tracing land use patterns within a proposed development site as well as providing important information on the topography and archaeological potential of an area. A number of maps were consulted for information about the area around Landfall B.

1st edition Ordnance Survey map, 1829-41, 6": 1 Mile

The possible linear earthwork (DU026-124) is not listed on this edition of the map. The map shows that the feature was part of a network of footpaths leading west from the adjacent former Ravenswell House to the sea, and indicated as 'footpath on top of bank'. In addition, part of the feature marks the line of the present county boundary between Dublin and Wicklow. Ravenswell House is also listed on this map.

The Martello tower (DU026-070) is listed on this edition of the map in the townland of Cork Great. Corke Abbey (DU026-06801) and the nearby holy well (DU026-069) were also listed on this edition of the map.

2nd edition Ordnance Survey map, 1887-1913, 25": 1 Mile

The possible linear earthwork (DU026-124) is not listed on this edition of the map, nor is the Martello tower (DU026-070). Corke Abbey is listed as 'on site of Abbey' and the holy well (DU026-069) to the south of the ecclesiastical remains is listed as a 'well'.

The buildings of Ravenswell House are present on this edition of the map, though they are identified as Ravenswell convent and Ravenswell School.

Discovery Map # 56

None of the aforementioned sites of archaeological or architectural interest are listed on this map.

6.2.4.4 Previous Archaeological Investigations

The Archaeological Excavations Bulletin was checked for a record of any licensed archaeological investigations carried out in the townlands surrounding Landfall A between 1970 and 2004. Two excavations have been carried out in the vicinity of potential Landfall B, details of which are included in the Archaeological Assessment Report prepared by Headland Archaeology Ltd. (Volume 3, Appendix D).

6.2.4.5 Metal Detector Survey

Landfall B is much closer to Bray than Landfall A and was affected by several factors which render the metal detection survey of limited validity. These included a history of littering and dumping in the area as well as evidence of construction waste (including plastic sheeting, rebar, rubble, etc.) associated with the levelling and consolidation of the area undertaken to facilitate the construction of the DART line. The selectivity of the metal detector was increased and a pattern designed to try and discrimate against ferrous and aluminium (caused by bottle tops and cans) in order to achieve meaningful results. However, there were still a considerable quantity of hits in the area. It was impossible to differentiate between modern debris and potential archaeological material due to the extent of dumping and levelling in the area. These factors in conjunction with the extent of erosion of the cliff face led Headland Archaeology to conclude that there were unlikely to be undisturbed archaeological remains present in the area of Landfall B.

6.2.5 Onshore Cable Route across Shanganagh Park

The area surrounding the proposed cable route across Shanganagh Park comprises a coastal plain which forms part of the green belt area around Dublin between the urban settlements of Shankill and Bray. At the east of the area is a pebble and shingle beach which leads to steep cliffs of up to 10m height. The land to the west of the cliffs is fairly level with gradual slopes up to around 15m OD. Most of the land is under recreational use as grass parkland with some areas of trees and playing fields and is zoned as such in the County Development Plan. The grounds around the 18th century Shanganagh Castle, which are zoned for housing development, are located to the north-west of the area. To the south-west is Shanganagh cemetery and to the south-east is Woodbrook Golf Course.

Most of the site remains undeveloped with field boundaries persisting since the first edition Ordnance Survey map was surveyed in 1837. Significant construction undertaken during the urbanisation of the adjacent area of Shankill to the north will have had an effect on cultural heritage within this area. The use of the land to the south for Shanganagh cemetery and development of both the historic Dublin and Southeastern railway and the modern DART rail-line within the proposed development site will have had a direct impact on any sub-surface archaeology. Coastal erosion is active at the proposed cable landfall to the east.

The following potential archaeological features were identified in the desk-based study and field survey undertaken by Headland Archaeology Ltd.

6.2.5.1 Designated Archaeological Monuments - Records of Monuments and Places (RMPs)

There are 11 recorded archaeological monuments, one of which is also a protected structure, in the RMP incorporated by the study area, which for the purpose of the assessment has been defined as extending to within 1km of the proposed development for National Monuments and Recorded Archaeological Monuments. There is one further recorded archaeological monument which does not have a precise location but is recorded within Shanganagh townland. Of the monuments with known locations, none are located within the proposed development site. None of these RMPs are National Monuments and none have Preservation Orders placed on them.

The earliest evidence for human activity represented by these monuments dates from the Bronze Age. This is in the form of a fulacht fiadh site (CH 10), which was excavated in advance of a housing development around 1990 to the north□east of the proposed cable route. The remains of two fulachta fiadh were excavated but no report was submitted to the database of excavation reports and so no additional information about this site is known. These excavations also recovered deer bones from within a rectangular enclosure. This lay to the west of the fulacht fiadh site was identified from aerial photographs as surrounding the church site (CH 1). The material recovered was consistent with an ecclesiastical foundation. The church site comprises the upstanding remains of the stone church (CH 1) reputed to have been established by St. Tucha; it is mentioned in the papal bull of 1179. Low masonry walls of three sides of a rectangular building survive to a height of 0.65m. Associated with this church is a graveyard (CH 2), of which there are no upstanding remains, a stone cross base (CH 3), two stone crosses (CH 4 and CH 6) and a further building (CH 5).

There is little information available about the isolated burial in the townland of Old Connacht (CH 12) and this could date from any period from prehistory onwards.

The remaining monuments date from the post□medieval period. The upstanding building of Shanganagh Castle (CH 11) was constructed in the 1760s, although this replaced an earlier ruinous tower. This earlier structure could date to the late medieval period, possibly a towerhouse, however the evidence for this is entirely anecdotal. The present building has additions which were constructed in modern times. The grounds associated with the castle retain many landscape features shown on Ordnance Survey maps and some of these were noted in the field survey.

On the coast to the north of the proposed cable route is the site of a Martello Tower (CH 7) and defensive redoubt (CH 8). Neither of these monuments remains upstanding and both are likely to have been removed by coastal erosion. A water mill (CH 9) recorded on the Down Survey was located in the townland of Shanganagh. No precise location for this monument is known and there is no other information about it. Further details about the monuments can be found in Appendix D to the Headland Archaeology Report.

6.2.5.2 Designated Architectural Heritage Sites – Record of Protected Structures

The Dún Laoghaire□Rathdown County Development Plan (2010□2016) was consulted for schedules of Protected Structures. These are buildings that a planning authority considers to be of special interest from an architectural, historical, archaeological, artistic, cultural, scientific, social, and/or technical point of view. Protected Structures receive statutory protection from injury or demolition under Section 57 (1) of the Local Government (Planning and Development) Act 2000. Protected structure status does not exclude development or alteration but requires the developer to consult with the relevant planning authority to ensure that elements which make the structure significant are not lost during development.

There are eight Protected Structures within the study area (please refer to Section 4.2: Study Area). These include Shanganagh Castle (CH 11) which is also recorded on the RMP. In the Record of Protected Structures it is noted as a ‘house, castle and gate lodge’. The former gate lodge of Shanganagh Castle is noted in the Record of Protected Structures as Crinken Cottage (CH 17). This building is located to the north of the present gate lodge. A further four houses are listed in the Record of Protected Structures. These are Beauchamp House (CH 13), Askefield House (CH 14), Rosedale House (CH 18) and Locksley (CH 19). Saint James’s Church along with its railings and gates (CH 15) and the building of Shanganagh Marble and Stone Centre (formerly Hackett Memorial Hall) along with its railings and gates and a granite milestone (CH 16) are also included in the Record of Protected Structures.

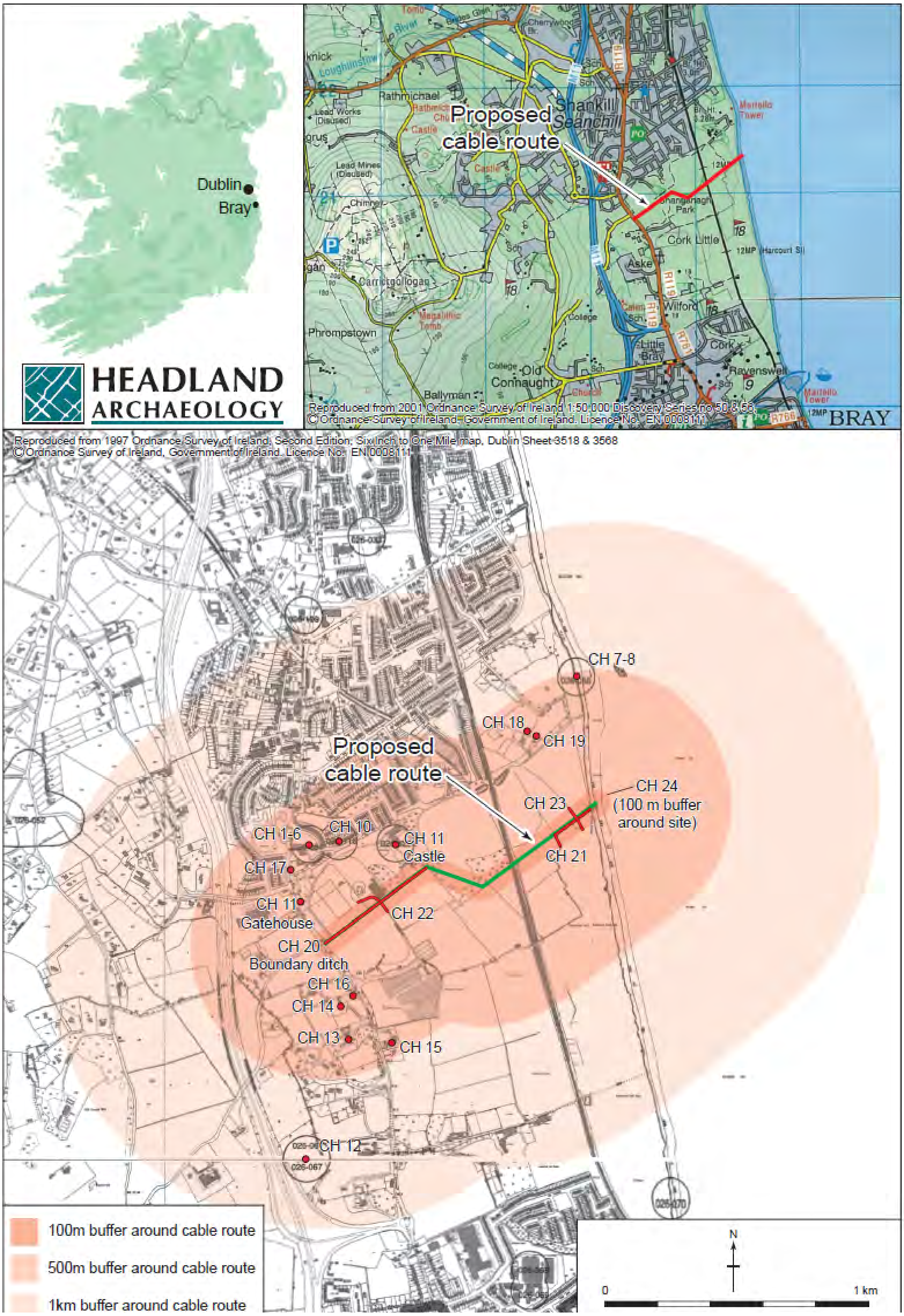


Figure 6.1 Site Location and RMP Extract showing sites of cultural heritage significance

6.2.5.3 Undesignated Cultural Heritage Sites

This section deals with sites that are considered to be of cultural heritage value but which do not fall within the above categories as they are not registered. Such sites may include lime kilns, dwellings/outhouses, trackways or townland boundaries etc identifiable on the First Edition 6"/25" OS maps or noted during the field visit.

There are four unregistered cultural heritage sites located within the study area which extends to within 100m of the proposed development for unregistered features of cultural heritage for the purpose of the assessment. Elements of the designed landscape (CH 20) surrounding Shanganagh Castle which are on the first edition Ordnance Survey map are still present. These include a boundary which is between what is now Shanganagh Park and the area to the west of Shanganagh Castle (see Section 5.2.6 below). Areas of trees, including a circular copse to the west of Shanganagh Castle, which were part of the designed landscape are indicated on the first edition Ordnance Survey map. Some of these have been incorporated into modern planted areas.

The initial 180 m long section of the cable route runs along the line of a part of the townland boundary between Shanganagh and Cork Little (CH 21) which is currently formed by field boundaries). The cable route also passes across the townland boundary between Shankill and Shanganagh (CH 22). The remains of the disused rail line of the Dublin and South Eastern Railway (CH 23) is upstanding in two fields adjacent to the route of the proposed cable. This is indicated on the second edition Ordnance Survey map and can also be seen on aerial photographs. It was also observed during the field survey.

6.2.5.4 Areas of Archaeological Potential

There is one area of archaeological potential within the study area. The route corridor of the proposed cable is considered to be an area of archaeological potential (CH 24). It is located wholly within the demesne lands of Shanganagh Castle, an 18th century estate, potentially with medieval origins (see above). The cable route intersects with the original route of the Dublin and South Eastern Railway (a significant industrial heritage feature) and the known archaeological sites within the study area point to settlement in the area from at least the Bronze Age.

The criteria which were applied during the study to help to identify individual low□visibility, unrecorded archaeological sites and the sites which were identified during this process are below:

Aerial photography

One process by which the archaeological potential of a site can be assessed is through the examination of aerial photography. Aerial photographs from 1995, 2000 and 2005 at http://maps.osi.ie/publicviewer were examined in order to identify any previously unrecorded archaeological sites indicated by crop marks, soil differentiations and/or patterns of field boundaries.

As noted in Section 5.5 the line of the Dublin and South Eastern Railway, indicated on the second edition Ordnance Survey maps adjacent to the coastline, was observed on the aerial photographs. Designed landscape features, such as copses of trees, associated with Shanganagh Castle were also observed on aerial photographs. No further features of potential archaeological significance were noted within the study area.

Features of Archaeological Potential Identified During the Field Survey

During the field survey of the study area (please refer to Section 4.2: Study Area), features of archaeological potential were identified which are detailed in Appendix 3. These include designed landscape features, such as copses of trees, associated with Shanganagh Castle (CH 20). The proposed route of the cable follows the south boundary of the area around the castle. This boundary has persisted since the first edition Ordnance Survey map was surveyed and may have an earlier origin. During the field survey it was observed that the hedgerow which forms this boundary has a ditch up to 1.5m wide and 1.5m deep running parallel to its south side. This could be associated with a designed landscape.

Also observed was the line of the disused Dublin and South Eastern Railway (CH 23) which is on the second edition Ordnance Survey map (Figure 3). The disused railway was observed as an earthen bank approximately 3m wide by 1.5m high. The disused railway extends beyond the study area to the north and south and extensive sections have been removed through coastal erosion.

Toponomy and Associated Cartographic Evidence Relating to Townlands

A search was undertaken to establish if any of the archaeological features from which a particular townland appears to have taken its name, are identifiable on historic cartographic sources. For instance, the inclusion of the term 'Killeen' (meaning 'little church' or 'children's burial ground') in the townland name 'Killeendaniel' would imply that a graveyard site is present within the townland. If evidence for this graveyard is not identifiable on accessible historic mapping then there is potential for this feature to be present within the proposed development site. A list of the townlands where there is potential for unrecorded archaeological sites, the nature of which is implied by the toponomy of the respective townland, is provided in the following table:

Townland Name	**Discussion**
Shankill	The townland name Shankill is derived from the Irish 'seanchill' meaning old church. This refers to the church of the same name; a foundation referred to in various early medieval sources, which subsequently became the focus for the archiepiscopal manor of Shankill in the later medieval period. Its exact location is unknown, but believed to lie close to the medieval tower house in Shankill over 1.5 km from the proposed development.
Cork Little	The townland name Cork is derived from the Irish 'corcaigh' meaning marsh.

Table 6.3 Townland cartographic/toponomy evidence

6.3 Potential Impact of the Proposed Development on Archaeology

6.3.1 Potential Impacts Offshore

Both the installation of turbine foundations and the laying of cables between turbines, combined with the laying of the export cable to shore have the capacity to damage remains of archaeological interest through mechanical disturbance.

The likely use of monopile foundations will minimise the extent of seabed preparation required to facilitate installation of the turbines and would be restricted to the footprint of the pile (c. 3.5-4.5m diameter). Multi-piled or gravity foundations would require the clearing and levelling of the site over a much larger area (up to approximately a 15 – 20 m radius from the central tower location). Should the universal foundation (suction pile) solution prove viable this will require the clearing of a slightly lager area than that required for the monopile solution (up to approximately a 7.5m diameter from the central tower location) but still substantially less than would have been required for the multipile or gravity solution. Any preparation of the seabed as described has the potential to damage or destroy archaeological remains in the vicinity.

6.3.2 Potential Impacts Onshore

The magnitude and significance of potential impacts, prior to the implementation of mitigation measures, on known cultural heritage sites within the study area are identified in Table 6.4 below.

CH No.	Impact Type	Description of Impact	Magnitude of impact prior to implementation of mitigation measures	Baseline Value	Significance level of impact prior to implementation of mitigation measures
21	Direct	Removal of 180 m long section of townland boundary between Shanganagh and Cork Little	Major	Medium/High	Moderate
22	Direct	Transection of townland boundary between Shanganagh and Shankill	Major	Medium/High	Moderate
23	Direct	Transection of Dublin and South Eastern Railway Line	Major	High	Significant
20	Direct	Removal or disruption of 500 m long section of demesne/designed landscape ditch feature	Major	Medium/High	Moderate
24	Direct	Excavation of cable trench within area of archaeological potential	Major	Medium/High	Moderate

Table 6.4 Magnitude and Significance of Potential Impacts

Excavation of the proposed cable trench across Shanganagh Park will require the partial truncation of two townland boundaries (CH21 and 22), as well as the alignment of the original railway cutting of the Dublin and South Eastern Railway (CH 23).

At least one section of the cable route is aligned within a substantial boundary ditch which may be a historic landscape feature within the demesne landscape of Shanganagh Castle (CH20); excavation of this section of the cable would substantially alter this feature.

As the proposed cable route constitutes an area of archaeological potential (CH 24), there is the possibility that excavation of the proposed cable trench could uncover previously unknown sub□surface archaeological features.
The indirect impacts, such as deposition of spoil and visual impact on the known cultural heritage sites within the study area will be moderate and short in duration, as they will be restricted to the construction phase of the project only. No long□term or permanent

indirect impacts on Cultural Heritage sites or features are likely as result of the proposed development.

6.4 Mitigation Measures

6.4.1 Offshore Mitigation Measures

The locations of wrecks and possible significant artefacts have been identified by the underwater surveys carried out by Hydrographic Surveys. The recommendations from the archaeological impact assessment carried out by Headland Archaeology are to:

- Monitor ground-works and dredging during construction
- Halt works in areas where archaeology is identified until appropriate investigation and recording can be carried out.
- Carry out visual dive surveys on any anomalies found in the sonar and magnetometry prior to commencement of works.

The Developers would comply with these recommendations.

The strategy for this development is to preserve any archaeological artefacts by avoidance. The underwater surveys have identified the location of targets of potential archaeological significance on the Kish and Bray Banks and cable route to shore. A number of the proposed turbine locations lie within the 100m exclusion zone around these targets. The exact location of the proposed turbine positions and cable routes would be confirmed as part of further geotechnical investigations that would be carried out as part of the engineering design of the wind farm prior to construction. If it is found that the proposed locations still lie within the recommended exclusion zone around potential archaeological targets, the targets would be further surveyed. Should the results of these surveys confirm that the targets are of archaeological significance then the proposed turbine / cable location would be modified to ensure that the targets are not adversely affected. In this way, no adverse impacts on remains of archaeological interest would occur.

It is possible that remains of archaeological interest which have not been revealed to date could be uncovered during the civil works of the development. As recommended by Headland Archaeology in their impact assessment report, the ground works would be monitored by a suitably qualified archaeologist during construction. If potential archaeological remains are discovered during construction, the remains would be examined at the Developer's expense by a maritime archaeologist to the satisfaction of the Department of the Environment, Heritage and Local Government. All marine archaeologists would be required to be licensed by the Heritage Service, The Heritage Service. If the remains are deemed by the Department to be of significant archaeological value, the location of the turbine or cable would be changed. If, on the other hand, the remains are not deemed by the Department to be of interest, the location of the turbine or cable would not be altered.

6.4.2 Onshore Mitigation Measures

Headland Archaeology Ltd. identified the following mitigation measures to be adopted in order to ameliorate the impacts that the proposed development may have on features of archaeological, architectural and/or cultural heritage within the study area associated with the cable route across Shanganagh Park.

- The route of the proposed cable should be adjusted to follow the amended proposed cable route (Figure 6.2) so as to avoid the section of ditch which forms the townland boundary between Shanganagh and Cork Little (CH 21) and also to avoid the demesne/designed landscape ditch to the south of Shanganagh Castle (part of CH 20). Repositioning of the cable location should take account of the Cultural Heritage sites identified by this study and further direct impacts on any of these sites should be avoided. The study area around the amended route does not incorporate any further sites of cultural heritage.

- A written, drawn and photographic survey of the section of the townland boundary between Shankill and Shanganagh (CH 22) and the section of the Dublin and South Eastern Railway line (CH 23), which will be transected by the proposed cable route should be undertaken in conjunction with the development works. Both sections of the cable trench should be excavated under archaeological direction and a full record of the profile of each recorded. Any significant archaeological artefacts should be retained in accordance with the guidance of the National Museum of Ireland. Following construction work the areas of the townland boundary and the disused railway should be reinstated to match their original morphology. This will allow for the industrial heritage feature of the railway to be read in the landscape.

- As there is a potential that previously unknown sub□surface archaeology could be uncovered along the entire proposed cable route, it is proposed that a suitably qualified archaeologist carry out monitoring of all ground works associated with this section of the proposed cable route. In the event that any archaeological features or deposits are identified, then the archaeologist will have to advise the National Monuments Service, Department of Arts, Heritage and the Gaeltacht and agree an appropriate mitigation strategy; this strategy may include a requirement for archaeological excavation or for preservation.

- The results of all archaeological work undertaken should be fully described in a report submitted to the National Monuments Service, Department of Arts, Heritage and the Gaeltacht and the National Museum of Ireland.

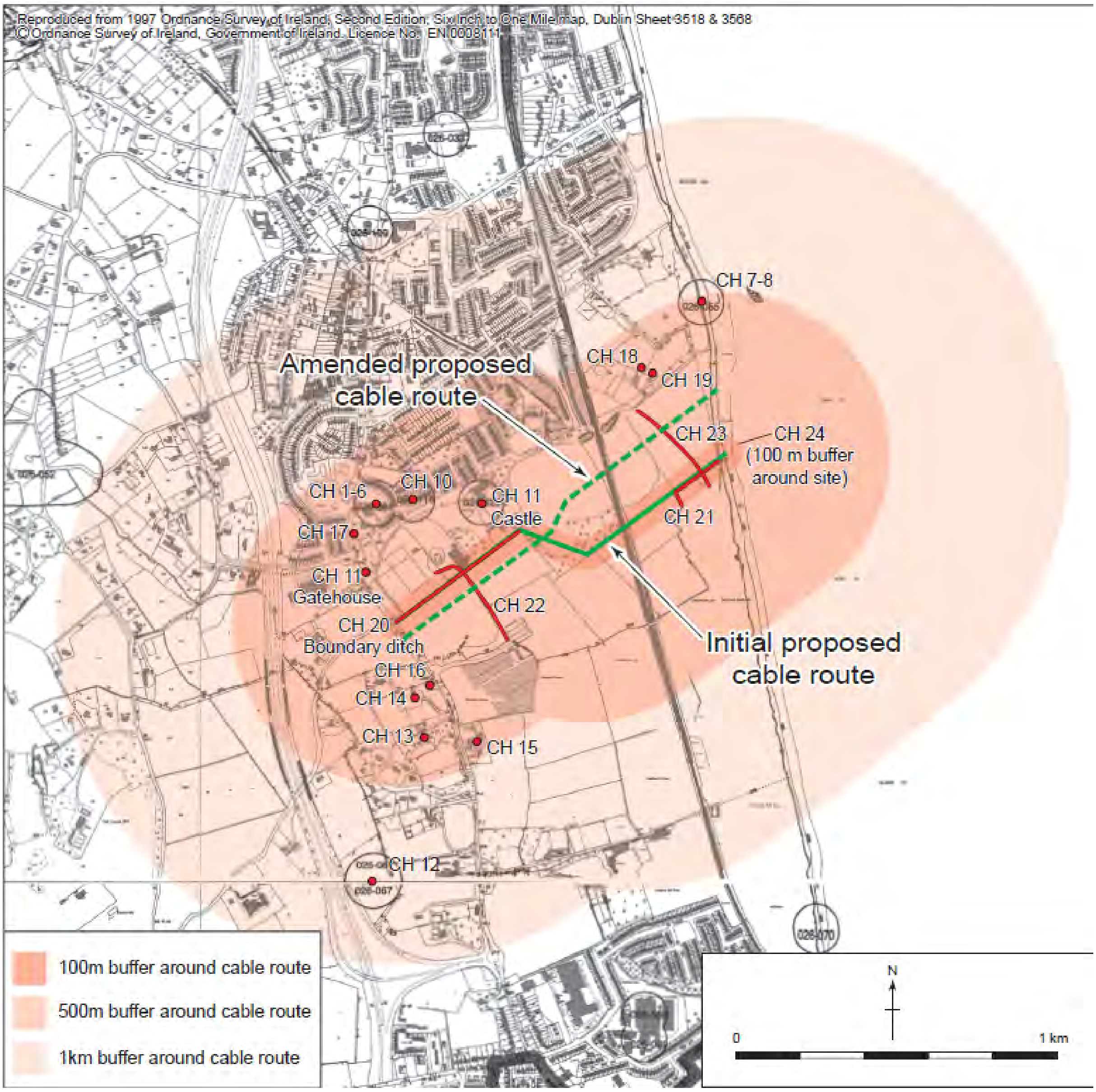


Figure 6.2 RMP Extract showing initial and amended proposed cable routes through Shanganagh Park

6.5 Actual Impact of the Proposed Development on Archaeology

6.5.1 Actual Impacts Offshore

Given the extent of archaeological surveys undertaken and the mitigation measures detailed in Section 6.4.1. above it is not envisaged that the proposed development will have a significant impact on archaeology offshore.

6.5.2 Actual Impacts Onshore

Following the implementation of the mitigation measures outlined in Section 6.4.2. above, including the re-routing of the cable route through Shanganagh Park, the residual impact on the possible boundary associated with Shanganagh Castle (part of CH 20) and the townland boundary between Shanganagh and Cork Little (CH21) will be indirect and negligible while the construction work is taking place. The townland boundary between Shanganagh and Shankill (CH22), industrial remains of the Dublin and South Eastern

Railway Line (CH 23), and any newly identified archaeological remains will be preserved by record. A table indicating the significance level of impact taking into account implementation of mitigation measures is below.

CH No.	Impact Type	Magnitude of impact prior to implementation of mitigation measures	Baseline Value	Significance level of impact taking into account implementation of mitigation measures
21	Direct	Negligible	Medium/High	Negligible
22	Direct	Moderate	Medium/High	Slight
23	Direct	Moderate	High	Moderate
20	Direct	Negligible	Medium/High	Negligible
24	Direct	Moderate	Medium/High	Slight

Table 6.5 Magnitude and Significance of Residual Impacts

6.6 Cumulative Impacts

It is not envisaged that there will be any cumulative impacts on archaeology associated with the proposed Dublin Array Offshore Wind Farm development on the Kish and Bray Banks in combination with other proposed developments along the east coast.

7 COMMERCIAL FISHERIES

7.1 Introduction

The proposed offshore windfarm development on the Kish and Bray banks will involve the installation of up to 145 wind turbines and associated works including foundations and cable laying. Ecological Consulting Services (EcoServe), who had undertaken an original survey and extensive desk study of available data in relation to commercial fisheries in the area on behalf of the Developers in 2002, and which was subsequently updated by them in 2008, were retained to complete a review and assessment of the potential impact of the proposed development on commercial fisheries in the vicinity of the Kish and Bray banks in early 2011. Their review took account of latest available data in relation to commercial fisheries in the area including data contained in the Marine Institute's Stock Book 2010. The Stock Book is produced annually by the Marine Institute and provides up to date information on the state of the fisheries resources exploited by the Irish fleet.

In addition to the Stock Book, data for the assessment of the potential impact of the proposed development on commercial fisheries in the area was gathered from several sources including the Marine Institute (MI), the Department of Communications, Energy and Natural Resources (DCENR), The Sea Fisheries Protection Authority (SEPA), Bord Iascaigh Mhara (BIM), the Irish Fishermen's Organisation (IFO), the Howth Fishermen's Association (HFA), the Central Statistics Office (CSO), the Inland Fisheries Ireland (IFI), Central and Eastern Fisheries Boards (CFB, EFB), local fishermen and sea anglers.

A complete copy of the report prepared by EcoServe on behalf of the Developers is included in Volume 3, Appendix E and the main findings of their review and impact assessment are presented in this chapter of the EIS.

7.2 Description of Existing Environment

7.2.1 Commercial Fisheries within Irish EEZ

The seas around Ireland (ICES Sub Areas VI and VII) contain some of the most productive and biologically sensitive areas in EU waters. Most of the fisheries resource within the area comes under the remit of the EU Common Fisheries Policy (CFP) and Figure 7.1 shows fishing activity hotspots in these waters based on data from the Vessel Monitoring Systems (VMS) of National and International fishing fleets within the Irish EEZ for the period 2005 to 2008. The 2010 fishing opportunities (i.e. Total Allowable Catches, TAC's) for the international fleets that operate within these seas were 994,155 tonnes of fish, with an estimated landed value of €1.18billion. This economic value is based on 2009 prices and represents a conservative estimate. Ireland share of these fishing opportunities represents 18% by tonnage and 16% by value. It should be noted that these figures do not include the valuable inshore fisheries (e.g. lobster, whelk) which do not come under the remit of the CFP. Fish represent a very important resource base for the coastal communities around Ireland.

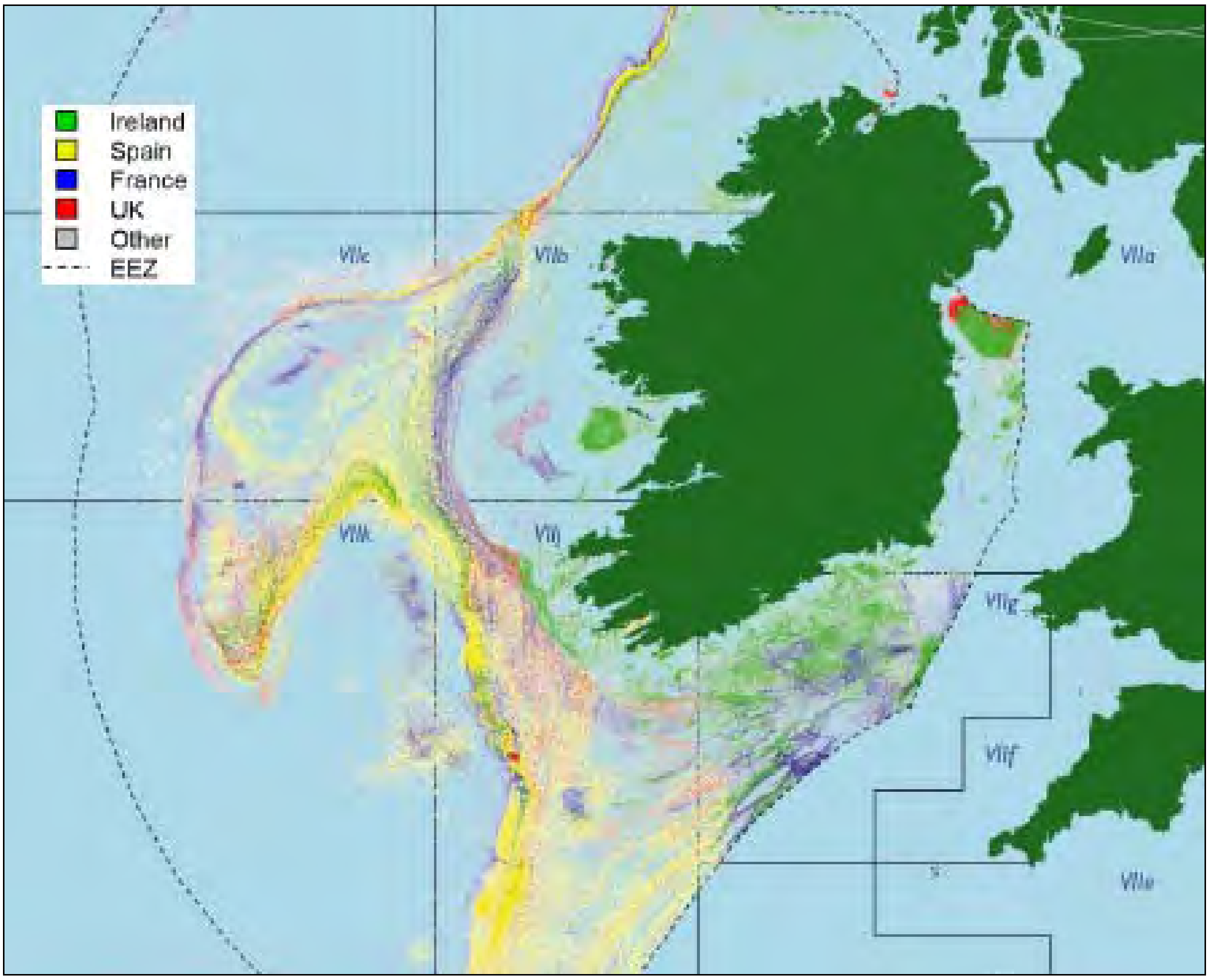


Figure 7.1 Fishing activity hotspots based on data from the Vessel Monitoring Systems (VMS) of National and International fishing fleets within the Irish EEZ for the period 2005 to 2008.

7.2.2 Commercial Fisheries and Fish Stocks in the Irish Sea

7.2.2.1 Introduction

Fish stocks are rarely as localised as a specific bank, such as the Kish and Bray Banks, and management occurs over a larger area, which in this case extends to the Irish Sea (ICES Area VIIa – refer to Figure 7.2). Data from national programs, such as that contained in the Marine Institute's Stock Book 2010, can be beneficial in highlighting what commercial activity is likely to be prevalent in a local area (e.g. the Kish and Bray Banks), but drawing conclusions at such a finer level is extremely difficult with this type of data (David Stokes, MI, pers. comm. with Ecoserve).

The Irish Sea supports commercial fisheries for cod, plaice and sole, all of which fall under the remit of the EU Common Fisheries Policy (CFP), as well as well as significant fisheries for nephrops, crabs, scallops, razors and whelks. The most abundant species recorded by the Marine Institute in trawl surveys are dab, plaice, solenette and common dragnet along with large numbers of poor-cod, whiting and sole. Lesser spotted dogfish is abundant throughout and there are also ray assemblage on sand hills in the Southern Irish Sea and Cardigan Bay. Herring and sprat are the main pelagic fish species recorded in the Irish Sea.

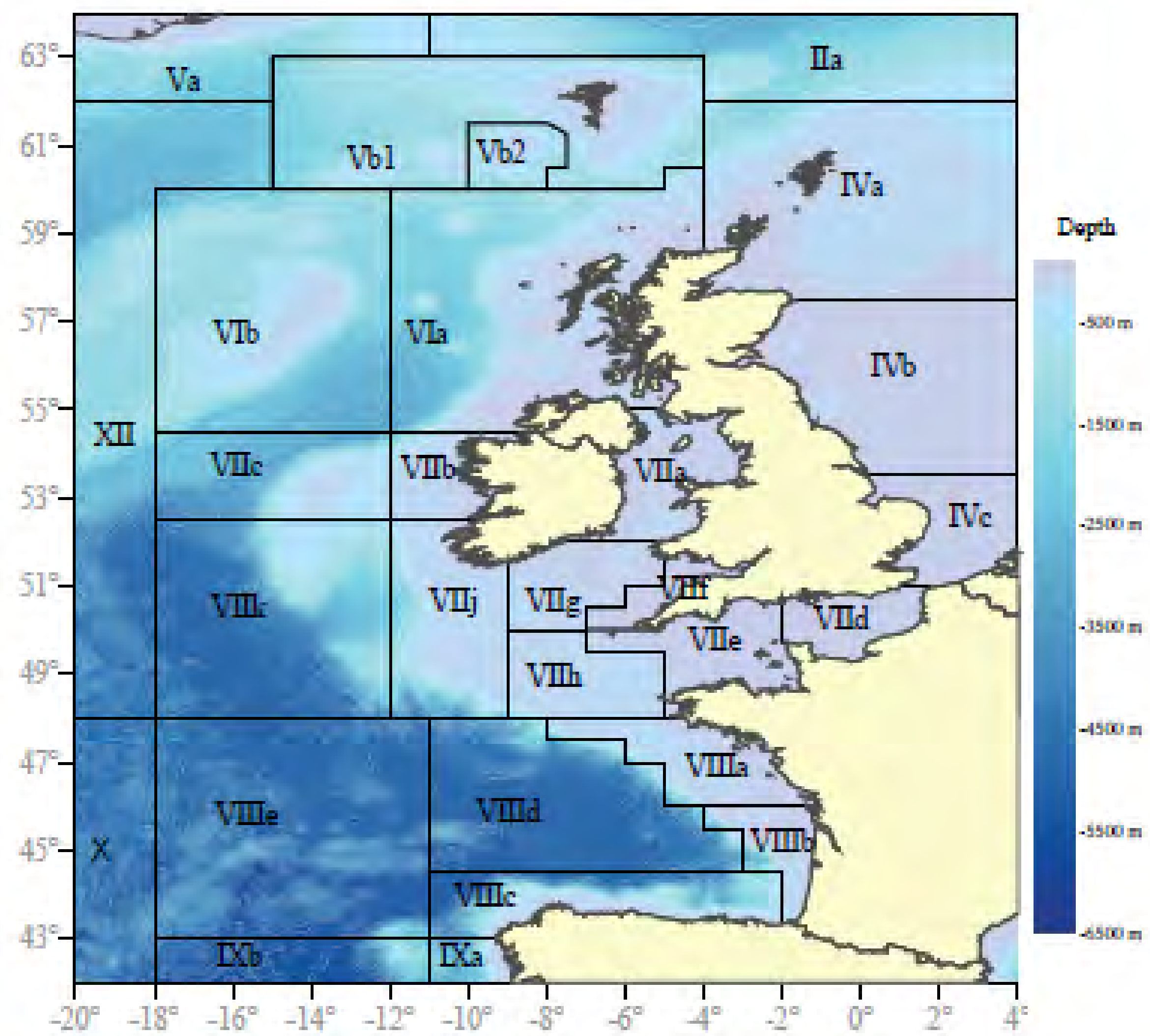


Figure 7.2 ICES Fishing Divisions around the Irish Coast

Stocks of cod, whiting and sole are severely depleted within the Irish Sea (ICES Area VIIa). Trawling for nephrops results in substantial bycatch and discards of other commercial species including cod, haddock, whiting, hake, monkfish and meagrim and this has a significant impact for cod and whiting stocks. The discard rate by fleet in 2009 for cod was 100% for one-year olds and almost all whiting caught were discarded.

The reduction in the abundance of large piscivorous fish species such as cod and whiting has been paralleled by an increase in the fish species which feed at a lower trophic level such a nephrops. This has resulted in a marked decline in mean trophic level of the fish community in the Irish Sea over time.

There has been a noticeable increase in water temperatures in this ecoregion over time, which is likely to have an affect on the distribution of some fish species, and some changes of distribution have already been noted. The combined effects of over exploitation and environmental variability might lead to higher risk of recruitment failure and a decrease in productivity.

Information on commercial fisheries and stocks of the main fish species within the Irish Sea, as detailed in the Marine Institutes Stock Book 2010, are detailed below.

7.2.2.2 Cod

The Irish Sea cod fishery has traditionally been carried out by otter trawlers targeting spawning cod in spring and juvenile cod in autumn and winter. Cod are also taken as a bycatch in fisheries for nephrops, plaice, sole and ray. Total landings in 2009 were estimated at 470t which is the lowest on record (Figure 7.3). Reliable discard estimates are not available. A long-term cod management plan was agreed by the EU in 2008 (Council Regulation (EC) 1342/2008) details of which are set out in the Marine Institutes Stock Book 2010. There is evidence that the reduction in cod recruitment observed in the Irish Sea since the 1990s may be due to a combination of small spawning stock biomass and poor environmental conditions coinciding with a shift towards above average sea temperatures. Spawning-stock biomass in the Irish Sea has declined tenfold since the 1980s and total mortality remains very high. However recruitment in 2009 was above the recent low average and was estimated to be the highest since 2001.

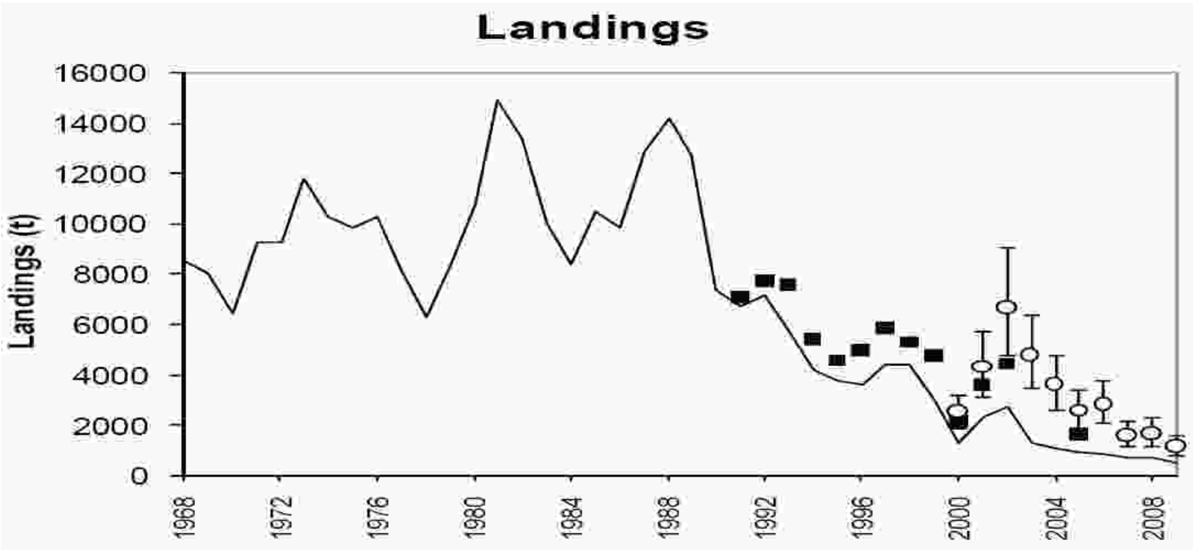


Figure 7.3 Cod landings from the Irish Sea (ICES area VIIa)

(Source: MI 2010)

Filled squares are landings incorporating sample-based estimates at three ports.
Open circles with 90% confidence intervals are total catches estimates

7.2.2.3 Whiting

There is no targeted whiting fishery within the Irish Sea. However whiting are a bycatch (and discarded) within the main Irish Sea fisheries for other fish species, particularly by those undertaken by otter trawlers. The nephrops fishery in particular shows high discards for whiting. The present stock size is extremely low. Landings of whiting have continuously declined since the early 1980s reaching lowest levels in the 2000s (Figure 7.4). In 2009, a number of vessels in the Irish Sea introduced a Swedish grid as part of the Cod Long Term Management Plan and this is expected to significantly reduce the whiting bycatch.

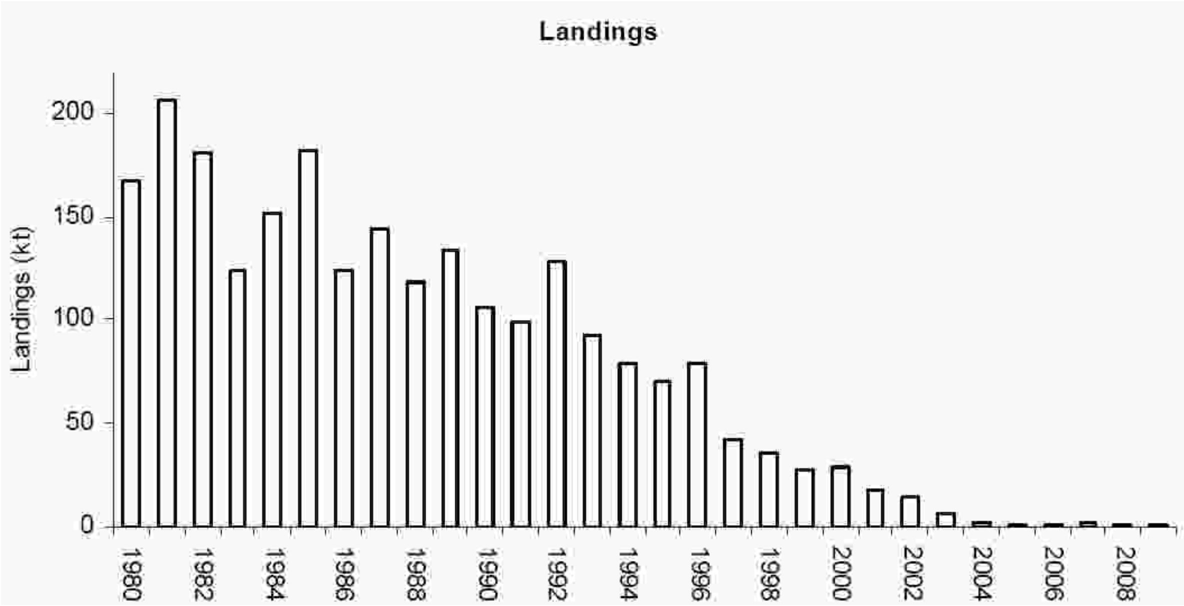


Figure 7.4 Whiting landings from the Irish Sea (ICES area VIIa)

(Source: MI 2010)

7.2.2.4 Haddock

Haddock are taken in Nephrops and mixed demersal trawl fisheries using mid-water trawls and otter trawls. Landings are made throughout the year but are generally more abundant during the third quarter. Total landings in 2009 are estimated at 800t (Figure 7.5). Discarding is a problem for this stock with discard rates by fleet in 2009 of 100% for one-year olds, 44-95% for two-year-olds and 19-75% for three year olds. However, stock trends show a general increase in spawning stock biomass over time. While there has been a reduction since 2008, recruitment in 2009 appears high and is expected to lead to an increase in spawning stock biomass again in 2011.

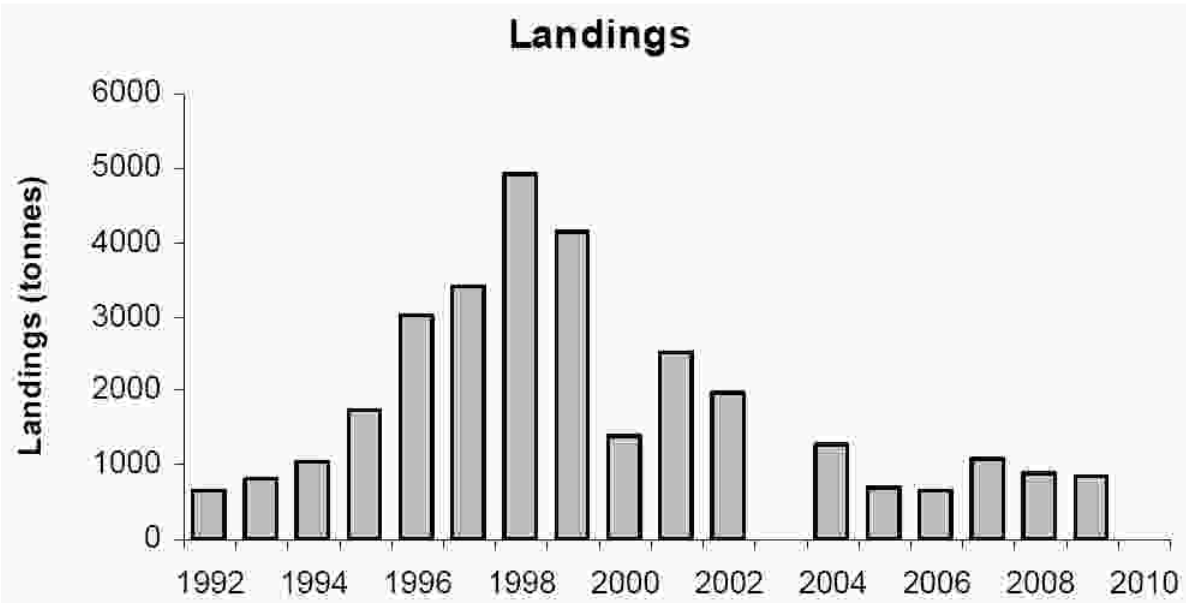


Figure 7.5 Haddock landings from the Irish Sea (ICES area VIIa)

(Source: MI 2010)

7.2.2.5 Nephrops

Nephrops are managed within distinct functional units with the Wetern Irish Sea covered by unit FU-15. Density of Nephrops in FU-15 is considered very high (average density $1.1/m^2$). Landings within this area in 2009 were 9,100t (Figure 7.6). Gear used are a mixture of single and twin-rig otter trawls and trawling for Nephrops results in significant bycatch and discards of other commercial species including cod, haddock, whiting, hake, monkfish and meagrim. A number of Irish vessels are using separator trawls and Swedish grids to reduce bycatch and a potential displacement of Nephrops-directed effort from the western Irish Sea into other stocks has been suggested by ICES, particularly associated with the cod long term management plan (EC 1342/2008). Nephrops are limited to a muddy habitat and require sediment with a silt and clay content of between 10-100% to excavate its burrows. On this basis the distribution of suitable sediments defines its distribution in the Irish Sea.

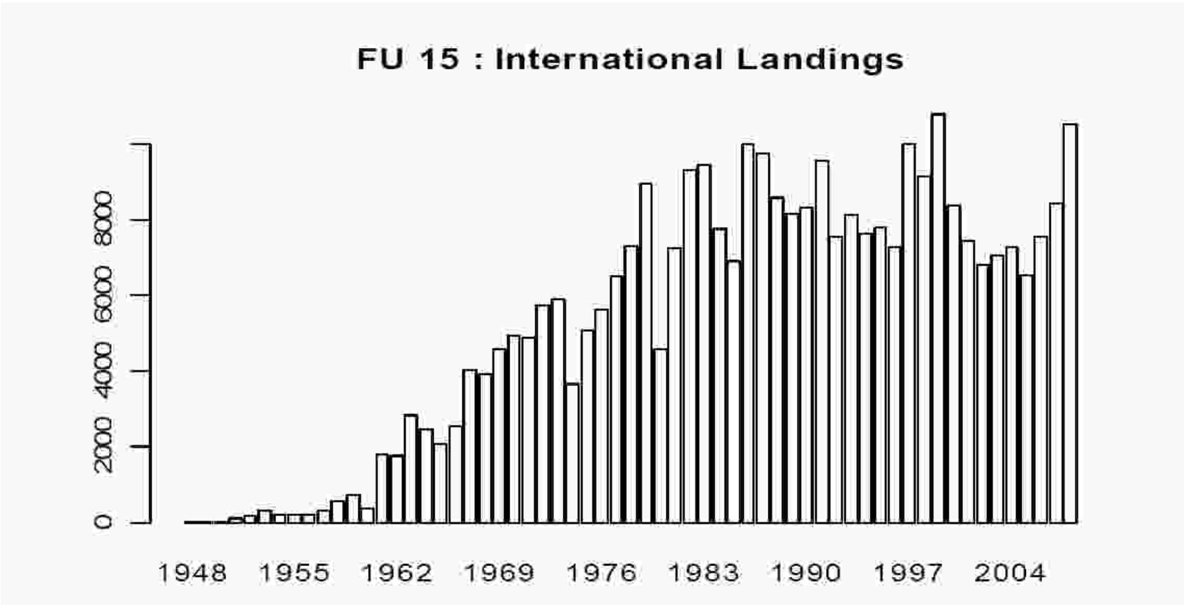


Figure 7.6 *Nephrops* landings from the western Irish Sea (ICES FU15 Zone)
(Source: MI 2010)

7.2.2.6 Plaice

Plaice are taken in a mixed demersal fishery by otter trawl and as a bycatch in targeted sole beam trawl fisheries. Fishing effort for plaice in the Irish Sea has declined to its lowest level since 1979 and there is a high discard rate. The otter trawl fleet seasonally targets plaice but this fleet has declined markedly in the last decade. Total landings in 2009 were 460t (50% by beam trawl and 50% by otter trawl) (Figure 7.7). There are no explicit management objectives or a management plan in relation to this stock. There are considered to be three principle spawning areas for plaice in the Irish Sea: one off the Irish coast, another northeast of the Isle of Man towards the Cumbrian coast and the third off the north Wales coast. Cardigan Bay has also been identified as a spawning ground for plaice. The level of mixing between the eastern and western components of the Irish Sea stocks appears low.

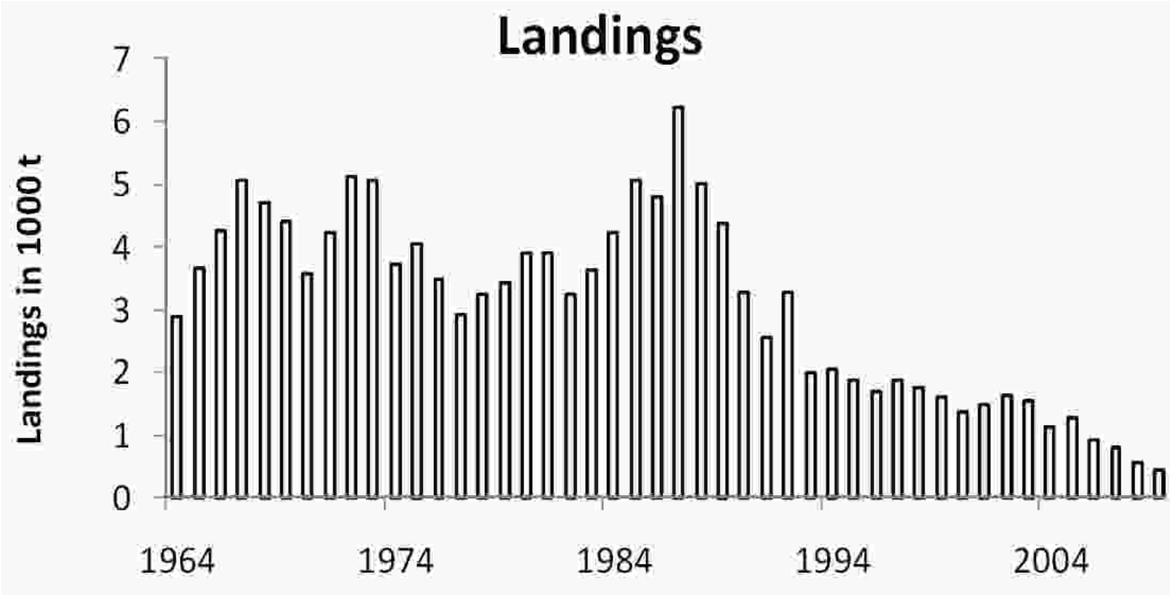


Figure 7.7 Plaice landings from the Irish Sea (ICES area VIIa)
(Source: MI 2010)

7.2.2.7 Sole

Sole are predominantly caught in a mixed fishery with other flatfish by beam trawl in the Irish Sea. Discards are understood to be low (0-8% by number) and total reported commercial landings in 2009 were 324t (Figure 7.8). The stock size is considered low and spawning stock biomass has continuously declined since 2001 reaching its lowest level in 2008. Although ICES have recommended zero catch to allow stock recovery there are currently no specific management plans for this stock.

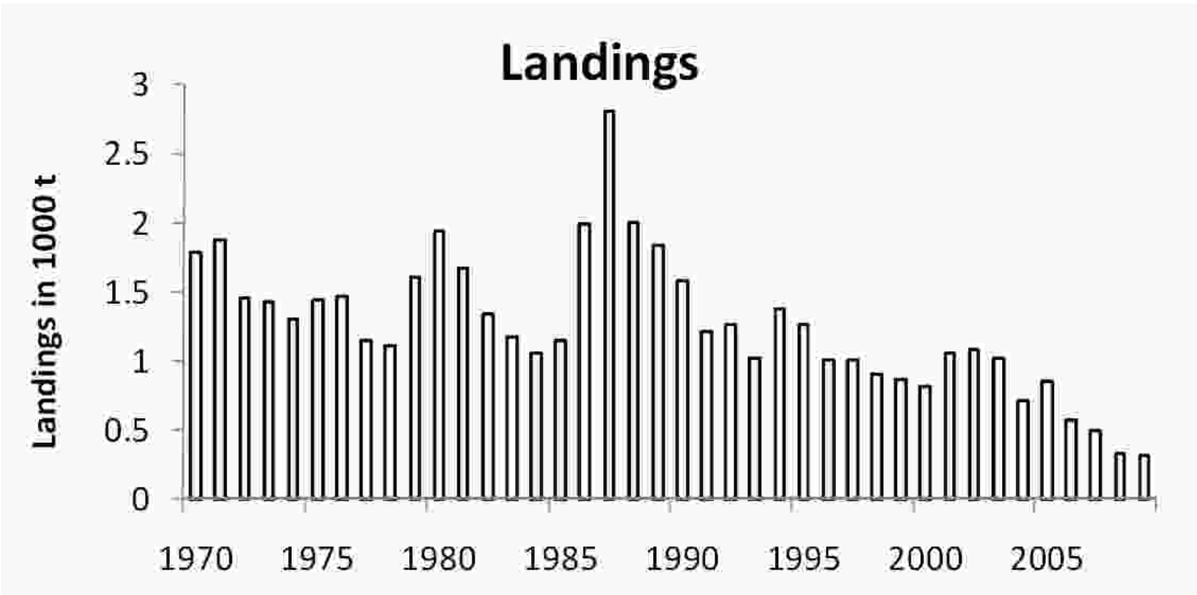


Figure 7.8 Sole landings from the Irish Sea (ICES area VIIa)
(Source: MI 2010)

7.2.2.8 Herring

A pair of UK based trawlers take the majority of herring catches in the Irish Sea although a small local fishery continues to record landings on the traditional Mourne herring grounds. Herring fisheries tend to be clean with little bycatch of other fish.Total reported commercial landings in 2009 were 4,594t. There are two closed areas to protect the spawning stock during part of the spawning season and recent spawning stock biomass assessments show an increasing trend. 2009 acoustic survey estimates suggest that it is close to its highest abundance in the 17 year time-series.

Herring are an important prey species in the ecosystem and also one of the dominant planktivorous fish. There are irregular cycles in the productivity of herring stocks and it is thought that the environment plays an important role through transport, prey and predation.

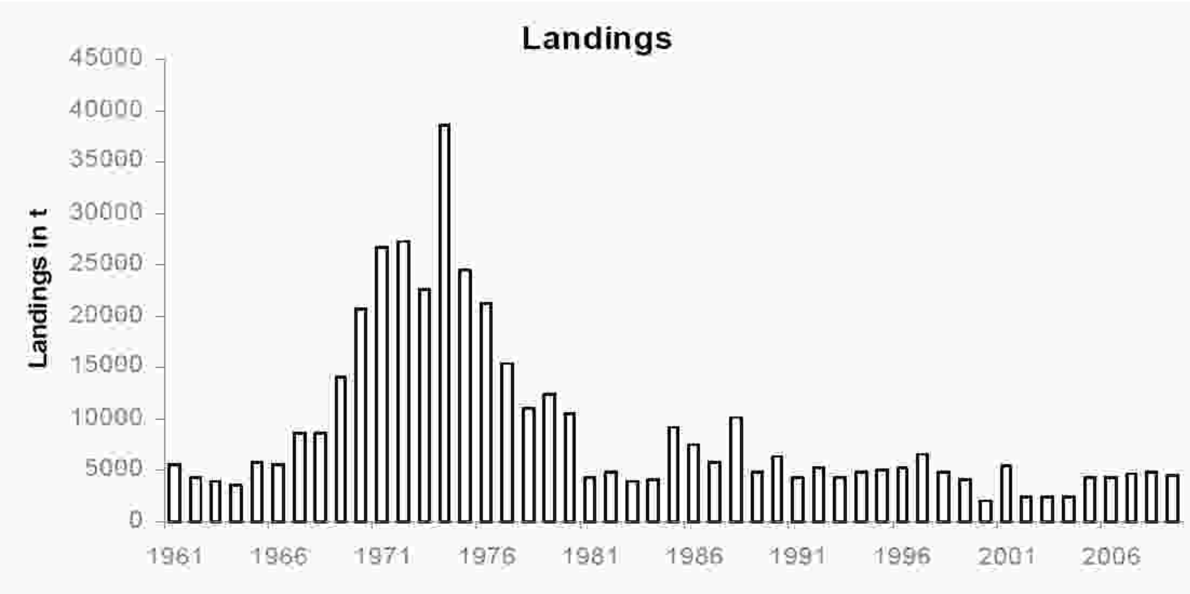


Figure 7.9 Herring landings from the Irish Sea (ICES area VIIa)

(Source: MI 2010)

7.2.2.9 Sprat

Landings from sprat fisheries display large inter-annual variation, both spatially and temporarily. Industrial fisheries of the 1970s have ceased. All recent Irish sprat landings from Division VIIa have taken place in Division VIIaS and are considered to be part of the Celtic Sea stock. Sprat fisheries in Irish coastal waters are unregulated and unassessed. There is no ICES advice for sprat in this area and there are no management regulations for sprat fisheries around Ireland. Sprat is an important forage fish.

7.2.3 Kish and Bray Banks Fisheries

7.2.3.1 Introduction

The main activity in the vicinity of the Kish Bank is whelk fishing (approx. 8-10 boats fishing whelk pots). Queen scallop fishing still takes place (including Northern Ireland boats). Mussels dredgers have also fished for seed in the area recently. There have been small trial attempts to fish for brown crab in the vicinity of the Kish Bank also (John Hickey, BIM, pers. comm. with EcoServe).

On the Bray bank, the main activity is whelk fishing with boats from Wicklow fishing this area. There has also been some fishing for scallop in the area, by one or two boats sporadically (John Hickey, BIM, pers. comm. with EcoServe).

Distribution of the fishing effort around the Irish coast is presented graphically in Appendix 2 of the Ecoserve Report included in Volume 3 Appendix E.

7.2.3.2 Whelks

According to MI data, in 2007 the southwest Irish Sea whelk fishery was at its lowest biomass level since MI commenced monitoring in 1994. A few boats fish over a wide area, which might include the northern limit of the Arklow-Wicklow nursery grounds and the Howth area (Edward Fahy, pers.comm.). There is no fishing with pots on the bank itself. The bank is surrounded by whelk pots as shallow as up to 10 m depth on the outside (east side) and up to 20 m depth on inside (west side) (Patricia Comiskey, BIM, pers. comm. with EcoServe).

Whelks are distributed in north-south orientated mud, sand and gravel banks in strong tidal currents, most of which are within five nautical miles from the shore. Rusk Bank and the nearby Codling Bank are thought to support the highest densities of whelk in the southern Irish Sea. Kish and Bray banks support low densities of whelks, potted mainly by vessels berthed in Dún Laoghaire and Howth.

7.2.3.3 Scallops

A profitable fishery for queen scallops used to take place in 1960s in the area approximately 6-8 miles south of the Kish Bank. Nowadays the fishery for this species is much more sporadic.

7.2.3.4 Mussels

Mussel seedbeds have been located inshore and south from the Kish and Bray banks over the years. As mussel settlement is not consistent and varies from year to year it is impossible to rule out any particular area as a likely settlement ground (Terrence O'Carroll, pers. comm. with EcoServe).

During the bentic survey, which was conducted by EcoServe in 2008, large numbers of mussel shells of approximately the same age were collected with a Van Veen grab at one of the stations to the east of the bank (Station 5), but only one live mussel was found in the dredge sample. This may suggest that there is a mussel bed close by and currents have selectively deposited the dead mussel shells within the sampling area.

7.2.3.5 Finfish

The area surrounding the Kish and Bray Banks used to be extensively trawled for haddock, plaice and spur dog, although very little trawling occurs inside the 20 m depth contour area from the north Kish Buoy to the northern half of the Bray Bank (i.e. on the banks) (John Lynch, Patricia Comiskey, pers. comm. with EcoServe). In addition, Welsh and Spanish boats were reported to trawl the surrounding area for ray (Charley Robinson, pers. comm. with EcoServe). However elasmobranches, such as spur dogs, basking shark and ray, which occur in the vicinity of the Kish Bank (with some prominent ray grounds to the south of the bank), have also been highlighted as species of some concern and may be the subject to a forthcoming EU plan of action on the conservation and management of sharks (Patricia Comiskey, pers.comm. with EcoServe). The Bray Bank is too dangerous to trawl and therefore acts as a sanctuary for fish. On the shallows of the banks flounder, plaice, dab, gurnard, whiting, coalfish, haddock and codling are caught (Charley Robinson, pers. comm. with EcoServe). Other species that have turned up in catches during last five years include: lesser spotted dogfish, mackerel, pollack, thornback ray, ballan wrasse and cuckoo wrasse (Norman Dunlop, pers. comm. with EcoServe). According to the consultations with anglers, stock levels of local species haven't changed much over the past few years with the exception of cod and plaice (Norman Dunlop, pers. comm. with EcoServe).

7.2.4 Commercial fish landings (Dún Laoghaire and Howth)

7.2.4.1 Introduction

Commercial fisheries data from the Kish and Bray banks area was collected from a variety of sources and examined. This data is summarised in Appendix 3 of the EcoServe Report. Information on fisheries in this area is sparse as specific landings for the Kish and Bray banks are not given and are estimated from landings into the fishing ports of Dún Laoghaire and Howth. Data was available from the Marine Institute, BIM, CFB, DCENR, HFO and sea anglers and this is presented in Tables 3.1-3.8 in Appendix 3 of the EcoServe Report. It was stressed that official figures were likely to be an underestimate as small boats, under 10 m, are not obliged to log their catch and there is a large unofficial market for fish in the Dublin area (Frank Doyle, pers. comm. with EcoServe).

Commercial fish caught in the vicinity of the Kish and Bray banks are mainly landed into the fishing ports of Dún Laoghaire and Howth. Figures for all fish (demersal, pelagic and shellfish) landings into Dún Laoghaire and Howth were supplied by the DCENR (2001) from 1997 to 2000 (Appendix 3, Tables 3.1 and 3.3 of EcoServe Report). Figures for all fish landings into Howth from 2004 to 2007 (Appendix 3, Table 3.4. of EcoServe Report) and for shellfish landings into Dún Laoghaire port during the years: 2006 and 2007 (Appendix 3, Table 3.2. of EcoServe Report), were supplied by the Sea Fisheries Protection Authority (SFPA, 2008). Figures for live weight of landings and their values for Howth from 2001 to 2006 were also obtained from SFPA (Appendix 3, Table 3.6. of EcoServe Report). Figures for live weight of sea fish landings and their values for Dún Laoghaire and Howth from 2001 to 2004 were also collected from Central Statistics Office (CSO, 2008) (Appendix 3, Table 3.7. of EcoServe Report). Since these values are for the total landings into Dún Laoghaire and Howth, it is not possible to ascertain the percentage of these that were actually caught on or around the Kish and Bray banks. Similarly, it is not possible to determine the percentage of fish caught around the Kish and Bray banks and landed to other ports, such as Clogherhead or Wicklow. Caution must also be taken when examining these figures, as they may not reflect the actual landings into a port as vessels under 10 m are not required to report landings. As such these figures may be an underestimate of actual catch landed at these ports.

7.2.4.2 Demersal (bottom-dwelling) fish

Figures for demersal landings into Dún Laoghaire port are markedly lower (20.4 t in 1997 and 13.9 t in 1998) than those for Howth. Figures from Dún Laoghaire for most demersal fish are low for 1999 (5.1 t) with no demersal landings recorded starting from 2000 (Appendix 3, Table 3.1 of EcoServe Report).

Total whiting landings were estimated to be 85 t in 2006. Vessels operating out of Dunmore East, Clogherhead and Howth traditionally take most of the Irish catches. Most of the recent Irish landings were from the Southern Irish Sea and may in fact be fish from the Celtic Sea stock (MI, 2007). However, according to SFPA (2008) data from Howth Port only, whiting landings were much higher and were estimated to be 176.7 t in 2004, 190.47 t in 2006 up to 205.37 t in 2007 (Appendix 3, Table 3.4 of EcoServe Report).

The Irish landings of haddock were estimated at 183 t in 2006. However, according to SFPA (2008) landings in Howth Port only were: 158.6 t in 2004, 201.56 t in 2006 and 229.8 t in 2007 (Appendix 3, Table 3.4 of EcoServe Report).

The main demersal species landed into Howth were ray and skate, cod, plaice, whiting and monkfish with peak landings of 3,397.1 t in 1998, dropping to 1,742.8 t in 2000 (Appendix 3, Table 3.3 of EcoServe Report). Cod landings into Howth continue to decline from 574.8 t in 1997 to 141.8 t in 2007 (Appendix 3, Table 3.3 and 3.4 of EcoServe

Report). The main cod fishery is however further north and fished mainly by the Northern Irish fleets.

Total plaice landings were estimated to be 934 t in 2006 where the Irish landings were estimated to be 176 t. The UK (England) usually takes over 40% of the total landings. The Irish and Belgian fleets each traditionally take about a quarter of the landings. The Irish landings of this stock are taken mainly by otter trawl (targeting mixed species such as cod, whiting and Nephrops, but also by beam trawlers targeting sole in vessels operating out of Howth, Kilmore Quay and Clogherhead. Plaice landings into Howth Port also decreased from 123.93 t in 2004 to 54.04 t in 2007 (Appendix 3, Table 3.4 of EcoServe Report). Estimated landings of sole were about 83 t in 2006.

7.2.4.3 Pelagic (mid-water) fish

Only a very small amount (0.5 t) of mackerel was landed into Dún Laoghaire in 1997; however since then no pelagic fish have been recorded as landed into this port (DCMNR, 2001, SFPA, 2008).

From 1997 to 1999 mackerel and herring were the only pelagic species landed into Howth with a maximum of 3.6 t landed in 1997, declining to 0.2 t in 1998 and 1.1 t in 1999. In 2000 however, 10.8 t of pelagic species were landed, which was mainly made up of ocean sunfish (8.1 t). According to SFPA data (2008) the situation has changed and in 2004 herring landings into Howth were recorded at 745 t with a maximum of 1,153 t in 2005 and strong decrease to 580 t in 2006. Other pelagic species landed into the port were: porbeagle in 2004 (vulnerable species), mackerel and John Dory (in very low amount every year from 2004 to 2007). Tuna-like fish and sardinella were also recently recorded as low landings (Appendix 3, Table 3.4 of EcoServe Report).

7.2.4.4 Shellfish

The main shellfish species landed into Dún Laoghaire are whelks. In 2000, shellfish were the only catch landed into Dún Laoghaire with 611 t landed, constituting 93% of the total catch. Edible and velvet crabs and lobster made up the remaining 7%. Whelks were also the main catch during 2006 (87% of total catch) and 2007 (91% of total catch). European lobster, edible and velvet crabs completed the remaining 13 % in 2006 and 9% in 2007 (Appendix 3, Table 3.2 of EcoServe Report). However, there has been a strong decline recorded in shellfish landings since 2000. The total shellfish landings are estimated for 22.5 t in 2006 and 11.5 t in 2007. (Appendix 3, Table 3.2 of EcoServe Report).

The main shellfish species landed into Howth are the prawn *Nephrops norvegicus* (1,978 t in 2007), whelks (27 t in 2007 with marked decline from 190.5 t in 2006) and mussels (190 t in 2007). Edible crab, razor shell, squids and scallops make up the rest of the landings (Appendix 3, Table 3.4 of EcoServe Report).

7.2.5 Spawning and nursery grounds

In general, pelagic species tend to have extensive spawning grounds whereas demersal species tend to have more restricted areas. Three species with extensive spawning areas are known to spawn within the development site, namely lemon sole, sprat and the prawn *Nephrops norvegicus* (Coull *et al*., 1998) (Table 4.1 and Figure 4.1 in Appendix 4 of EcoServe Report). Sprat have a widespread spawning area that extends around the whole Irish coast, including the Irish Sea. Sprat spawn between May and August. The spawning area of lemon sole extends from Strangford Lough in Northern Ireland to Skibbereen in Co. Cork. Spawning occurs from April till the end of September. The Dublin Bay prawn, *Nephrops norvegicus*, has a wide spawning area around Ireland extending from Coleraine in Northern Ireland to Wicklow Head, south of the proposed development. Spawning occurs year round although peak occurs between April and June.

Nursery areas which occur in the proposed development area include those for cod, haddock, whiting, lemon sole and Nephrops. The cod nursery area extends from Dundalk peninsula to Arklow bank; the haddock nursery area extends from Bangor to Wicklow Head; the whiting nursery area extends from Strangford Lough to Wicklow, the lemon sole from Newcastle to Skibbereen and those of Nephrops norvegicus from Coleraine to Wicklow Head (Figures 4.2-4.6 in Appendix 4 of EcoServe Report).

Although the spawning and nursery areas of these species fall within the survey area it does not mean that these sites are exclusively important for the species. Spawning occurs over a wide area, which encompasses the proposed development site.

7.2.6 Recreational Angling

7.2.6.1 Shore Angling

Shore angling is popular throughout the area. Most common species are codling, coalfish, plaice, pollock, dogfish, dab, bass, and whiting. Other fish caught include conger, mackerel, mullet, wrasse, nursehound, smoothound, spotted ray spurdog, thornback ray, cod, dogfish, gurnard, pouting, sole, turbot, ray and tope.

A wide range of fish turn up in the catches in Howth, Dún Laoghaire, Bray and Greystones. North Beach Greystones is renowned for its shore fishing for coalfish, codling, dogfish, dab, plaice and occasional turbot, sole and conger. Shore fishing from the beach at Killiney can be excellent at times for plaice, bass, codling, dogfish, coalfish and pollack. Newcastle offers some of the best winter fishing for cod and dab is to be found there just north of the access road. Killoughter beach produces the widest range of species from the shore in Co. Wicklow. Specimen homelyn ray, smoothound, spurdog, thornback ray and bullhuss have all been recorded recently, while the more "normal fishing" for dogfish, codling and flatfish has been above average. (David Byrne, IFI, pers. comm. With EcoServe) (See Table 5.1 in Appendix 5 of EcoServe Report for detailed species list).

7.2.6.2 Off-shore Angling

General bottom fishing for plaice, codling, whiting, ray, tope, dogfish, dab, gurnard and mackerel takes place in the area. Large spurdog and tope turn up regularly in boat catches. Popular charter angling destinations include Ireland's Eye, Scotsmans Bay and Dalkey Island. Wreck and reef fishing off the Kish and Burford banks is also popular. Tournament boat fishing is extremely popular off Greystones with a number of events staged annually. (David Byrne, IFI, pers. comm. with EcoServe).

The Kish Bank is a popular fishing location for small and charter boat anglers. It is home to a very large number of ship wrecks, which provide an ideal habitat for many species including conger, pollock, cod, mackerel, wrasse, coalfish, flatfish species, dogfish, bass, ray, spurdog and tope (David Byrne, IFI, pers. comm. with EcoServe) with the latter two turning up in good numbers (Charley Robinson, pers. comm. with EcoServe).

Pollock and occasionally conger eels were recorded around the Kish Lighthouse in slack water. In the deeper water, to the east of the bank significant numbers of spur dog and ray were found in spring and summer. On the southern side of the bank where it drops off, one- and two-year codling and whiting were found in autumn and large fish have been lost on rod and line near the surface and bass have been recorded on the bank from time to time (Norman Dunlop, CFB, pers. comm. with EcoServe).

7.2.7 Fisheries Research

7.2.7.1 Introduction

Detailed annual surveys of the fisheries in the Irish Sea are conducted by the Marine Institute, Fisheries Services Division. Two surveys, the Irish Sea and Celtic Sea Ground Fish Survey and the Juvenile Plaice Survey, annually sample in the Kish and Bray banks area as part of the greater survey. However, in general the development area has not been studied in detail due to difficulties in sampling the banks.

7.2.7.2 Irish Sea and Celtic Sea ground fish survey

The Irish Sea and Celtic Sea Ground Fish Survey has been in operation since 1997 and are conducted in November of each year. The location of the sites within the local area of the Kish and Bray banks area are shown in Appendix 6, Figure 6.1 and Table 6.1 of EcoServe Report. A number of these sites are within the development area and some are as far as 3 km from the development site. A Grande Ouverture Verticale (GOV) trawl was deployed at each site and a straight tow conducted for 30 minutes before being hauled and the contents identified.
A diverse range of fish species were recorded from these surveys; 34 species in total (Appendix 6, Table 6.2 of EcoServe report). Of these whiting, plaice, sprat, lesser spotted dogfish, dab and haddock were the most abundant in the survey area.

Demersal species
Whiting, haddock and cod were the most abundant demersal fish recorded from the trawls with the plaice and dab being the most abundant flatfish. The thornback ray and lesser spotted dogfish were the most abundant elasmobranchs recorded.

Species that are non-target, but are taken as commercial by-catch, include common dragonet, common goby, bib, pogge, grey and tub gurnard and butterfly blenny. These species are not of direct commercial value, but may be important prey items for a number of commercial species and are thus indirectly important.

Pelagic species
Sprat were the most abundant fish in terms of numbers caught in the area, followed by herring and poor cod. Sprat were recorded from surveys since 1997, but herring and poor cod were only recorded since 2000 and 2001.

7.2.7.3 Juvenile Plaice Survey

The Juvenile Plaice Survey (1992-2002) was designed to examine juvenile plaice recruitment. A 3 m beam trawl was deployed for 15 minutes before it was hauled and the contents of the trawl identified. Surveys were conducted between May and September each year. Up until 1996 only plaice were recorded, however after this date all species caught were recorded. The survey has a number of sites in the Kish and Bray bank area (Appendix 6, Table 6.3). Two of the sites occur within the development area, with the rest being up to 15 km away.

Thirty one species were recorded in total. Plaice and dab were the most dominant species within and around the survey area (Appendix 6, Table 6.4 and Table 6.5).

Demersal species
The most abundant flat fish recorded were plaice and dab. The lesser spotted dogfish was the most abundant elasmobranch recorded from the trawls. Species such as sand eel, grey gurnard, cod and pipefish were recorded in low numbers.

Pelagic species
Pelagic fish were not well represented in the Juvenile Plaice Survey, with herring only recorded at one site. This is to be expected owing to the type of gear used in this survey.

7.2.7.4 Biological sampling survey

This survey was planned to address the requirements of the Data Collection Regulation 1639/2001. Information on growth, maturity and sex ratio (biological data) were collected for a range of commercially important species. Ovary samples were collected to validate visual maturity staging. Additionally, ovary samples were taken for the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) in Lowestoft (UK) and tissue samples were taken for genetics projects within the Marine Institute as well as other labs. Samples of whole flatfish were taken for meristics analysis by the Galway-Mayo Institute of Technology (Marine Institute, 2004). The survey sampled a number of sites in the Kish and Bray bank. Six species were recorded in total. Haddock and whiting were the most dominant species within and around the survey area (Appendix 6, Figure 6.2).

Demersal species
Haddock and whiting were the most abundant demersal fish with plaice, cod and monkfish being less abundant. Ray was the only elasmobranches recorded.

Pelagic species
No pelagic fish were recorded within the Kish and Bray banks area during the survey.

7.3 Potential Impacts of the Proposed Development on Commercial Fisheries

7.3.1 Construction Phase Impacts

The use of heavy jack-up barges, piling equipment, cranes, trenching and cable laying vessels, and the deposition of rock armour during the construction stage of the project are likely to generate noise and vibrations and disturbance to seabed sediments in the vicinity of the site. Potential impacts on fish species and commercial fisheries associated with these operations during the construction stage of the project include:

7.3.1.1 Substratum Loss

Disturbance of mobile species associated with the loss of seabed habitats and associated feeding and spawning grounds under the footprint of the turbine foundations and associated scour protection, and along the route of the inter-turbine cabling and the export cable to shore. These impacts are however likely to be minimal as they will be restricted to the immediate footprint of the works which represents a very small percentage of the overall seabed habitat available on the Kish and Bray Banks. The loss of seabed habitat associated with the laying of the inter-turbine and export cables will only be temporary and will involve the formation of the trench, installation of the cable and backfilling of the trench which are performed in a single operation using a specially designed plough towed behind the installation vessel. Once the cable is installed habitats and feeding grounds are expected to return to their original state within a short timeframe.

7.3.1.2 Smothering

Smothering of fish spawning habitat and shellfish habitat in the immediate vicinity of the works due to settlement of disturbed sediments. The coarser fraction of sediments disturbed by operations such as seabed preparation, piling and cable trenching operations are likely to be initially redeposited on the seabed within 50m of the works before being resuspended and distributed by the natural hydrodynamic process. The effects are only expected to be temporary on this basis. It is understood that most finfish species are not sensitive to smothering and those that are generally have a low sensitivity. The spawning areas of finfish species herring and sandeels are highly sensitive to smothering but these are not known to occur on the banks. Shellfish inhabiting the seabed are generally more sensitive to the effects of smothering.

7.3.1.3 Increased Suspended Sediment and Turbidity

There is likely to be an increase in the turbidity of the water associated with the preparation of the sea-bed and installation of turbine foundations, scour protection and power cables during the construction of the wind farm. This increase in turbidity could result in increased siltation, smothering or negative effects on adult and juvenile shellfish, fish, larvae and eggs. High levels of suspended sediment may clog the gills of fish. Other fauna that fish feed on, the substrata or seaweeds that fish lay their eggs on may be lost or impacted on. High levels of suspended solids settling on the seabed can alter habitat resulting in a potential loss of feeding and spawning grounds. The turbidity of the water may reduce light levels, which would effect seaweed growth. Mobile species may move away from unfavourable conditions, however sessile, bentic fauna and flora may be smothered and lost.

Impacts are likely to be minimal as there is a high degree of naturally suspended solids on the Kish and Bray banks due to the high tidal current regime and sedimentary nature of the area. Additional suspended solids are likely to be rapidly dispersed by the strong currents, while the coarse nature of the sediment across much of the study area will result in the sediment resettling close to the point of disturbance.

7.3.1.4 Noise and Vibration

Noise and vibrations from shipping vessels and equipment and from operations such as pile driving during the construction phase of the development may disturb marine mammals, fish and bentic organisms around the site, particularly during spawning, nursery or migratory periods. Pile driving in particular can generate very high sound pressure levels and given the likely use of monopile foundations to support the turbines for the Dublin Array it is anticipated that the underwater noise generated by the installation of the piles during the construction stage of the project is likely to have the greatest potential effect on marine wildlife.

Detailed research into the effects of offshore wind farm noise on marine mammals and fish was undertaken on behalf of COWRIE Ltd (Collaborative Offshore Wind Research into the Environment) the results of which are presented in the following report:

- biola, Hamburg, Germany - Effects of offshore wind farm noise on marine mammals and fish (Thomsen, F., Ludemann, K., Kafemann, R., Piper, W.), (2006).

A detailed joint study investigating underwater effects from pile driving operations and reviewing marine mammal and fish mitigation and monitoring measures for the proposed London Array, Greater Gabbard and Thanet Round 2 offshore wind farm projects in the Thames Estuary in the UK was completed by RPS Energy and Subacoustech Ltd for CORE Limited on behalf of the Developers of those projects. The results of the study are presented in the following reports:

- RPS Energy - Underwater Noise Impact Assessment on Marine Mammals and Fish during Pile Driving of Proposed Round 2 Offshore Wind Farms in the Thames Estuary for CORE Limited on behalf of London Array Limited, Greater Gabbard Offshore Winds Limited and Thanet Offshore Wind Limited – Report No. EOR0523 Final Version 5.1, Authors: Dr Barry Shepherd, Caroline Weir, Dr Chris Golighty, Dr Terry Holt, Nathan Gricks, Approved: Chris Jenner, Date: 24/07/2006.

- Subacoustech – Underwater noise impact modeling in support of the London Array, Greater Gabbard and Thanet offshore wind farm developments – S J Parvin, J R Nedwell and R Workman, 29th June 2006, Subacoustech Report No. 710R0517.

Given the likely use of similar monopile foundations to support the turbines on the Dublin Array as those proposed for the wind farm developments in the Thames estuary, the above documents form the basis of the assessment of the potential impact of noise from the construction and operational phases of the proposed Dublin Array Offshore Wind Farm on fish included in this Chapter of the Environmental Impact Statement.

Since water is a relatively dense, incompressible medium compared to air, the pressures associated with underwater sounds tend to be much higher. Sound also travels much faster in water (c. 1500 m/s) than in air (340 m/s). The Subacoustech report refers to research by Nedwell *et al* (2003) identifying common background levels in the order of 130 dB re. 1 μPa for coastal waters and notes that such a level equates to about 100 dB re. 20 μPa in the units that would be used in air. It further notes that while such high noise levels in air would be considered to be hazardous to human beings and terrestrial animals, marine animals have evolved to live in this environment and are thus comparatively insensitive to sound compared with terrestrial mammals.

The steel mono-pile supports onto which each wind turbine will be secured are typically 40 to 50 m in length, and for the Dublin Array Offshore Wind Farm development, may vary in diameter from 4.0 to 6.5 m depending on the wind turbine selected, water depth, detailed geotechnical investigations and final design. The impact piling operation to secure the pile into the seabed involves the use of a large pile hammer mounted on a 'jack-up' barge. A typical impact piling operation to secure a single pile may take from 3 to 5 hours, and involve 3000 to 4000 individual blows, each with impact energy of some 300 to 500 kJ.

During the piling operations noise is generated both in air, and in the water, as a result of the impact of the pile hammer with the steel pile. Some of this airborne noise is transmitted into the water, but of more significance is the noise radiated into the surrounding water medium as a consequence of the compressional, flexural and other complex structural waves that travel down the pile. As the density of steel is closer to that of water than air, sound waves in the submerged section of the pile couple more efficiently into the surrounding water. These waterborne waves will radiate outwards usually providing the greatest contribution to underwater noise.

The report prepared by Subacoustech Ltd for the Thames Estuary projects identified the following potentially harmful physical and behavioural effects of high-level underwater noise, such as that which might be generated by impacts from the pile driving, on species of fish and marine mammals:

Lethal Effect: At very close range from the source the peak pressure levels have the potential to cause death, or severe injury leading to death, in human divers, marine mammals and fish.

Physical Injury: At greater range from the source, the construction noise may cause physical injury to organs surrounding gas-containing structures of the body.

Hearing Impairment: At high enough sound levels and particularly where there are repeated high level exposures from activities such as impact piling the underwater sound has the potential to cause hearing impairment in marine species. This can take the form of a temporary loss in hearing sensitivity, known as Temporary Threshold Shift (TTS), or a permanent loss of hearing sensitivity known as Permanent Threshold Shift (PTS). For transient noise such as piling this may occur where species are exposed to a number of repeated pile strikes. The potential for injury is related to the level of underwater sound, and the duration, duty cycle and hearing bandwidth of the species.

Behavioural Response: At greater range the underwater sound wave may not directly injure species, but has the potential to cause behavioural disturbance. Subacoustech have developed a weighted metric system, dBht (species) to quantify the risk of this behavioural effect on different marine mammals and fish species. It gives a species-specific noise level referenced to a species hearing ability, and therefore a measure of the potential of the noise level to cause an effect on that species. The measure that is obtained represents the loudness of the sound for that species. This is very important because even apparently loud underwater noise may have no effect on a particular species if it is at frequencies outside that species hearing range.

Audible Range: The audible range, the range over which marine species can hear the construction activity, will extend to the distance that the construction noise either falls below the ambient perceived sea noise level or the auditory threshold of the species.

There is an extraordinary diversity in hearing structures among fish, resulting in different auditory capabilities across species. While many fish species hear in the range of about 30 Hz to 1 kHz, some investigations have demonstrated species-specific hearing capabilities in the infrasonic range of less than 20 Hz (Karlsen 1992; Knudsen et al. 1997; Sand et al. 2000), and in the ultrasonic range of over 20 kHz (Mann et al. 1998, 2001; Popper et al. 2004a). Anthropogenic underwater noise, including, for example, shipping, seismic airguns, pile driving, and operational noise of wind turbines exhibits major energy below 1,000 Hz and is thus within the frequency range of hearing of most fishes (Richardson et al. 1995; Popper et al. 2003)

Fish possess two principal mechanosensory organs for the detection of underwater vibrations, the lateral line system and the inner ear. The lateral line system is stimulated by low frequency (generally below 150 Hz) water flow relative to the fish body (Sand 1984; Enger et al. 1989; Coombs and Montgomery 1999; Wahlberg and Westerberg 2005). Very close to the sound source the lateral line system can detect the acoustic field. However, the limited detection range makes the lateral line probably unimportant in the context of the reaction of fish to signals from wind turbines (Wahlberg and Westerberg 2005).

The inner ear includes three semicircular canals and associated sensory regions and three otolith end organs, the saccule, utricle, and lagena (e.g. Popper and Fay 1999; Popper et al. 2003). Each otolith organ consists of a solid calcareous stone (the otolith) closely associated with a sensory epithelium containing mechanoreceptive hair cells. The otoliths are denser than the surrounding tissues and the water so that their movements in a sound wave will be at a different phase and amplitude than that of the epithelium, thus creating shearing movement of the hair cells. The otolith organs are therefore in principle *particle motion detectors* (e.g. Hawkins 1993; Popper et al. 2003; see below). They tend to respond to sound induced motions of the fish�begins body in both the near and the far field (Popper and Fay 1999). The perception of *sound pressure* is restricted to those fish species containing air-filled swim bladders. Due to the higher compressibility of gas compared to water, the swim bladder responds to sound pressure fluctuations. This motion of the swim bladder may be transmitted to the otolith organs of the inner ear (e.g. Fay and Popper 1999). In other words, the swim bladder transforms incident sound pressure into particle motion which stimulates the ear. The dual sensitivity of many fish species to sound pressure and particle motion may provide the animals with valuable information about sound source characteristics, including distance and location (Popper and Fay 1999; Popper et al. 2003).

Fish can perform the same basic auditory tasks, such as discrimination between sounds, determining the direction of a sound, and detecting biologically relevant sounds in the presence of noise as do terrestrial vertebrates. Indeed, it has been shown that all species of fish tested are able to hear (Popper et al. 2003). However, hearing capabilities among species vary greatly. For classification purposes, the terms *hearing specialist* and *hearing generalist* (or *nonspecialist*) are commonly used (Fay and Popper 1999). This classification is independent of the taxonomic grouping but is based entirely on a species‛hearing capability.

Hearing specialists have some means of mechanical coupling between the swim bladder and the inner ear (e.g. Weberian ossicles of the Ostariophysi, bulla auditoria of the Clupeidae). As a result of these additional indirect pathway to the ears, hearing specialists have high sound pressure sensitivity and generally low hearing thresholds when compared to generalists. They can detect sounds to over 3 kHz with best sensitivity from about 300 to 1,000 Hz (Popper et al. 2003).

In contrast, the majority of fishes are not known to have hearing specializations and only detect sounds up to 500 - 1,000 Hz, with best hearing generally from 100 - 400 Hz (Popper et al. 2003). They are classified *hearing generalists* (Fay and Popper 1999). These species hear primarily via the direct pathway (that is particle motion via the otoliths) with relative poor sensitivity (Popper and Fay 1999). The hearing generalists may be further divided into those species lacking gas-filled structures and those species possessing a swim bladder but lacking specialized coupling mechanisms (Popper at al. 2003).

The COWRIE Report selected four key species (dab, Atlantic salmon, Atlantic cod and Atlantic herring), whose hearing capabilities are well investigated, to represent different levels of auditory capabilities among the large range of fish species which exist in northern European waters.

Dab (*Limanda limanda*) does not possess a swim bladder. Sound travels directly to the otolith organ via tissue conduction. As a result, dab is only sensitive to particle motion (Chapman and Sand 1974). The species is relatively insensitive to sound and hears over a very restricted range of frequencies. Dab hears in a frequency range between 30 and 250 Hz. The hearing threshold was determined as 89 dB re 1 µPa at 110 Hz (Chapman and Sand 1974) (Figure 7.10). Dab was chosen in order to represent other fish species of very low sensitivity to sound, especially flatfishes without a swim bladder.

Atlantic salmon (*Salmo salar*) possess a swim bladder that is not always completely filled. In addition, it is disconnected from the skull; therefore Hawkins and Johnstone (1978) conclude that the swim bladder plays no part in hearing of the species. Hearing in the Atlantic salmon was studied by means of a cardiac conditioning technique by Hawkins and Johnstone (1978). Salmon responded only to low frequency tones (below 380 Hz) with best hearing (threshold 95 dB re 1 µPa) at 160 Hz (Figure 7.10). As a consequence of the hearing mechanism, particle motion, rather than sound pressure, proved to be the relevant stimulus. The hearing of salmon is poor with narrow frequency span, poor power to discriminate signals from noise, and low overall sensitivity (Hawkins and Johnstone 1978). Salmon has been selected as a target species because of its protection status.

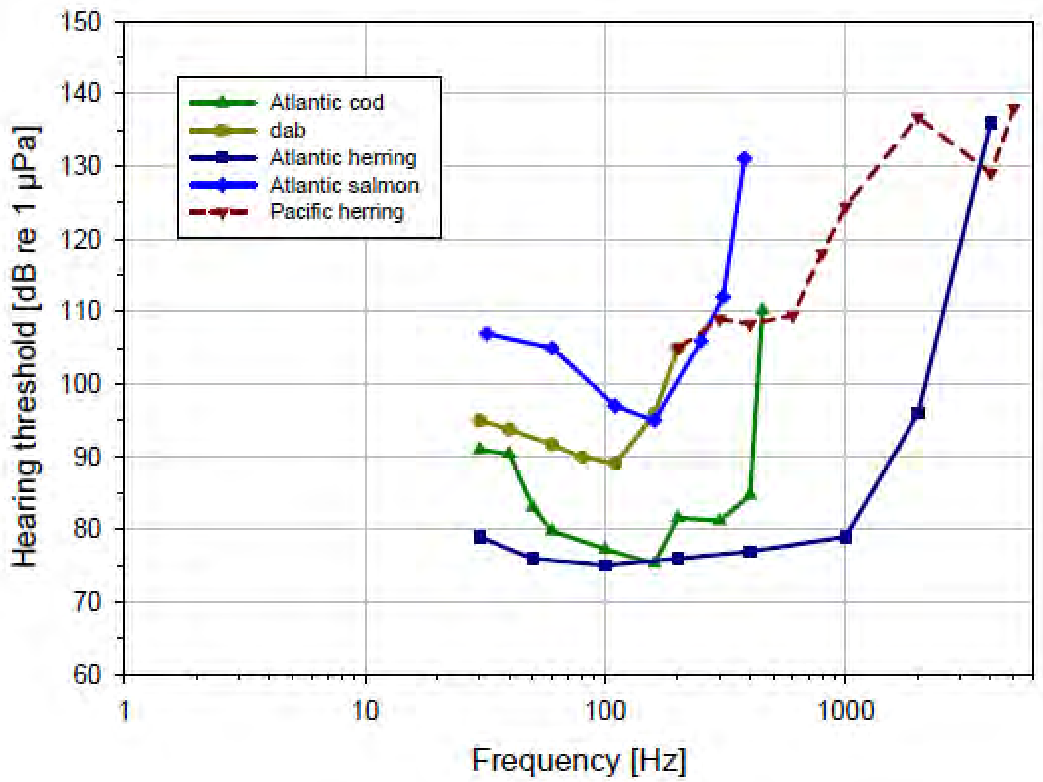


Figure 7.10 Audiograms of Atlantic salmon (Salmo salar) (Hawkins and Johnstone 1978), Atlantic cod (Chapman and Hawkins 1973), Atlantic herring (Enger 1967), and dab (Chapman and Sand 1974).

For comparative purpose the audiogram of Pacific herring (Mann et al. 2005) is included

Atlantic cod (*Gadus morhua*) has a gas-filled swim bladder. Though there is no direct connection between the swim bladder and ear, the anterior of the swim bladder is in close proximity to the inner ear, which is positioned well back in the occiput (Hawkins and Johnstone 1978). Therefore, the species is more sensitive to sound than both dab and Atlantic salmon. Audiograms have been determined by classical cardio-conditioning technique. A change in heart beat obtained with the repeated presentation of a sound followed by a mild electric shock is taken as evidence that a given sound has been perceived by the animal. Buerkle (1967) has established a cod audiogram, but in a later publication (Buerkle 1968), the author stated that the experimental sound had been masked by ambient noise in the tank. Chapman and Hawkins (1973) investigated a total of 43 juvenile cod in a field study. Offutt (1974) based his audiogram on the investigation of 20 specimens in a tank. The best sensitivity was determined at 150 and 160 Hz, respectively in both of the latter studies. Saccular microphonic potentials were measured by Sand and Enger (1973) in four cod in order to investigate the role of the swim bladder in hearing. Considering the difficulties arising when measuring fish hearing in small tanks, especially when the species is sensitive rather to particle motion, the hearing curve determined by Chapman and Hawkins (1973) in the ocean is taken as a basis for further calculations. Highest sensitivity of cod is 75 dB re 1 µPa at 160 Hz (Figure 7.10). Sand and Karlsen (1986) found sensitivity in the infrasonic range below 1 Hz (see Astrup and Møhl 1993 for sensitivity in higher frequencies). Cod are capable of distinguishing between spatially separated sound sources (Buwalda et al. 1983), and also between sources in different distances (Schuijf and Hawkins 1983). In cod, both particle motion and sound pressure are important stimuli, especially for determining sound direction (Schuijf and Hawkins 1983).

Like all members of the order Clupeiformes, **Atlantic herring (*Clupea harengus*)** has a swim bladder and inner ear structures which explain their special hearing capabilities. Structural specializations include an extension of the swim bladder that terminates within the inner ear and a high degree of specialization within the utricluar region of the inner ear (Popper et al. 2004b). Atlantic herring hears in an extended range of frequencies between 30 Hz and 4 kHz, with a hearing threshold of 75 dB re 1 μPa at 100 Hz (Enger 1967) (Figure 15). The audiogram was determined in a neurophysiological investigation rather than in behavioural experiments. Nervous responses to pure tone stimulation were measured (Enger 1967). More recent investigations demonstrated ultrasound detection in clupeiform fishes like the American shad (*Alosa sapidissima*) (Mann et al. 1998) and gulf menhaden (*Brevoortia patronus*) (Mann et al. 2001). However, this capability is probably restricted to the subfamily Alosinae (shads) (Mann et al. 2001). The hearing of the closely related Pacific herring (*C. pallasii*) was investigated by ABR technology and it was shown that it does not include ultrasound (Mann et al. 2005). In the lower frequencies (100 - 5,000 Hz), the hearing thresholds were typical of other clupeids and had a similar shape but less sensitivity than the neural recordings performed with Atlantic herring (Enger 1967) (Figure 15).

On the basis of the above the COWRIE Report concluded that cod and herring will be able to perceive piling noise at large distances, perhaps up to 80 km from the source. It also considered that dab and salmon might detect pile-driving pulses also at considerable distances from the source but since both species are predominantly sensitive to particle motion and not pressure the detection radius could not be defined. Behavioral effects, like avoidance and flight reactions, alarm response and changes of shoaling behaviour are possible due to piling noise. The spatial extension of the zone of responsiveness can not be calculated as the available threshold levels vary greatly. The zone of potential masking might in some cases coincide with the zone of audibility. Also physical effects, like internal and external injuries or deafness (TTS/PTS) up to cases of mortality may happen in close vicinity to pile driving operations.

The study undertaken by RPS Energy and Subacoustech Ltd for CORE Limited on behalf of the Developers of the Thames estuary offshore wind farm projects included a more comprehensive analysis of the potential physical and behavioural effects on marine mammals and fish associated with the underwater noise generated by the pile driving operations for the steel monopile foundations.

The dB_{ht} (Species) metric developed by Subacoustech Ltd forms the basis of the analysis, as it provides a measurement of sound that accounts for inter-species differences in hearing ability by passing the sound through a filter that mimics the hearing ability of the species. A set of coefficients is used to define the behaviour of the filter so that it corresponds to the way that the acuity of hearing of the candidate species varies with frequency. The level of sound is measured after the filter; the level expressed in this scale is different for each species (which is the reason that the specific name is appended) and corresponds to the likely level of perception of the sound by that species. It is thus closely analogous to the dB (A) scale used for human noise exposure. The Subacoustech report notes that while the scale was still in the process of validation, initial experimental results indicated that at levels of 90 dB_{ht} and above, strong avoidance reaction occurs and that strong avoidance in this context related to a high proportion of fish (c. 90%) being deflected from their swim path. The scale therefore has the benefit that it is prospectively possible to apply it to both hearing damage and behavioural effects such as avoidance. The dB_{ht} can be applied to both narrow and broadband sources by integrating the level above threshold over the frequency range of the sound source.

The Subacoustech report notes how the concept of auditory injury from exposure to noise is well established for airborne sound exposure to humans. At a high enough level of sound, traumatic hearing injury may occur even where the time exposure is short and injury of this type is normally associated with immediate and irreversible hearing loss. Injury also occurs at lower levels of noise where the period of exposure is long and in this case the degree of hearing damage depends on the level of the noise and the period of exposure to it. The report describes how the degree of hearing damage for complex and time varying signals can be related to 'Noise Dose' which effectively combines the continuous noise level containing the same sound energy as the time varying sound (the equivalent level of noise, or L_{eq}) and the duration of exposure. The report refers to research by Ward (1997) providing guidance on the exposure period to sound levels above hearing threshold (dB_{ht}) over which hearing injury can occur in humans and by Schlundt *et al* (2000)) as to how this effect translates to marine mammal and fish species exposure to underwater sound. It also quotes a recent review by Marsden *et al* highlighting experiments with marine mammals demonstrating a near linear relationship between sound exposure level and duration of exposure (i.e. an equal 'Energy Dose' relationship) and presents a Table, similar to Table 7.1 below showing how each doubling of the noise energy (3 dB increase in noise level) results in a halving of the acceptable exposure period. The same 'Noise Dose' (and therefore potential for auditory injury) occurs, for instance, following an exposure of 90 dB above threshold level for a species for a duration of 8 hours, 93 dB above threshold levels for 4 hours or 130 dB above threshold for a few seconds. Hearing impairment in the form of Temporary Threshold Shift (TTS) in hearing may occur where a species is exposed to these levels for the durations identified, and Permanent Threshold Shift (PTS) will occur with repetitive exposure. The higher the 'Noise Dose' above this limit, the more rapid will be the damage.

Exposure Level dB(A) or dB_{ht}	**Exposure Duration**
90	8 hours
93	4 hours
99	1 hour
110	Approx. 5 minutes
120	Approx. 30 seconds
130	Approx. 3 seconds

Table 7.1 Comparison of noise exposure level and duration for the same cumulative 90_{LEPD} Noise Dose

On the basis of the above it is concluded that fish may suffer hearing impairment should they be exposed to continuous or repeated underwater sound from a source such as the pile driving for a period of time. The 'Noise Dose' that a species will accumulate will depend on the following:

- The incident level of the underwater sound and hence the distance from the source.
- The hearing threshold and associated dB_{ht} of the particular species.
- The behaviour of the species to the noise – if the fish moves away from the source following the initial pile strikes the incident levels of subsequent strikes will reduce accordingly.
- The time period and repetition rate of the pile strikes.

In order to predict auditory and behavioural response effects on different fish species, Subacoustech Ltd. estimated the level of noise from the proposed piling operations by making use of an existing database of piling noise measurements undertaken by them of piling noise in similar coastal locations. The measured data from piling operations at Barrow, North Hoyle, Scroby Sands and Kentish Flats offshore wind farm developments indicated a clear dependence on the depth of water with piling operations in very shallow water conditions (a few metres), over a number of kilometres are also very shallow, lead to poor underwater sound propagation and low sound levels. At deeper water sites (10m or more), the sound propagates to greater range and the underwater sound levels are much higher. Allowance was made in the estimates for the different underwater sound propagation conditions that can result from varying bathymetric conditions and also for variations in pile diameter which can affect the source level of the noise.

Estimates of noise were made both in conventional units such as unweighted peak pressure and impulse, and using the frequency weighting technique developed by Subacoustech Ltd. based upon the hearing threshold of the species (dB_{ht}), to predict auditory and behavioural response effects.

The lethal range for impact piling operations was estimated at 5m in shallow water and 10m in deep water sites. The corresponding physical injury ranges were estimated at 50m and 150m respectively.

Auditory injury was assessed by considering the cumulative 'Noise Dose' for a marine species based on the continuous equivalent loudness level. The results indicated that auditory injury can occur from within the 150m physical injury range, based on a single pile strike, to a range of up to 3 km for a fish with high auditory sensitivity such as herring should the fish remain within this range for the full c. 5 hour duration of a typical piling operation. Outside of this range, the predicted perceived loudness is sufficiently low that auditory injury is unlikely to occur. In practice, unless a marine species is within a range of c.300m of the piling operations and receives an unacceptable 'Noise Dose' causing auditory injury within the first few minutes of piling, the loudness of the transient pressure wave is likely to cause an aversive behaviour response resulting in the fish fleeing the area before auditory injury occurs. On this basis it is concluded that the analysis suggests that the duty cycle of the transient pressure wave noise from the repeated pile strikes is sufficiently low that auditory injury from the accumulation of noise in marine species is considered unlikely.

Behavioral impact of marine species was assessed using a 90 dB_{ht} peak to peak level criteria. The analysis predicted that the piling noise is likely to be aversive to fish species in ranges varying from 4km for bass to 28km and 30km for cod and herring respectively.

The data in the following table summarises the impact range data for typical fish species from a 6.5m diameter piling operation for a deep water site based on current best information regarding Source Level noise from impact piling operations as presented in the Subacoustech report. Sound transmission loss with range has been predicted from measured data in similar bathymetric conditions. Hearing threshold is based on current peer review data, and in general, more sensitive data were preferred thereby providing a conservative over-estimate of loudness. The behavioural impact is based on a strong avoidance response (deflection) to the sound at a level of 90 dB_{ht}.

Species	**Peak to peak Perceived Source Level (dB_{ht} @ 1m)**	**Auditory injury range 92 dB_{ht} L_{eq}**	**Behavioral Impact 90 dB_{ht}**	**Range to background sea noise**
Cod (Gadus morhua)	163	2 km	28 km	100 km
Herring (Clupea harengus)	180	3 km	30 km	100 km
Dab (Limanda limanda)	154	200 m	7 km	80 km
Bass (Dicentrarchus labrax)	152	50 m	4 km	80 km

Table 7.2 Summary of impact range for typical fish species from a 6.5 m diameter piling operation for a deep water site

Given the varying bathymetric conditions on the Kish and Bray banks with water depths varying from a few metres towards the crest of the banks up to c. 30m towards the outer edges of the array it is considered that the adoption of the higher predicted noise levels for the deeper water as presented in the above table will represent the most onerous condition that might apply. It is also noted that the predicted source levels in the Subacoustech Report for the Thames estuary projects are based on a 6.5m diameter impact piling operation which is the maximum pile diameter envisaged for the Dublin Array project and that any subsequent reduction in pile diameter is likely to reduce the source level accordingly.

Table 8.2 of the report prepared by RPS Energy on the Underwater Noise Impact Assessment on Marine Mammals and Fish during Pile Driving for the Thames Estuary Wind Farm projects summarises the likely impacts on fish based on the above physical and behavioural effects associated with the noise from the impact piling operations as follows:

Mortality and Physical Injury: The table concludes that in the presence of soft start up techniques, as proposed for the Dublin Array under mitigation measures below, it is considered highly likely that both cod and herring would move a sufficient distance from the piling works to reduce the risk of mortality or auditory injury to ones of negligible to possibly minor significance. For other species, including sole, plaice and bass it considers that the impacts are likely to be of minor to possibly moderate significance in the absence of soft start up and negligible to minor significance with the use of soft start up.

Displacement: The table concludes that the potential impact on herring spawning as a consequence of displacement as being of minor to possibly major significance given the behavioural impact distance of up to 30km for this species. However, there are no known herring spawning grounds within this range of the Dublin Array. For other species the report considers the impact the be of negligible to minor significance on the basis of extensive spawning grounds and with the exception of cod, the relative small distances over which disturbance is likely. As detailed in Section 7.2.5., three species with extensive spawning grounds are known to spawn within the development site for the Dublin Array, namely, lemon sole, sprat and nephrops. On a similar basis to the Thames estuary projects given the extensive spawning areas for these species and the limited distances over which disturbance is likely it is considered that the impact of noise from the piling operation will be of negligible significance.

7.3.1.5 Pollutants and Waste

Pollutants and chemicals used during the construction phase of the wind farm could contaminate the area. Potential contamination of sediments and marine organisms from the accidental release of organic polymers or heavy metals associated with cementing and/or grouting materials from the foundations may occur. This material could be toxic to marine organisms whilst the grout is wet, while potentially contaminating the seabed sediments and inhibiting decolonisation of the area after construction. Chemical contamination could also occur from accidental spillages, such as oil and other chemicals through poor operational management, non-removal of spillages, storage, handling and transfer of oil and chemicals. However, suitable precautions and best practice for the storage, handling and disposal of such material will be followed, reducing this potential impact to insignificant levels.

7.3.2 Long Term Impacts

7.3.2.1 Changes to Habitat and Feeding Grounds

There would be a permanent, direct loss of seabed habitat under the 'footprint' of the turbine foundations. As a result non-mobile species occurring in the 'footprint' would be lost by smothering and clogging, and mobile species utilising these habitats for feeding and spawning would lose this resource. However, the total area of the turbine 'footprints' would be low compared to the total, available habitat in the area.

Habitats may be altered locally around the turbine structures due to changes in the hydrodynamic environment. The physical presence of the turbines would result in local changes of water movement around the base of the turbines. This may result in a change in sediment deposition and erosion patterns which could lead to changes in the substratum and habitat at these locations. The impact on sediment transport and erosion patterns would be addressed through the use of scour protection and through careful design of the turbine foundations, and so these changes are not expected to be significant. Neither is it expected that there would be a change to the hydrodynamic regime on a wider scale due to the interaction of impacts from multiple turbines, and so it is expected that there would be no changes to the wider fisheries environment due to changes in the hydrodynamic regime.

7.3.2.2 Loss of Species

There will be a permanent, direct loss of sessile species under the 'footprint' of the turbine foundations. Mobile species will not be directly affected as they will move from the disrupted area but may be indirectly affected as feeding and spawning grounds would be reduced.

Species composition may change as a result of the alteration of water movements, the addition of new habitats in the form of hard substrata and potential changes in seabed morphology and water depth. However, it is predicted that these impacts would be minimal as the existing environment is already a dynamic one.

7.3.2.3 Noise and Vibration

The main source of underwater noise associated with the operational phase of the project will be structural noise transmitted into the water column via the supporting monopiles. An overview of the expected sources and potential impacts of such noise sources on fish is presented in the COWRIE report (Thompson *et al.* 2006). Their modelling concluded that species such as dab and salmon might detect the operational noise at relatively short distances of less than a km while for the more sensitive species, such as cod and herring, the zone of audibility could extend up to 4 to 5 km. The level of behavioural response within this detection area is not well understood but is likely to occur only within very close range. Wahlberg and Westererg (2005) estimated the range to which fish can be scared away from an operational wind turbine at only 4 metres.

7.3.2.4 Electromagnetic Fields

Electromagnetic fields formed around submarine cables could potentially have an effect on electrosensitive marine fauna. A number of research projects have been undertaken by COWRIE into the likely field strengths and potential effects on marine species CMACS 2003; CMAS 2005; CMACS 2006). A literature review of research into this area, undertaken for the Scottish Marine Renewables SEA (Scottish Executive, 2006) concluded the following:

- Electrical and magnetic fields generated by the operation of offshore wind, wave and tidal devices are likely to be small and within the variation range of naturally occurring fields in the study area, but detectable to electro/magnetosensitive species. Burial of the cables will offer protective barrier to such species from the strongest magnetic and induced electric fields generated next to the cable.
- Marine teleost (bony) fishes do not react to electric field strengths of less than 6 V/m (several orders of magnitude greater than the estimated field strength from the inter array and export cables). No effects are expected.
- Current research indicates that certain species of elasmobranches are likely to be able to detect the level of electric field that will be generated by a typical export

cable but the field would not cause an avoidance reaction. Furthermore there is no evidence to indicate that existing cables have caused any significant effect on elasmobranch migration patterns.

There is also a potential for heat emissions from the cables while conducting electrical current. However this would generally dissipate into the immediate sediment covering the cable and not increase the temperature at the surface of the seabed in a measurable way.

7.3.2.5 Pollutants and Waste

Contamination of the area due to accidental spillage of pollutants or waste from vessels maintaining the turbines is a potential risk during the operational phase of the wind farm. However, suitable precautions and best practice for the storage, handling and disposal of such material will be followed, reducing this potential impact to insignificant levels.

7.3.2.6 Obstructions to Fishing Activity

Potential impediments to fishing activity depend on the type of activity involved. The use of static gear would not be affected. For instance, the setting out of pots for fishing of whelks or similar shellfish would remain possible in the presence of the turbines. Indeed the rock armouring may provide habitat suitable for lobster and other crustaceans fished for with static gear. Bottom trawling would not be possible on the banks. This is not expected to have a negative impact on fisheries since the banks are not important for trawling (the Bray Bank is too dangerous to trawl).

7.3.2.7 Decommissioning

The impacts that would arise during decommissioning of the turbines would be similar to the short term impacts described above. A larger impact would be experienced during the removal of the foundations and the cables as the habitats that would have developed on these structures would be removed.

7.3.3 Cumulative Impacts

When assessing the cumulative impacts it is necessary to also consider the effect of other developments that together with the current project would have a cumulative impact on the marine environment. This impact could be at a regional level (within the immediate geographic area of the development), but also in terms of the resource that is being impacted such as the sandbanks along the east coast of Ireland. These are a finite habitat resource.

The Arklow Bank wind farm, off the coast of Co. Wicklow, was the first offshore wind farm development to be granted a foreshore lease for development around Ireland. The Arklow Bank is located approximately 40 km south of the Kish and Bray Banks and it is proposed that 200 turbines will be erected on the bank over a 4-5 year period with a generating capacity of 500 MW. To date, seven turbines, with an installed capacity of 25.2 MW, have been constructed. The Codling Bank wind farm (Fred Olsen Renewables & Treasury Holdings) has also been granted a foreshore lease. This is to consist of 220 turbines arranged in a grid pattern with an installed capacity of between 550-1100 MW. It will be located to the immediate south of The Dublin Array. Many other exploratory licences have been granted for the other sand banks along the east coast, including the Blackwater Bank (Wind Farm Developments and Harland & Wolff licences Ltd), Dundalk Bay (Oriel Windfarm Ltd) and Clogher Head (Sure Engineering (Europe) Ltd) off Co. Louth.

The main cumulative impacts of offshore wind farms on fish are the loss of habitat and species under the ‘footprint’ of the turbine foundations and cable laying, the alteration of the hydrology and the effects of vibration, noise and electromagnetic fields emanating from the cables.

7.3.3.1 Loss or Alteration of Habitats and Loss of Species

It is predicted that the total area of fisheries lost by cumulative developments is likely to be low compared to the total available habitat along the east coast of Ireland. In addition cumulative species loss is likely to be low as the sand banks are low in species diversity due to the mobile nature of the substratum. The increase in areas of hard substratum may increase the species diversity along the banks over time as new species colonise the turbine foundations and attract fish and mobile invertebrates.

7.3.3.2 Alteration of Hydrology

The siting of wind turbines on the sand banks may alter the water movements locally but not on a wider scale. It is highly unlikely that the cumulative effect of the developments along the east coast of Ireland would have a significant effect on the hydrodynamics of the coast in general and therefore would have little potential cumulative impacts on commercial fisheries.

7.3.3.3 Noise and Vibrations

The distance between the various proposed wind farms is such that the cumulative effects of noise, vibrations and electromagnetic fields emanating from the cables and turbine foundations on commercial fisheries would be negligible.

7.3.3.4 Electromagnetic Fields

It is difficult to quantify the cumulative electromagnetic impacts of electrical cables along the east coast of Ireland, however it is predicted that electromagnetic fields will be localised and as such will not result in a cumulative effect.

Overall, it is expected that the cumulative effect of the other consented wind farm developments and The Dublin Array on the fish of the sand banks along the east coast of Ireland would be minimal.

7.4 Mitigation Measures

7.4.1 Loss or Alteration of Habitats and Loss of Species

To minimise habitat and species loss and disturbance, the area of seabed disturbed by the cable trench and turbine foundations would be kept to a minimum. Following construction of the cable trenches, efforts would be made to restore habitats to their current condition, if impacted upon. Cable trenches would be filled to their pre-construction level, minimising changes in the water flow regime, and with material of a similar particle size to allow decolonisation of bentic species. The siting of the turbine foundations and cable trenches in low species diversity habitats would minimise the loss of species. In the case of the cable route, the cable may be rerouted to avoid areas of sensitive habitat completely.

7.4.2 Increased Turbidity and Scour Protection

The amount of suspended solids released into the water column due to construction is considered to be insignificant compared to background turbidity levels. In any case, to minimise the amount of suspended solids released into the water column during construction, efforts would be made to minimise the area of seabed disturbed.

Scouring by waves and tidal currents around the base of the turbines would be prevented by the installation of rock armour around the turbine bases.

7.4.3 Noise and Vibration

The report prepared by RPS Energy on the Underwater Noise Impact Assessment on Marine Mammals and Fish during Pile Driving for the Thames Estuary Wind Farm projects examined a number of potential mitigation measures to reduce the impact of noise from the piling operations. These included noise reduction and noise transmission mitigation measures (e.g. bubble curtains, cushioning, etc.), soft start, acoustic harassment devices, marine mammal observers (MMOs), acoustic monitoring (passive and active), etc. The review indicated that mechanical soft starts would reduce the lethal and injurious effects of noise on fish within close proximity to the piling operations. The review of noise reduction measures indicated that emerging technologies associated with marine piling are not yet established. On this basis it is concluded that adopting a mechanical and acoustic soft start procedure will represent the most effective mitigation measure to reduce the impact of noise from the piling operations on fish.

7.4.4 Electromagnetic Fields

Further detailed studies are required to fully ascertain the impacts of these fields on fish. Cables would avoid sensitive areas such as those used for spawning or nursing and electromagnetic fields will be minimised by the use of appropriately sheathed/insulated cables and burial of the cables to a minimum depth of 1 m below the seabed.

7.4.5 Pollutants and Waste

To minimise the impact of pollution and waste from maintenance and boat traffic it is necessary to minimise the likelihood of any spillage or contamination. Potential contaminants would be stored in suitable storage facilities, such as bunded containers while at sea. Contractors installing turbines would use chemicals that have been approved for use in the marine environment and employ methods that minimise the release of polluting materials into the water column.

Waste and litter generated during construction would be returned to the shore for authorised disposal at suitable facilities. Utmost care and vigilance would be followed to prevent accidental contamination of the site and surrounding environment during the construction of the wind farm. Construction and on site operating procedures would be followed to the highest industrial standard to minimise unnecessary disturbance and prevent accidental spillage of contaminants. Turbine towers would be bunded to prevent any such leakage of industrial fluids.

7.4.6 Obstruction to Fishing Activities

Due to the lack of usage of the banks for trawling and the lack of restrictions on other fishing activity by the proposed development, combined with the fact that the characteristics of the turbines, inter-turbine cables and export cables are inherent to the functioning of the wind farm and cannot be changed, no mitigation measures are proposed.

8 MARINE ECOLOGY

8.1 Introduction

The proposed Dublin Array offshore wind farm development on the Kish and Bray banks will involve the installation of up to 145 wind turbines and associated works including foundations and cable laying. This section of the EIS describes the bentic flora and fauna (that is marine life that lies on the sea bottom) at the shore (littoral zone) in the vicinity of the proposed electricity cable landfall locations and beneath the sea (sub-littoral) on the Kish and Bray Banks and along the proposed cable route to shore. Also detailed are fish and plankton species in the existing environment, both on the Kish and Bray Banks and in the surrounding areas. Potential impacts of the proposed development during construction, operation and decommissioning are discussed and mitigation measures proposed by the Developers are addressed.

An initial bentic survey of the Kish and Bray banks, conducted by Ecological Consulting Services Ltd. (Ecoserve) on behalf of the Developers in 2002, provided an assessment of the baseline bentic flora and fauna, fish populations, zooplankton and phytoplankton communities. Sampling was carried out during July (bentic flora and fauna), September (fish and plankton) and November (plankton) of 2002. Due to unsuitable weather conditions it was not possible to conduct any fieldwork during May and June 2002. A copy of EcoServe's report on this initial baseline assessment of the marine ecology on the Kish and Bray banks is presented in Volume 3, Appendix F.

Ecological Consulting Services (EcoServe) were subsequently engaged by the Developers to undertake a re-characterisation survey and to update their assessment in 2008. The scope of the re-characterisation survey and associated assessment included the following:

- Conduct a littoral and sub-littoral survey of the proposed development area in order to provide updated data on fauna and flora of the Kish and Bray banks area,
- Assess the bentic habitat, flora and fauna of the proposed off-shore cable route and the two potential landfall sites being considered at that stage,
- Assess changes, if any, to the bentic marine environment of the Kish and Bray banks since the original survey,
- Make an assessment of likely impacts of the proposed development on the existing bentic environment
- Provide recommendations and mitigation measures to minimise any potential impacts of the proposed development on the existing bentic environment.

A copy of the Ecological Consulting Services Ltd. (EcoServe) Report on same is included in Volume 3, Appendix F.

8.2 Description of Bentic Flora and Fauna, Fish and Plankton in the Existing Environment

The Kish Bank and Bray Bank are submarine banks consisting mainly of sand and gravel. The northern 10-12 km is called the Kish Bank and is located 10 km east of Dun Laoghaire, Co. Dublin. South of this point the bank extends a further 10 km as the Bray

Bank. It is approximately 2.2 km wide at its widest point. The area of the bank shallower than 20 m BCD (below chart datum) is 28 km², of which half is shallower than 10 m BCD. The shallowest part of the bank is 1.6 m BCD and slopes down to depths exceeding 40 m BCD to the east and steadily shallows towards the land to the west. As detailed in Chapter 5, the main shipping channel into Dublin Bay runs close to the northern end of the bank.

Sand banks comprise of sloping plains of sediment. They are primarily composed of sandy sediments permanently covered by water. The diversity of communities associated with this habitat is determined particularly by sediment type together with a variety of other physical and chemical factors. Sandbanks in Irish waters are found predominantly in the Irish Sea (NPWS, 2008). Sandbanks which are slightly covered by seawater all the time are listed under Annex I of the EU Habitats Directive (92/43/EEC). Annex I highlights natural habitat types of community interest whose conservation requires the designation of a representative sample of the habitat type as Special Areas of Conservation (SAC). Ireland has already identified sandbanks for SAC designation which do not include the Kish and Bray banks.

Shallow sandy sediments are typically colonised by burrowing polychaete worms (*Glycera lapidum*, *Nephtys* spp., *Spiophanes bombyx*, etc.), crustaceans (*Pontocrates arenarius*, *Bathyporeia elegans*, etc.), bivalve molluscs (*Abra Alba*, *Fabulina fabula*, etc.) and echinoderms. Epifauna at the surface of the sandbank may include mysid shrimps, gastropods, crabs and fish. Sand-eels (*Ammodytes* spp.), an important food for birds, often live in sandy sediments, whereas coarse stable material, such as shells or stones is inhabited by hydroids, bryozoans and ascidians (NPWS, 2008)

Shallow sandy sediments are often important nursery areas for fish and consequently can provide feeding grounds for seabirds (especially puffins *Fratercula arctica*, guillemots *Uria aalge* and razorbills *Alca torda*) and sea-duck (e.g., common scoter *Melanitta nigra*) (NPWS, 2008). Kish and Bray banks were surveyed on a number of occasions since 1996 (Table 8.1).

Survey	**Reference**	**No. of stations**	**Sampling technique**
BioMar, 1996	Picton & Costello, 1998	9	Biological dredge
SensMap, 1999	EcoServe, 2001	11	Biological dredge
Dublin Array Windfarm Baseline Study, 2002	EcoServe, 2004	41, 4, 3	Biological dredge, Agassi trawl, Plankton survey
Bentic surveys of sand banks in the Irish Sea, 2005	Roche et al., 2007	12	Day grab

Table 8.1 Previous marine surveys conducted in the Kish and Bray bank area

8.2.1 Sublittoral bentic invertebrates

The BioMar project surveyed nine sites on and around the Kish and Bray bank areas using a rock dredge and recorded 66 macroinvertebrate species or higher taxa with an average of 15 species per site (Picton & Costello, 1998). During the SensMap project 11 sublittoral sites located between the banks and the shore were characterised with a total of 77 macroinvertebrate species recorded with an average of 13 species per site (EcoServe, 2001). A more comprehensive marine survey (41 sites) conducted by EcoServe for a baseline study in relation to the proposed offshore wind farm development on Kish and Bray banks recorded 107 macroinvertebrate species with an average of 12 species per site (EcoServe, 2004). The differences in total number of bentic invertebrate taxa recorded were likely to be attributable to the different sampling effort (number of samples) rather than to species richness, with more comprehensive studies covering a greater diversity of microhabitats. Full species lists from the 2002 EcoServe survey are included in their respective reports for the 2002 and 2008 surveys (Volume 3, Attachment F). More recently, Roche *et al*. (2007) sampled 12 sites on Kish bank and found a total of 101 species.

The species composition recorded by Roche *et al*. (2007) was dominated by oligochaete worms (>50% taxa recorded), which is different to previous studies. Macrobentic fauna from the baseline study samples were dominated by molluscs, whereas the SensMap and BioMar surveys recorded more even proportions of different taxonomic groups (Figure 8.1). These differences are most likely a result of different sampling methodology, with grab samples recording a greater abundance of smaller (<1 cm) infaunal species compared to biological dredge method.

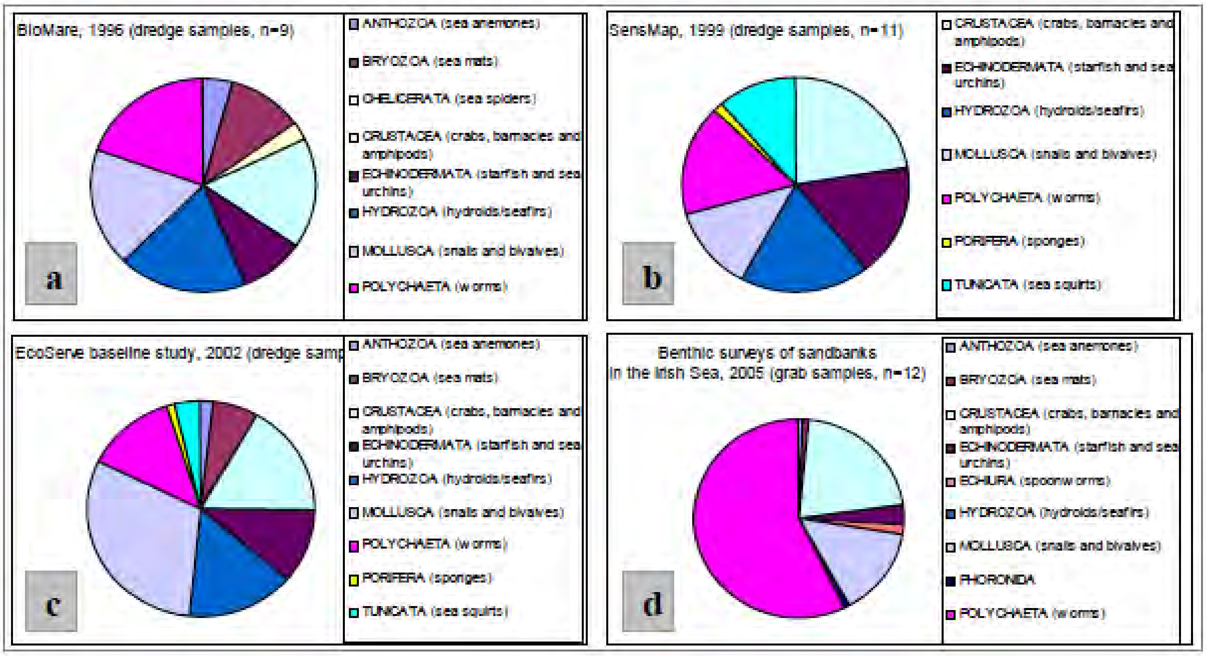


Figure 8.1 Relative proportion of different taxonomic groups in bentic invertebrate samples from Kish and Bray banks area

(Based on data from: (a) Picton & Costello, 1998 (b) EcoServe, 2001 (c) EcoServe, 2004 (d) Roche et al., 2007)

The highest species diversity was recorded in areas of coarse shell, pebbles and cobbles in the southwest, south and east of the banks, whereas very few species were recorded from the fine sand on the banks (EcoServe, 2004).

The polychaete worm, *Sabellaria spinulosa*, was recorded at one location in 1996 (Picton & Costello, 1998). *S. spinulosa* is an occasionally gregarious segmented worm that builds tubes from sand or shell fragments and was recorded in the area during BioMar survey. It is mostly found individually, but may form thin crusts or large biogenic reefs under some conditions and occurs on all British and Irish coasts (Jackson & Hiscock, 2008). The species is noted as important by the Marine Conservation Society (Gubbay, 1988) and Nature Conservancy Council (Davidson *et al*., 1991) and is included in the UK Biodiversity Action Plan. To date there is no statutory conservation status assigned to *S. spinulosa* in Ireland.

During the baseline study (EcoServe, 2004), the following distinct faunal assemblages (biotopes) were identified in the sublittoral zone of the study area:

- (IGS) Infralittoral gravels and sands
- (IGS.Mob) Sparse fauna in infralittoral mobile clean sand
- (IGS.ScupHyd) *Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral cobbles or pebbles in coarse sand
- (IMS.EcorEns) *Echinocardium cordatum* and *Ensis* spp. in lower shore or shallow sublittoral muddy fine sand
- (CMS.AbrNucCor) *Abra alba*, *Nucula nitida* and *Corbula gibba* in circalittoral muddy sand or slightly mixed sediment
- (MCR.FaAlC.Abi) Faunal and algal crusts, *Echinus esculentus*, sparse *Alcyonium digitatum*, *Abietinaria abietina* and other grazing-tolerant fauna on moderately exposed circalittoral rock
- (ECR.PomByC) *Pomatoceros triqueter*, *Balanus crenatus* and bryozoan crusts on mobile circalittoral cobbles and pebbles
- (ECR.Alc) *Alcyonium*-dominated communities (tide-swept/vertical)

8.2.2 Fish fauna

Four trawls were taken during the 2002 Baseline survey: one to the north, south, east and west of the Bank. Eight species of fish were caught, all of which were bottom feeding species. Numbers of fish recorded during the 2002 trawl survey were generally low and species included flatfish such as plaice (*Pleuronectes platessa*), dab (*Limanda limanda*) and lemon sole (*Microstomus kitt*) as well as Thornback Ray (*Raja clavata*), Whiting (*Merlangius merlangus*), Grey gurnard (*Eutrigla gurnardus*), Lesser Weever fish (*Echiichthys vipera*) and Butterfish *(Pholis gunnellus*). In addition, herring (*Clupea harengus*), two-spotted clingfish (*Diplecogaster bimaculata*), lesser sand eel (*Ammodytes tobianus*), greater sand eel (*Hyperoplus lanceolatus*) witch flounder (*Glyptocephalus Cynoglossus*) and dab (*Limanda limanda*) were recorded from dredge samples. Potential impacts of the proposed development on fish species and commercial fisheries is addressed in Chapter 7 of this Environmental Impact Statement.

8.2.3 Plankton community

Two zooplankton and phytoplankton samples were taken during the September 2002 survey: one to the north and one to the south of the Kish Bank. During the November 2002 survey it was only possible to take plankton samples from the north of the Banks due to poor weather conditions. Two replicates were taken at each site.

Two sites were examined in September 2002, one to the north of the Kish Bank and one to the south of the Bray Bank and a total of 20 zooplankton species or higher taxa were recorded from samples. Calanoid copepods were the dominant fauna. The analysed samples showed plankton composition typical of coastal temperate regions in autumn. The presence of numerous diatoms *Coscinodiscus* spp., *Biddulphia* spp., *Eucampia zodiacus*, *Chaetocerous* spp. and the dinoflagellate *Noctiluca* spp. in the net samples, particularly at the stations, indicated that an autumnal phytoplankton bloom was occurring at the time of sampling. Small calanoid copepods were the dominant zooplankton representing 80-90% of total. *Temora longicornis* was the best represented species (38 - 54%) followed by *Centropages hamatus* (27 - 43%). The station to the north of Kish Bank recorded a higher proportion of larval stages, particularly of

polychaetes and bivalves reflecting more coastal characteristics than the station south of Bray Bank. No fish eggs or fish larvae were found at any of the stations examined.
One site located to the north of Kish Bank was examined in November 2002, and a total of 14 zooplankton species or higher taxa were recorded from the sample. The samples analysed presented a large amount of macro-algal debris and fine to large sand grains indicating that water column was thoroughly mixed at the time of sampling. The plankton composition was similar to that observed in September with few exceptions. The large diatoms particularly *Coscinodiscus* spp., *Biddulphia* spp., which were found two months earlier, had largely disappeared leaving behind few broken cell remains. The zooplankton assemblage was still dominated by copepods (43 % - 58 %), although their proportion had substantially decreased. Among the copepods, *C. hamatus* (22 % - 26 %) was still well-represented whereas *T. longicornis* had been replaced by *Pseudo-paracalanus* spp. (13 %-27 %), a species more tolerant of winter conditions. Bivalve and brittle-star larvae were better represented and had achieved a larger size suggesting that environmental conditions (i.e. food sources and temperature) were still favourable for the growth of these organisms. A thorough screening of the complete samples indicated that no fish eggs or their larvae were present.
A total of 19 and 17 species or higher phytoplankton taxa were recorded in September and November 2002 surveys respectively (EcoServe, 2004).

8.2.4 Physical Environment

Temperature and dissolved oxygen data collected during the baseline study showed little variation between depth and site and showed that the waters in the top 20 m around the Kish Bank were well mixed (EcoServe, 2004). Roche *et al*. (2007) reported that the sediment was dominated by fine and medium sand with very low organic carbon fraction.

8.2.5 Re-Characterisation Survey Methodology

8.2.5.1 Littoral survey

A characterisation survey of the species and biotopes of the intertidal area of the proposed development was carried out on 6th May 2008 during low spring tide. The survey was based around the two landfall sites being considered at that stage (Landfall A was subsequently selected as the preferred option). Species and biotopes along the stretch of the shore up to 500 m north and south of each landfall site were identified and mapped, with the exception of southern Landfall B study section, which ended on the north Bray Harbour wall. Two core samples of the sediment were taken along the proposed cable route at each landfall location to be analysed for infauna. Epifauna and flora species were identified and recorded *in situ*. Species difficult to identify were retained for microscopic examination.

8.2.5.2 Sublittoral survey

A re-characterisation survey of the bentic biotopes of the Kish/Bray Bank area identified in 2002, and the cable route along the seabed between the Kish/Bray Bank and the coast was carried out on 14th May 2008. The survey was based around the sites of the original survey, representing a subset of eight sites on the Kish and Bray banks and three new sites along the cable route. Sites were selected within the previously identified subtidal biotopes that were likely to be representative of the current environmental conditions, i.e. tidal streams, wave action and substratum, thus covering the range of species and habitats likely to occur in the area (EcoServe, 2004) (Figure 8.4).

Samples were collected using a biological dredge sampler, with a rectangular opening of 0.5 x 0.25 m equipped with a 1 cm mesh bag for collecting sample material. A 0.1 m2 Van Veen Grab could not be successfully deployed due to an abundance of coarse material in the sediment (mainly coarse shell and some pebbles). The duration of the dredge sample was adjusted based on expected substratum in order to keep the sample volume at representative yet manageable size. Site 8 was dredged twice as the first sample returned very little material.

Samples from the biological dredge were passed through a 1 mm mesh sieve. Where feasible, material was sorted on board. Large and conspicuous fauna was identified on board and returned to the water.

8.2.5.3 Sample processing

Collected sample material was preserved using 4% formalin solution and returned to laboratory. After 48 hours samples were transferred into 70% Industrial Methylated Spirit (IMS) for further processing. Samples with a large amount of fine material were stained using Rose Bengal for sorting. Organisms were then identified to species level, where possible, using standard keys and enumerated. Colonial and encrusting organisms were not counted. Species nomenclature followed the European Register of Marine Species (ERMS). The results were compared to the existing data and interpreted using the marine biotope classification (Connor *et al*., 2004). Notes on the substratum type were recorded and a photographic record of the material returned by the dredge was taken. All sample sites were geo-referenced using a hand-held GPS for mapping and future monitoring.

8.2.5.4 Biotope mapping

A biotope is a term which describes the physical 'habitat' of an area with its biological 'community'. Using the list of species recorded from each site and information on the habitat type each sample site was assigned to a biotope following the descriptions from Connor *et al.* (2004) and applying the principle of best fit to each site. Dredging tends to record many neighbouring biotopes. As a result, data collected may display characteristics of more than one biotope and the final selection was based upon best fit image. Biotope maps of the survey area were then produced.
Biotope codes used for characterisation of marine habitats have been revised since the 2002 survey. This study follows the most recent biotope classification from Connor *et al.* (2004), while the biotope codes used in the 2002 survey were from Connor *et al*. (1997).

8.2.6 Re-Characterisation Survey Results

8.2.6.1 Littoral zone

Altogether eight biotopes represented by 50 species of marine fauna and flora were recorded from the intertidal zone within the study area. Full species lists and biotopes are provided in Appendix 2 of the EcoServe Report (Volume 3 - Attachment F), while full biotope descriptions are found in Appendix 4 of same.

The upper shore at the Landfall A location was composed of approximately 10-20 m zone of pebbles and cobbles with occasional pockets of coarse mobile sand and gravel. No apparent fauna or flora was recorded from this zone. Core sample (Core Site 4) taken from a sediment pocket contained only one unidentified Polychaete worm in one of the replicate samples. This barren shingle (**LS.LCS.Sh.BarSh)** zone constituted the upper shore of the whole Landfall A study area. This zone was backed by soft cliffs approximately 5 – 8 m high.

The mid-shore at the Landfall A location was composed of an approximately 10 m zone of boulders covered with ephemeral green algae (*Enteromorpha* spp.) and foliose red algae (*Porphyra* spp.) Sparse fauna was recorded from boulders at Site J (*Semibalanus balanoides*, *Actinia equina*, *Nucella lapillus* and *Patella* spp.) while Site K and Site L were devoid of epifauna. This zone was classified as ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata (**LR.FLR.Eph.EphX**).
The sublittoral fringe zone at the Landfall A location was composed of fine sand. No redox potential discontinuity layer was visible within the depth of the core sampler penetration (25 cm) indicating well-drained and oxygenated sediment. Core samples of the sediment (Core Site 3) revealed amphipod and polychaete dominated species

community typical of clean, mobile sand (**LS.LSa.MoSa.AmSco**). This zone of fine sand continued to the north of the Landfall A location, gradually replacing the boulders.

The upper part of the shore at Landfall B site was approximately 15 m wide zone of stable boulders. The lower section of the boulders (Site B) was partly covered by green ephemeral algae (*Enteromorpha* spp.) with some foliose red algae (*Porphyra* spp.) and fucoids (*Fucus serratus* and *F.* spiralis) and was classified as the biotope *Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock (**LR.FLR.Eph.EntPor**). The upper part of the boulders (Site I) was devoid of macroscopic life and was classed as High energy littoral rock (**LR.HLR**).

The lower section of the shore was composed of fine rippled sand (Site C). No redox potential discontinuity layer was visible within the depth of the core sampler penetration (25 cm) indicating well-drained and oxygenated sediment. Some *Arenicola* spp. casts were noted, but little else. Core samples of the sediment (Core Site 1 and Site 2) revealed amphipod and polychaete dominated species community typical of clean, mobile sand and the zone was assigned to the biotope Amphipods and *Scolelepis* spp. in littoral medium-fine sand (**LS.LSa.MoSa.AmSco**).

The southern end of the Landfall B study area was delineated by boulder zone with a robust community of fucoid and/or red algae (Site A, **LR.HLR.FR**). The lower shore featured some *Laminaria digitata*. This section was backed by the northern wall of Bray Harbour. Some lichens were recorded on the wall (*Verrucaria marina* and *Caloplaca marina*).
Approximately 100 m to the north of the Landfall B location, the upper shore was composed of mobile coarse sand with some gravel, pebbles and cobbles (Site H, Barren littoral shingle - **LS.LCS.Sh.BarSh**). No fauna or flora were recorded from this biotope and this barren shingle zone constituted the upper shore of the remaining part of the Landfall B study area. This zone was backed by soft cliffs approximately 5 – 8 m high.

The zone of mobile sand continued for approximately 250 m north of the Landfall B location, where it narrowed down; gradually giving place to rocky features. Site D was an area of large boulders/bedrock covered by turf-forming red algae *Rhodothamniella floridula* (Plate 4 in Appendix 5) forming the biotope *Rhodothamniella floridula* on sand-scoured lower eulittoral rock (**LR.MLR.BF.Rho**). In places the *R. floridula* turf was covered with dense community of sandtube-dwelling polychaete worms *Fabricia stellaris* and *Polydora* spp.

Further to the north, a more elevated boulder zone was found (Site E). Higher sections held high densities of the limpet *Patella vulgata* and the acorn barnacle *Semibalanus balanoides*, while the lower parts were dominated by brown, red and ephemeral green algae community (**LR.FLR.Eph.EphX**).

Site F was a boulder zone similar in species composition to Site B, with green ephemeral algae (*Enteromorpha* spp.) with some foliose red algae (*Porphyra* spp.) and fucoids (*Fucus serratus* and *F. spiralis*) and was assigned the biotope Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata (**LR.FLR.Eph.EntPor**).

Site G was a boulder zone and it featured algae as well as considerable densities of gastropods *Littorina litorea*, *Nucella lapillus* and *Patella* spp. and was classified as the biotope *Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles (**LR.HLR.MusB.Sem.LitX**).

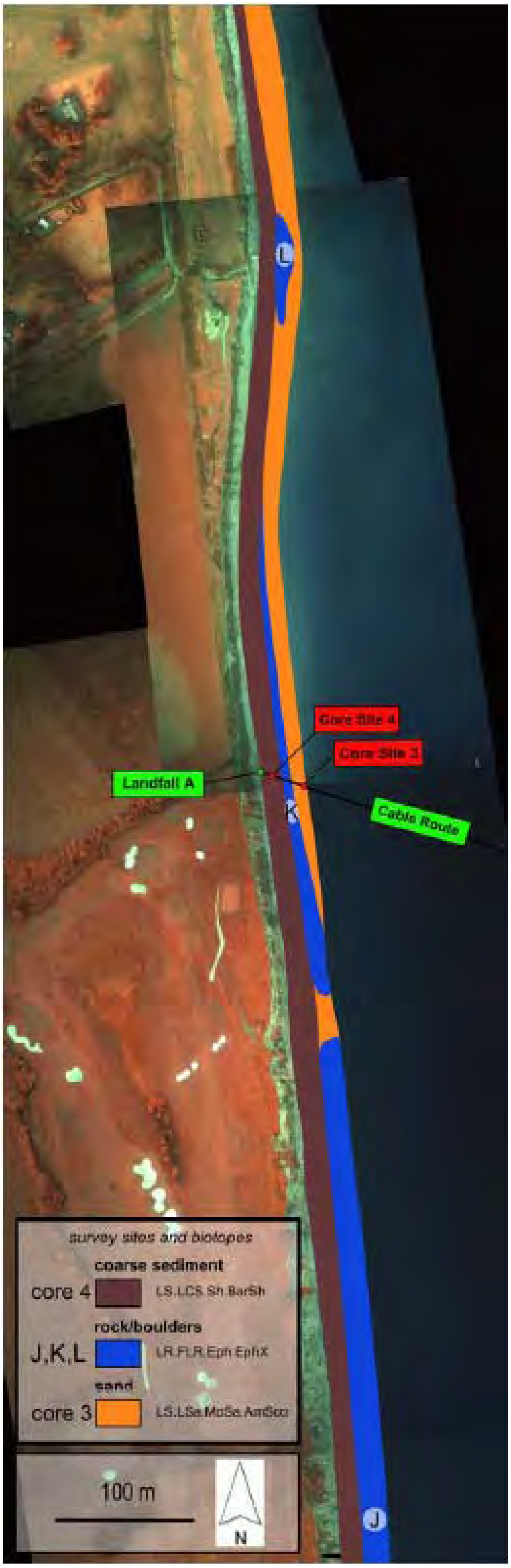


Figure 8.2 Biotope map of Landfall A area

Figure 8.3 Biotope Map of Landfall B Area

8.2.6.2 Sublittoral zone

Altogether eight biotopes represented by 180 species of marine fauna and flora were recorded from the sublittoral zone within the study area. Full species list and biotopes are provided in Appendix 2 while full biotope descriptions are found in Appendix 4.

Dredge sample number 8 was taken from the **centre** of the sandbank at the proposed origin of the cable route. The sample retained very little material. As a result the dredge was deployed twice at this station. The two sub-samples originated at the same point (8E) but ended at two different locations (8.1E and 8.2E). **Site 8** recorded very little fauna (one hermit crab *Pagurus bernhardus* and several species of Hydrozoa). No mud or stones were recorded in the sample material. The site was classified as infralittoral mobile clean sand with sparse fauna biotope (**SS.SSa.IFiSa.IMoSa**).

The **northern** part of the study area was represented by sample Site 1, Site 2 and Site 3. Site 1 was located on the landward side (north-west) of the bank, Site 2 was located on the sandbank, while Site 3 was located to the east of the sandbank. **Site 1** and **Site 2** recorded fauna typical of a coarse sand biotope complex. Macroinvertebrate community appeared to be dominated by polychaete worms with some crabs, amphipod crustaceans, bivalve molluscs, with echinoderms also present. No mud or stones were recorded in the sample material. Site 1 showed a somewhat richer fauna assemblage, similar to the *Glycera lapidum* in impoverished infralittoral mobile gravel and sand biotope (SS.SCS.ICS.Glap). However, as only two individuals of *Glycera lapidum* were recorded at this site, both stations were classified as infralittoral coarse sediment biotope (**SS.SCS.ICS**). **Site 3** was located to the north-east of the sandbank. Some mud was visible in the sample material. Large number of epibentic species recorded (predominantly hydrozoans) indicated presence of some stable substratum. Among the remaining fauna, there was no clear dominant species and the species composition could be most accurately classified as that of the biotope *Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment (**SS.SMx.CMx.MysThyMx**).

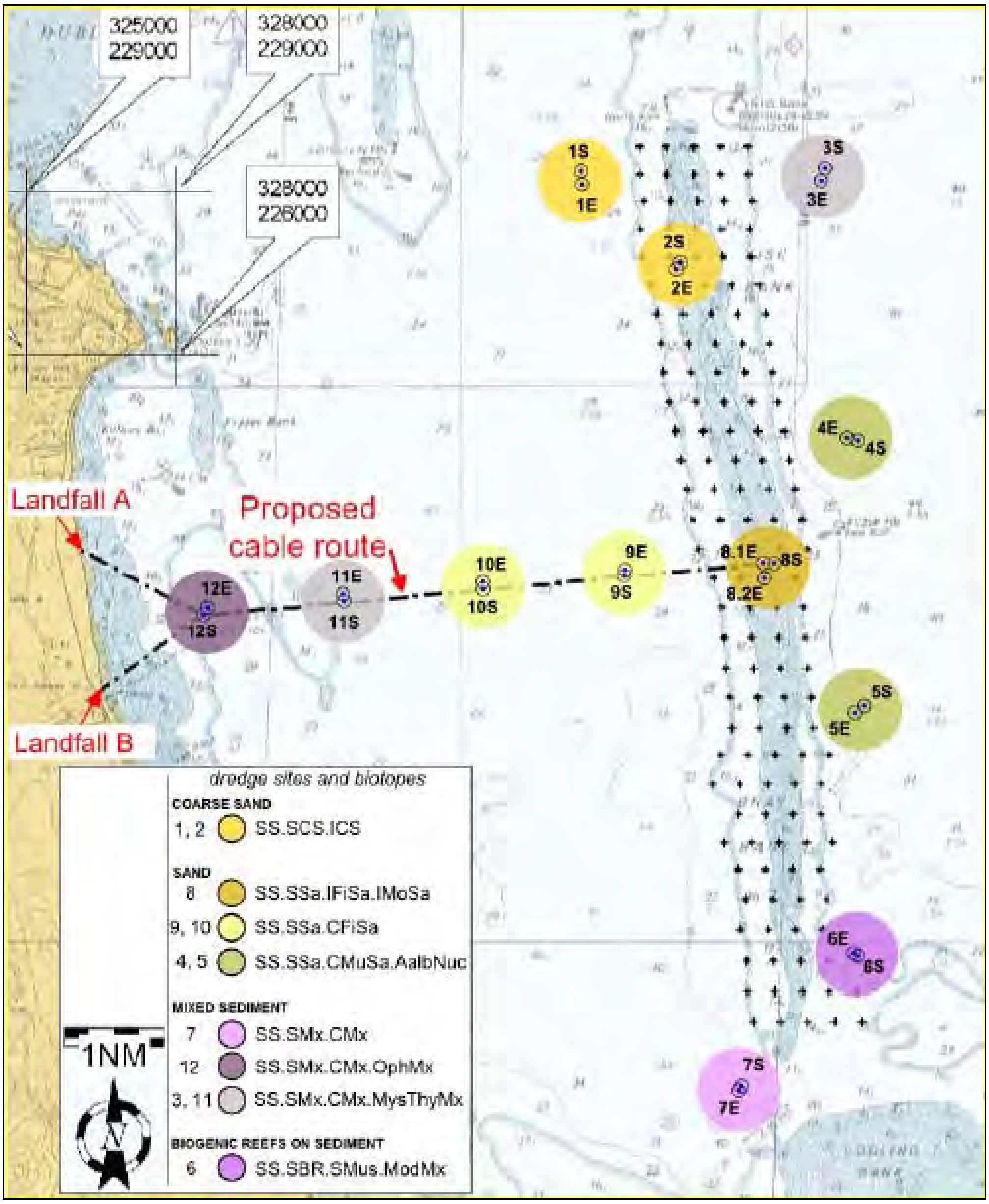


Figure 8.4 Sublittoral biotopes identified within the survey area.

Blue dots in black circles are dredge survey sites (S – start, E – end). Sample 8 comprised of two dredges originating at the same point.

The **eastern** part of the study area was represented by sample **Site 4** and **Site 5**. Material recovered from Site 5 contained some mud. In addition, it contained large quantity of *Mytilus edulis* shells, but only one living individual. Both samples recorded similar fauna composition with the highest species diversity recorded in the study area (50 and 68 species in sites 4 and 5 respectively). Relatively large numbers of polychaete worms were recorded in both. Other well-represented groups in both samples included amphipod crustaceans, crabs and bivalve molluscs (including the horse mussel, *Modiolus*

modiolus). In addition, Site 5 recorded a diverse fauna of gastropod molluscs and echinoderms and contained some mud among the shell debris. One individual reef-building sabellid worm *Sabellaria spinulosa* was recorded from Site 5. Based on the fauna composition, both sites were identified as the biotope *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (**SS.SSa.CMuSa.AalbNuc**).

The **southern** part of the study area was represented by sample Site 6 and Site 7. Sample material from both stations contained some large pebbles. Both stations contained a diverse fauna with significant abundance of epifauna, including Anthozoa (*Alcyonium digitatum*, *A. glomeratum* and Actiniaria), acorn barnacles (*Balanus balanus* and *B. hameri*) and tube-building polychaetes (*Pomatoceros* spp.) indicating presence of some stable substratum. Also, both stations contained a diverse community of polychaete worms, crabs and bivalve molluscs. A significant number of the horse mussel *Modiolus modiolus* and a high abundance of the barnacle *B. hameri* (on coarse shell debris) were recorded at Site 6. Also recorded at Site 6 was a diverse gastropod fauna, including reasonable numbers of *Buccinum undatum*. Based on the fauna composition, **Site 6** was identified as the biotope *Modiolus modiolus* beds on open coast circalittoral mixed sediment (**SS.SBR.SMus.ModMx**). Despite high species richness, **Site 7** fauna had no clear dominant species and the biotope was identified as the circalittoral mixed sediment biotope complex (**SS.SMx.CMx**).

The **western** part of the study area was represented by four sites (Sites 9 – 12) arranged in a transect line along the proposed cable route. Sample material from **Site 9** and **Site 10** showed similar characteristics. Both dredge tows retained little material indicating a large proportion of fine, non-cohesive sediment. No clear dominant species were recorded from the samples, although both contained high densities of the epifaunal polychaete worm *Pomatoceros* spp. Even though Site 10 recorded a somewhat greater diversity of polychaete worms and bivalve molluscs, both sites were identified as the circalittoral fine sand biotope (**SS.SSa.CFiSa**). A high diversity of polychaete worms was recorded from **Site 11**. Other taxonomic groups were poorly represented. The species composition could be most accurately identified as that of the *Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment biotope (SS.SMx.CMx.MysThyMx). The fauna composition recorded at **Site 12** was distinctively different to the rest of the study area. The macrofauna community was strongly dominated by echinoderms, with the brittlestars *Ophiothrix fragilis* and *Ophiura sarsi* particularly abundant. Other well-represented groups included polychaete worms, bivalve molluscs and hydrozoans. Overall fauna composition was indicative of the biotope *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment(**SS.SMx.CMx.OphMx**).

8.2.7 Review of Re-Characterisation Survey Results

None of the species or habitats recorded in the intertidal part of the study area are of specific conservation importance. *Rhodothamniella floridula* on sand-scoured lower eulittoral rock biotope (LR.MLR.BF.Rho) is considered uncommon (Riley, 2002). All other species and habitats recorded from the littoral zone are common around the Irish coast.
None of the sublittoral species or higher taxa recorded in the survey area are uncommon, rare or are protected and all have been previously recorded on the east coast of Ireland (EcoServe unpublished data, Picton & Costello, 1998). However, as stated above, sandbanks which are slightly covered by seawater all the time are listed under Annex I of the EU Habitats Directive. Species diversity was highest in areas of coarse shell, pebbles and cobbles in the southwest, south and east of the banks whereas very few species were recorded from the fine sand on the banks.

Most re-visited sites did not differ significantly to the previous characterisation. However, some differences in sample composition were observed:

- Site 12 markedly different with a rich echinoderm community that was not recorded in 2002 (Hydrozoa-dominated in 2002).
- Site 3 was previously characterised as Alcyonium-dominated communities but no Alcyonium spp. was recorded from the site during this study.
- Site 6 had a similar fauna composition, but no *Modiolus modiolus* was recorded in 2002.

These differences could represent a habitat shift. Alternatively they could result from seabed heterogeneity and different microhabitat range sampled within one dredge tow. All the remaining sites showed fauna variability within the error margin expected from characterisation of biotopes using dredge sampling technique.

Of interest was the presence of the ross worm, *Sabellaria spinulosa*, recorded at site 5. *Sabellaria spinulosa* is an occasionally gregarious segmented worm that builds tubes from sand or shell fragments and occurs on all British and Irish coasts. It is mostly found individually but may form thin crusts or large reefs under some conditions (Jackson & Hiscock, 2008). No statutory conservation status has been assigned to *S. spinulosa*, although it is noted as important by the Marine Conservation Society (Gubbay, 1988) and Nature Conservancy Council (Davidson *et al*., 1991) and is included in the UK Biodiversity Action Plan. *S. spinulosa* was recorded from the northern section of the bank (BioMar survey site 2). Roche *et al.* (2007) reported another reef-building polychaete worm *S. alveolata* from the north-west of the bank but this record is questionable as *S. alveolata* typically occurs on hard substratum on the shore and shallow sublittoral (Jackson, 2008).

8.3 Potential Impacts of the Proposed Development on Marine Ecology

The EcoServe report (Volume 3, Attachment F) includes an assessment of the short term (construction phase) and long term (operational phase) impacts of the proposed development on marine ecology. The cumulative impacts of offshore wind farms are also considered.

8.3.1 Short Term Impacts

The following impacts on benthic communities in the vicinity of the construction works have been identified:

8.3.1.1 Substratum Loss

Direct loss of seabed habitat and disturbance to species as a result of the installation of the piles/turbine foundations, cable trenching and deployment of anchors and jack-up rigs. These habitats will also be unavailable for feeding and spawning during this period. The loss of habitat will be localised and temporary and the effects will be limited to localised mortality or displacement under the footprint of the pile/foundation/scour protection, over a narrow corridor along the route of the cable and where anchors and support structures to jack-up rigs come into contact with the seabed. Given the relatively mobile state of seabed sediments with currents and tides, habitats will be expected to quickly return to their natural state following construction and recruitment from adjacent unaffected areas should ensure rapid recovery of benthic communities. The impact of the temporary loss of feeding and spawning habitat will be negligible given the small area of seabed likely to be impacted relative to the extensive area of similar feeding and spawning habitat available.

8.3.1.2 Smothering

Smothering of sensitive species can occur within the immediate vicinity of the works as the coarser fraction of the disturbed sediment is likely to be re-deposited on the seabed within 50m of the works. This effect is likely to be temporary as the material deposited is likely to be quickly re-suspended and distributed by the natural hydrodynamic processes over the banks and will only affect those species and habitats which are sensitive to smothering.

8.3.1.3 Increased Suspended Sediment and Turbidity

Construction of the cable trenches and turbines would result in a short term increase in the turbidity of the water as increased suspended solids enter the water column. This increase in turbidity could result in increased siltation, smothering of organisms and a reduction of light for phytoplankton and seaweed over the construction period. High levels of suspended solids settling on the seabed could alter habitat resulting in a potential loss of feeding and spawning grounds. Mobile species may move away from unfavourable conditions, while sessile, bentic fauna and flora could potentially be smothered and lost. However, given the high tidal current regime and sedimentary nature in the vicinity of the Kish and Bray Banks, there is already a high degree of naturally occurring sediments in the area. Since species in this area are naturally adapted to this turbidity during storm conditions, it is considered that this temporary impact would not have a detrimental effect on any of the marine benthos.

8.3.1.4 Contaminated Sediments

Disturbance of contaminated sediments during piling operations and cable laying is possible should any of the proposed works take place within an area of contaminated seabed. This could potentially affect any species sensitive to such contamination. There are no known areas of contamination within the vicinity of the proposed works.

8.3.1.5 Pollutants and Waste

Pollutants and chemicals used during the construction phase of the wind farm could potentially contaminate the area. Potential contamination of sediments and marine organisms from the accidental release of organic polymers or heavy metals associated with cementing and/or grouting materials from the foundations may occur. This material could be toxic to marine organisms whilst the grout is wet, while potentially contaminating the seabed sediments and inhibiting recolonisation of the area after construction. Chemical contamination could also occur from accidental spillages, such as oil and other chemicals through poor operational management, non-removal of spillages, storage, handling and transfer of oil and chemicals. There is also potential for accidental spillage of pollutants, such as oil and grouting materials, or release of waste during the construction phase of the project. However, best industrial practice for the storage, handling and disposal of such material will be followed, reducing the risks listed above to negligible levels.

8.3.2 Long Term Impacts

The following impacts on benthic communities in the vicinity of the wind farm during the operational stage of the project have been identified:

8.3.2.1 Substratum Loss

There will be a permanent loss of existing seabed habitat under the footprint of the turbine foundations and any scouring of the surrounding seabed. However, the area of the piles and associated scour protection is very small compared to the extent of surrounding habitat and any associated impact will therefore be negligible.

8.3.2.2 Introduction of Hard Substrate

The monopile foundations and associated rock armour scour protection will introduce an area of hard substrate thereby creating a limited area of new habitat similar to an artificial reef. Areas of hard strata are currently limited on the Kish and Bray banks, and it is possible that these areas of new habitat could be colonised by species new to the banks. However, the overall impact of the introduction of these limited areas of hard strata is not expected to be significant given that they will represent a tiny proportion of the overall surrounding seabed habitat which which will be unaffected by the works.

8.3.2.3 Alterations to Hydrodynamic Regime

Habitats may be altered locally around the turbine structures due to changes in the hydrodynamic environment. The physical presence of the turbines would result in local changes of water movement around the base of the turbines. This may result in a change in sediment deposition and erosion patterns which could lead to changes in the substratum and habitat at these locations. The impact on sediment transport and erosion patterns would be addressed through the use of scour protection and through careful design of the turbine foundations, and so these changes are not expected to be significant. Neither is it expected that there would be a change to the hydrodynamic regime on a wider scale due to the interaction of impacts from multiple turbines, and so it is expected that there would be no changes to the wider bentic environment due to changes in the hydrodynamic regime.

8.3.2.4 Electro-Magnetic Fields (EMF)

A number of research reports have been undertaken by COWRIE into the likely strengths of electro-magnetic fields associated with the inter array and export cables and potential impacts on marine species (CMACS 2003; CMACS 2005; CMACS 2006). A literature review undertaken by Scottish Marine Renewables SEA (Scottish Executive 2006) concluded that marine flora and macro-invertebrates are not sensitive to electric or magnetic fields. It is concluded on this basis that there will be no impact on the bentic ecology associated with electro-magnetic fields from the inter array and export power cables for the Dublin Array.

8.3.2.5 Pollutants and Waste

Contamination of the area due to accidental spillage of pollutants such as hydraulic fluids or waste associated with the maintenance and operation of the wind turbines and offshore substation could occur during the operational phase of the wind farm. The Developers will ensure that the appropriate procedures and safeguards are put in place to minimise the risk of such an occurance and potential impacts are not considered significant on this basis.

8.3.3 Decommissioning

The impacts that would arise during decommissioning of the turbines would be similar to the short term impacts identified for the construction stage of the project.

8.3.4 Cumulative Impacts

Given the localised nature of the potential impacts on bentic ecology identified in this Chapter of the EIS for both the construction and operational stages of the proposed Dublin Array offshore wind farm on the Kish and Bray Banks and the likely similar localised impacts of other similar permitted and proposed developments on sand banks along the East coast of Ireland, and given the extensive areas of similar available habitat in the Irish Sea there should be no significant cumulative impacts on bentic ecology associated with the proposed development in combination with other such developments.

8.4 Mitigation Measures

The following mitigation measures will be adopted to minimise the impact of the proposed development on bentic ecology:

- In order to minimise the extent of potential habitat loss and sediment disturbance associated with the construction and operation of the wind farm the extent of seabed disturbed to facilitate the installation of the piles, scour protection and cable trenches will be kept to a minimum.

- Cable trenches will be formed, the cable installed and the trench backfilled in a single operation using a purpose designed plough thereby allowing immediate re-colonisation of the affected substratum from surrounding unaffected areas by the natural hydrodynamic regime over the banks.

- Scour protection will be provided on the seabed around the base of each pile in order to limit the extent of seabed affected by scour associated with the alteration of hydrodynamic flows around the pile.

- The Construction Management Plan will include strict controls to minimise the risk of pollution or contamination associated with the construction stage of the proposed development including the storage and use of lubricants, placement of grout, and management of waste which will be sorted and returned to shore for recycling/disposal by a Licenced contractor.

- Similar controls will be adopted during the operational stage of the project to prevent pollution and contamination.

9 BIRDS

9.1 Introduction

The proposed Dublin Array offshore wind farm development on the Kish and Bray banks will involve the installation of up to 145 wind turbines and associated infrastructure including offshore substation and inter-turbine array cables as well as the export cable from the offshore substation to shore. This chapter of the EIS addresses the potential impacts of the proposed development on the many species of seabird which are known to use the waters on and around the banks. Potential impacts of the proposed development during construction, operation and decommissioning are discussed and mitigation measures proposed by the Developers are addressed.

This Chapter of the EIS has been prepared by Ecological Consultancy Services Ltd. (EcoServe) and edited by MRG Consulting Engineers on behalf of the Developers.

Initial baseline seabird surveys were carried out on the Kish and Bray banks on behalf of the Developers by Ecology Consulting in the period 2001-2002 (Percival et al., 2002) on the basis of which a desk based impact assessment for the proposed development was completed by Coveney Wildlife Consulting Ltd. in 2004 and subsequently updated in 2009. A copy of Coveney Wildlife Consulting's report is included in Volume 3, Attachment G of this EIS.

In order to address concerns regarding potential changes to seabird populations on the Kish and Bray banks since the initial baseline surveys were undertaken in 2001/2002 and associated concerns regarding the methodology used to establish the conservation importance of bird species in the assessment undertaken by Coveney Wildlife Consulting Ltd (which used Bird Units(BU) and Regional Bird Units (RBU) calculated on the basis of national and biogeographic populations based on estimates from the Seabird 2000 Survey (Mitchel et al.,2004), the Developers engaged Ecological Consultancy Services Ltd.(EcoServe) in 2010 to undertake an up to date assessment for inclusion in the Environmental Impact Statement. This included the commissioning of a new baseline survey which was completed by BirdWatch Ireland on behalf of EcoServe between June 2010 and June 2011 in order to reflect current populations on and in the vicinity of the banks throughout the year. This assessment forms the basis of the impact assessment included in this chapter of the Environmental Impact Statement.

9.2 Description of the existing environment

9.2.1 Conservation

An overview of the main statutory obligations, instruments and legislation applying to the conservation and protection of the marine environment including birds in the context of the proposed Dublin Array Offshore Wind Farm development on the Kish and Bray banks are presented below:

9.2.1.1 Conservation Designations

A number of conservation designations exist in Ireland providing protection to habitats and species. These include:

Special Protection Areas (SPAs) which are created under the European Union's Birds Directive (2009/147/EC) and are designated for the protection of species of wild birds. No formal criteria are set out in the Directive for selecting SPAs, so Ireland has set the following criteria:

- Site regularly used by 1% or more of the all-Ireland population of an Annex 1 species
- Site regularly used by 1% or more of the biogeographical population of a migratory species
- Site regularly used by more than 20,000 waterfowl. In addition, sites important for dispersed species require protection under the Directive.

There are currently 150 sites designated as SPAs in Ireland, with a small number still being considered for designation.

As well as providing for the designation of SPAs, the Birds Directive provides general protection to all wild bird species in Ireland.

Special Areas of Conservation (SACs) are designated under the European Union's Habitats Directive (92/43/EEC), which was transposed into Irish law by the European Communities (Natural Habitats) Regulations 1997 (S.I. 94/1997) as amended. SACs are designated for the protection of habitats, plants or animals listed under Annex I and II of the Directive. A total of approximately 13,500 km^2 has been designated as SAC in Ireland and its surrounding waters.

Natural Heritage Areas (NHAs) are designated under the Wildlife Acts 1976 & 2000 (as amended) for the protection of Ireland's natural heritage, including habitats, species or geological features. To date, 148 NHAs have been designated throughout Ireland, though these are limited to areas supporting two habitat types: Raised Bog and Blanket Bog. In addition to the 148 designated NHAs, there are 630 non-statutorily proposed NHAs (pNHAs), which have no statutory protection and will not have any until they are statutorily proposed.

Ramsar sites are internationally important sites designated under the Convention on Wetlands of International Importance (Ramsar, Iran, 1971), to which Ireland is a Contracting Party. Ramsar sites may be designated for a number of reasons. The criteria for selection are based on wetland types, species and ecological communities, waterbirds, fish, and other taxa. Ireland has 45 Ramsar sites, covering an area of 66,994 ha.

The **Irish Red Data Book** was used in parallel with EU legislation as a guideline to assess the status of certain seabird species recorded in the area. This book is a comprehensive review of rare and threatened mammals, birds, amphibians and fish in Ireland. It is a summary of the currently available information about those vertebrates in Ireland that have been listed as rare or threatened to some degree or have become extinct in the past 300 years. It describes the process employed in selecting the species, presents an account of the status of each species and considers the conservation issues which the Red Data Book Selection raises. Its main purpose is to provide basic information about these animals for all those engaged in wildlife conservation (Whilde, 1993).

BirdLife International has assessed the conservation status of all European bird species (BirdLife International, 2004). **Species of European Conservation Concern** SPEC 1 indicates a species of global conservation concern – a globally threatened species. SPEC 2 indicates a species with an unfavourable conservation status whose global distribution is concentrated in Europe. SPEC 3 indicates a species with an unfavourable conservation status whose global distribution is not concentrated in Europe.

BirdWatch Ireland has prepared a “red amber green” categorisation of Irish birds. “Red” is defined as of high conservation concern, “amber” as of medium conservation concern and “green” as of no conservation concern (Lynas *et al.*, 2008).

9.2.1.2 Conservation Requirements in Designated Areas

Consideration of the potential impacts of this project has been undertaken in the context of the EU Habitats Directive. An Appropriate Assessment (AA) was carried out under the EC Habitats Directive (92/43/EEC) for this project in order to assess whether the development is likely to have significant effect on any internationally important sites for nature conservation (see Article 6.3 and 6.4 below). These internationally important sites include Special Protection Areas (SPAs) and Special Areas of Conservation (SACs). By doing this from the outset, the manner in which nature conservation issues are dealt with will be compatible with whatever designations may apply in the future. For offshore developments that require a Foreshore Licence, the Habitats Directive is implemented by Section 31 of the Natural Habitats Regulation (94/97).

Article 6(3) of the Habitats Directive establishes the need for appropriate assessment;

“Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the 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.”

Article 6(4) discusses alternative solutions, overriding public interest and compensatory measures;

“If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.”

In certain cases, mitigation measures and avoidance measures cannot remove an adverse effect on the SPA or SAC. In accordance with the precautionary principle where it is uncertain whether adverse effects will occur, the following steps must be taken;

- Consider alternative solutions that do not have an adverse impact; and
- Declare Imperative Reasons of Overriding Public Interest (IROPI Test); and
- Develop and agree compensation measures.

If it can be demonstrated in an auditable fashion that there are no feasible alternative solutions, the competent authority will consider whether there are imperative reasons of overriding public interest that require the plan to proceed. If it is decided that a plan must go ahead for imperative reasons of overriding public interest, compensation for its effects must be identified and agreed. The compensation measures could include recreation or restoration of comparable habitat at a new or existing site, and may occur in another country if necessary.
The IROPI Test is for reasons of a social or economic nature however, where the European site concerned “hosts a priority natural habitat type and/ or a priority species

the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission to other imperative reasons of overriding public interest" (Article 6 paragraph 4).

9.2.1.3 Conservation Designation – Kish and Bray Banks

No offshore Special Protection Areas (SPAs) have been designated or proposed anywhere in Ireland, including the Kish/Bray bank area, for marine birds listed on Annex I of the EU Birds Directive. Listing of a bird species on Annex I requires member states to take "*special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution*". Similar measures must also be taken for migratory species.

All existing SPAs for marine birds in Ireland relate to their breeding areas and waters immediately adjacent to them. Similarly there are no proposed Natural Heritage Areas (pNHAs) for marine birds in offshore areas on the informal listings proposed to date. There are no SACS or Ramsar sites in the immediate vicinity of the Kish and Bray banks. Table 9.1 and Figure 9.1 list the nature conservation areas along the Wicklow and Dublin coasts and their ornithological significance, while Figure 9.24 identifies the location of offshore seabird colonies in the western Irish Sea.

9.2.1.4 Conservation Designations in the vicinity of the Kish and Bray Banks with respect to birds

There are a number of SACs and SPAs within 35km of the proposed wind farm site. Table 9.1 summarises the nature conservation areas on the Dublin & Wicklow coasts and corresponding occurrences of sea birds recorded within the proposed development area from the NPWS site synopses unless the data source is stated.

Site Name	Designation	Ornithological conservation importance	Distance (km) from Array
Co. Dublin			
Dalkey Island	SPA (004172)	Breeding populations of Common Tern (62 pairs), Arctic Tern (24 pairs), Roseate Tern (5-11pairs), (one of only three known breeding sites in the country); roosting site - along with other parts of south Dublin Bay the area is used by the three tern species as a major post-breeding/pre-migration autumn roost area. Peaks of 83 common/arctic and 113 sandwich terns were counted in 2006 (Merne et al. 2008).	9
Howth Head Coast	SPA (004113), SAC (000202)	Nationally important breeding populations of Kittiwake (2,269 pairs) and Black Guillemot (39 pairs); regionally important breeding populations of Common Guillemot (990 ind.), Razorbill (416 ind.) and Fulmar (33 pairs); other breeding birds: Shag (12 pairs)	9
North Bull Island	SPA (004006), SAC (000206)	Internationally important wintering population of Light-bellied Brent Goose (1,548 ind.); regionally important wintering population of Cormorant; Black-headed Gull (2,196 ind.), Common Gull (332 ind.) and Herring Gull (331 ind.) also occur here.	10.5
South Dublin Bay and River Tolka Estuary	SPA (004024), SAC (000210)	An internationally important wintering population of Light-bellied Brent Goose (525 ind.); nationally important breeding population of Common Tern (>400 pairs, one of the most important sites in the country); other breeding birds: Arctic Tern; Wintering birds: Black-headed Gull (3,040 ind.), Common Gull (330 ind.), Herring Gull (348 ind.) and Great Crested Grebe (21 ind.); important roost site for Common, Arctic and Roseate Terns in the autumn - annual peaks ranged 8,000-11,700 ind. in recent years in late August (Merne et al. 2008; Merne 2010).	12

Table 9.1 Nature conservation areas on the Dublin & Wicklow coasts and corresponding occurrences of sea birds recorded within the proposed development area.

Site Name	Designation	Ornithological conservation importance	Distance from the Array (km)
Co. Dublin			
Ireland's Eye	SPA (004117), SAC (002193)	Nationally important breeding populations of Gannet (202 pairs - one of five in the country and the only one on the east coast), Cormorant (438 pairs), Herring Gull (~250 pairs), Great Black-backed Gull (110 pairs), Kittiwake (1024 pairs), Guillemot (2,948 ind.), Razorbill (>686 ind.). Other breeding birds: Shag (39 pairs), Puffin (<20 ind.) and Black Guillemot (15 ind.).	12
Baldoyle Bay	SPA (004016), SAC (000199)	An internationally important wintering population of Light-bellied Brent Goose (726 ind.); nationally important population of Great Crested Grebe (42 ind.)	14.5
Malahide Estuary	SPA (004025), SAC (000205)	An internationally important wintering population of Light-bellied Brent Goose (956 ind.); regionally important population of Great Crested Grebe (52 ind.)	19
Lambay Island	SPA (004069), SAC (000204)	Internationally important breeding populations of Cormorant (675 pairs – largest colony in Ireland), Shag (1,122 pairs – largest colony in Ireland), Razorbill (4,337 ind.) and Guillemot (59,824 ind.). Nationally important breeding populations of Fulmar (635 pairs), Lesser Black-backed Gull (309 pairs), Herring Gull (1,806 pairs – largest colony in Ireland), Great Black-backed Gull (193 pairs) and Kittiwake (4,091 pairs). Other breeding seabirds are Puffins (265 ind. – the largest colony on the east coast) Manx Shearwaters (<50 pairs – the only known east coast colony) and Black Guillemot (several pairs)	19.5
Rogerstown Estuary	SPA (004015)	Internationally important wintering population of Light-bellied Brent Goose (1,194 ind.)	22.5

Table 9.1 (Cont'd) Nature conservation areas on the Dublin & Wicklow coasts and corresponding occurrences of sea birds recorded within the proposed development area.

Site Name	Designation	Ornithological conservation importance	Distance from the Array (km)
Co. Dublin			
Skerries Islands	SPA (004122)	Nationally important breeding population of Cormorant (558 pairs), Shag (100 pairs), Herring Gull (270 pairs) and Great Black-backed Gull (75 pairs). Other breeding birds: Fulmar (35 pairs) and Lesser Black-backed Gull (1 pair) Internationally important wintering population of Brent Goose (242); nationally important wintering population of Cormorants (391); other wintering birds: Herring Gull (560), Great Black-backed Gull (250) and Blackheaded Gull (110).	30.5
Rockabill	SPA (004014)	Internationally important breeding population of Roseate Tern (1,093 pairs). Nationally important breeding populations of Common Tern (1,940 pairs – one of the largest in Ireland), Arctic Tern (250 pairs) (Merne 2010). Black Guillemot (34 pairs). Other breeding birds: Kittiwake (111 pairs).	32.5
Co. Wicklow			
The Murrough	SPA (004168), SAC (002249)	Nationally important wintering population of Little Tern (30 pairs – one of the largest colonies in the country); internationally important wintering population of Light-bellied Brent Goose (859 ind.); nationally important numbers of Red-throated Diver (32 ind.), Black-headed Gull (997 ind.) and Herring Gull (506 ind.); Cormorant also occur at the site.	9.5
Bray Head	SAC (000714)	Nationally important breeding populations of Kittiwake (561 pairs) and Black Guillemots (103 ind.). Other breeding birds are: Fulmar (61 pairs), Shag (14 pairs), Guillemots (500 ind.), Razorbills (182 ind.) and a few pairs of gull species.	10
Wicklow Head	SPA (004127)	Nationally important breeding populations of Kittiwake (956 pairs) and Black Guillemots (70 ind.). Other breeding birds are: Fulmar (62 pairs), Shag (11 pairs), Herring Gull (20 pairs), Guillemot (420 ind.) and Razorbill (186 ind.).	20.5

Table 9.1 (cont'd) Nature conservation areas on the Dublin & Wicklow coasts and corresponding occurrences of sea birds recorded within the proposed development area.
(Unless the data source is stated, bird counts come from the NPWS site synopses)

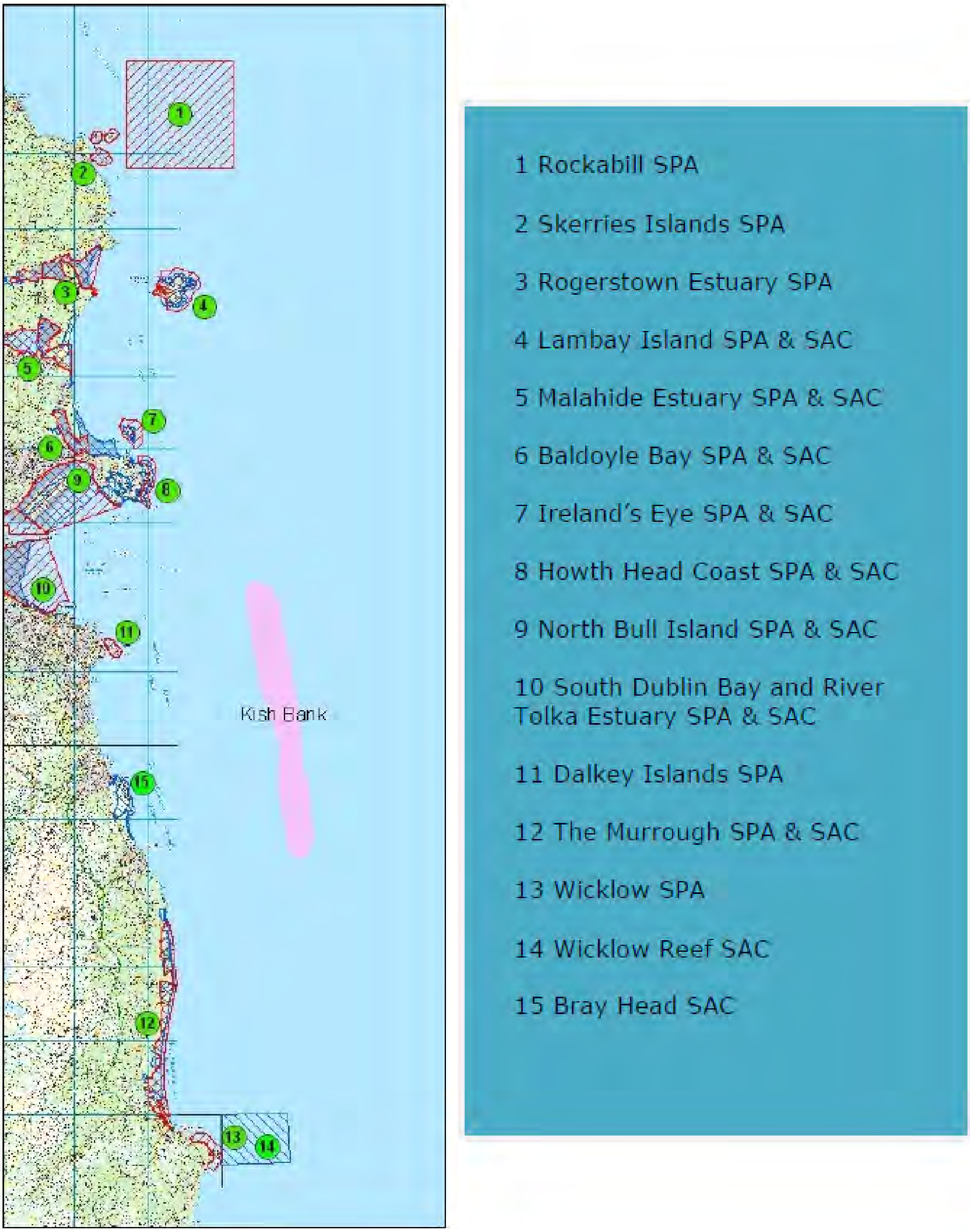


Figure 9.1 SACs and SPAs within 35km of the proposed wind farm site (identified here as Kish Bank) with known populations of seabirds, wildfowl and waders.

9.2.2 Seabirds in the Irish Sea

Ireland's geographic position in Europe helps to explain why we have so many of Europe's seabirds. The shallow Irish Sea provides an abundance of small prey fish for seabirds, contributing to the diverse range of seabirds having chosen our shores to breed. The Irish Sea also provides a strategic corridor for high latitude seabirds moving to wintering grounds further south.

Knowledge of breeding seabird sites and populations around Britain and Ireland has developed from national surveys in the late 1960s and early 1970s (Cramp *et al.,* 1974) and again in the mid-1980s (Lloyd *et al.,* 1991). In addition, all-Ireland surveys of terns were carried out in 1985 and 1995 (Hannon *et al.,* 1995). Gathering of information on seabirds at sea developed later. However the work of the Joint Nature Conservation Committee (JNCC) in the 1990s has provided good baseline information on seabird distributions in the Irish Sea at a broad scale (Pollock *et al.,* 1997). Tern densities, especially of the roseate tern, were also much higher than those of JNCC (Newton & Crowe, 1999). Seabird 2000 was the third complete census of the entire breeding seabird population of Britain and Ireland. Beginning in 1998 and completed in 2002 and published in 2004 (Mitchell *et al.,* 2004), Seabird 2000 maintained the survey coverage of species well-surveyed in the previous complete census, the Seabird Colony Register (SCR). The Seabird survey also improved the coverage by extending the survey to some 900 inland colonies of terns, gulls and Great Cormorants. For the first time accurate baseline estimates for populations of Leach's and European Storm-petrels and Manx Shearwaters were derived. A regular stand-alone census of all British and Irish gannet colonies takes place every 10 years; the last complete survey was undertaken in 2004/5. The following accounts summarise the most regularly occurring species in the Irish Sea.

9.2.2.1 Divers and Grebes

Red-throated Diver: The red-throated diver has a circumpolar breeding distribution that reaches its southern European limits in Donegal. It nests on the edges of pools, lakes and sheltered marine inlets in treeless terrain. It winters on most European coasts from Norway to the northern Mediterranean. Its biogeographic population is now listed at 1,000,000 (Delany & Scott 2002), which is a considerable increase on the previous figure of 75,000 (Colhoun 2001). This has the effect of reducing the significance of the birds recorded in the study area.

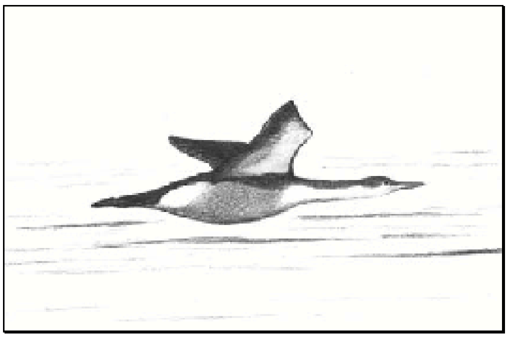


Figure 9.2 Winter-plumaged red-throated diver

In Cos. Dublin, Wicklow and Wexford, the main wintering concentrations are in Wexford Bay, Brittas Bay in Co. Wicklow and off the North Wicklow Coastal Marshes with mean peaks in the five winters to 1998/99 of 92, 47 and 28 birds, respectively. However, the national population is poorly known because the species is widely dispersed around the coast in smaller numbers and because accurate counts are dependent on very calm weather conditions (Colhoun 2001).

The current population estimate is 1025 birds in all of Ireland (6-10 breeding pairs in the Republic of Ireland) (BirdWatch Ireland, 2011). The species does not normally come to land other than to nest. At sea it feeds by diving from the surface and catching fish. It flies at a range of heights. JNCC only recorded it close to Dublin Bay and off south Wexford at densities of up to 0.1 birds/km^2. It was not generally recorded in the Irish

Sea because it is normally an inshore species (Colhoun 2001, del Hoyo et al. 1992, Hagemeijer & Blair 1997, Hutchinson 1989, Pollock et al. 1997).

The red-throated diver is listed on Annex I of the EU Birds Directive. It was listed by BirdLife International as SPEC 3, i.e. a species with an unfavourable conservation status whose global distribution is not concentrated in Europe. It received this listing because of a large decline in its breeding population due to loss and deterioration of breeding habitat and disturbance of breeding sites. It is not known to be threatened on its marine wintering areas. As with all marine species, however, oil spills are always a potential danger (Tucker & Heath 1994).

As with all bird species, the red-throated diver is protected in Ireland under the 1976 Wildlife Act. It was listed as a rare breeding species in the Irish Vertebrate Red Data book (Whilde 1993). In BirdWatch Ireland's "red amber green" categorization of Irish birds, it received an amber listing as a rare breeder and because of its SPEC 3 status (Lynas *et al.* 2007, Newton *et al.* 1999).

Great Northern Diver: The great northern diver is very similar to the smaller red-throated diver. Its breeding distribution is mainly from west Greenland through Canada to Alaska. In Europe, only some 300 pairs breed in Iceland. Several thousand, presumably including Greenland or North American birds, winter off western European coasts mainly from Norway to Brittany. In Ireland, the main concentrations are in Donegal and Galway Bays with five year mean peaks of 146 and 78, respectively. The main east coast concentration is in Wexford Bay and Harbour with close to 50 birds. The current population estimate is 1310 birds in all of Ireland (BirdWatch Ireland, 2011).

Figure 9.3 Winter-plumaged great northern diver

Numbers using Irish waters that cannot be counted from land are poorly known. Its biogeographic population is 5,000 giving a very low threshold for international importance of only 50 birds. It breeds in large lakes in the taiga and subarctic zones and winters at sea, where it feeds by diving from the surface and catching fish. JNCC recorded only a handful in the Irish Sea, in contrast to the west of Scotland, where they were more numerous (Colhoun 2001, del Hoyo et al. 1992, Hagemeijer & Blair 1997, Hutchinson 1989, Pollock et al. 1997).

The conservation status of great northern divers is secure (Tucker & Heath 1994).

Great Crested Grebe: The great crested grebe is the largest of the grebe species. It is resident in Ireland, with the population increasing to 5,385 in winter due to migration from European populations (Lynas, Newton & Robinson, 2007. Their distribution is widespread with greater concentrations occurring in midlands of the North and Northeast. There are eight sites in Ireland that regularly support internationally important numbers of Great Crested Grebe over winter, one of which is Dundalk Bay in Co. Louth. It has been found that in Ireland, just 10 sites support 92% of the wintering population (Lynas, Newton & Robinson, 2007). Due to the localised nature of the population in winter, Great Crested Grebes are amber-listed in Ireland, although the European population is regarded as secure.

9.2.2.2 Fulmar and Manx Shearwater

Fulmar: The fulmar is essentially a circumpolar species of petrel with Iceland as its European headquarters. Up to 250 years ago, it was largely confined to Iceland and St. Kilda west of the Hebrides. However, it has since spread through the Faeroes and Britain and began to colonise Ireland from 1911. It now breeds around most of the country wherever there are cliffs. However, there are large gaps in its distribution along the mainly low coasts of the eastern counties. Some 826 pairs breed in Cos. Dublin and Wicklow out of an Irish Sea population of 14,600 pairs, which in turn is some 0.43% of the biogeographical population of some 3.4 million pairs. The current population estimate is 38,910 in all of Ireland (32,981 breeding pairs in the Republic of Ireland) (BirdWatch Ireland, 2011).

Figure 9.4 Fulmar

Most of the birds in the three counties breed on Lambay Island in Co. Dublin and on Great Saltee Island in Co. Wexford with smaller colonies at Ireland's Eye, Howth (both Co. Dublin), Bray Head, Wicklow Head (both Co. Wicklow) and perhaps a scattering of pairs elsewhere. Other than at breeding sites, it does not normally come to land. It winters in the North Atlantic mainly north of a line from Brittany to New England.

At sea, it is normally a low flier which practices "dynamic soaring" to take advantage of differing wind speeds between waves and troughs. Densities in most of the Irish Sea are typically less than 1 bird/km^2 but a late summer concentration of greater than 5 birds/km^2 occurs at the Irish Sea front. It feeds at or near the surface on a wide variety of marine items including shrimp, squid, fisheries discards and carrion (Merne 1987, del Hoyo *et al*. 1992, Hagemeijer & Blair 1997, Hutchinson 1989, Lloyd *et al*. 1991, Merne & Madden 1999, Mitchell *et al.* 2004, Nairn et al. 1995, Pollock et al. 1997, Pollock *et al*. 2000, Snow & Perrins 1998). The fulmar's conservation status is secure in Europe and green in Ireland (Lynas *et al.* 2007, Newton *et al.* 1999, Tucker & Heath 1994).

Manx shearwater: The Manx shearwater's global distribution is centred on Britain and Ireland, with the main breeding concentrations on Rhum off western Scotland, in Pembrokeshire in west Wales, and on the west Kerry Islands. Other than at Great Saltee it probably breeds irregularly in Cos. Dublin, Wicklow and Wexford. Some 175,000 pairs breed in the Irish Sea, mainly on the Pembrokeshire Islands. This is some 47% of the biogeographical population of 375,000 pairs. Other than at breeding sites, it does not normally come to land and then only at night to avoid gull predation because of its clumsiness on the ground when accessing its burrows. With development of reliable diurnal techniques to census birds in burrows, its population estimates in Britain and Ireland are now much better. It winters mainly off the east coast of South America. The current population estimate is 37,178 pairs in all of Ireland (32,545 breeding pairs in the Republic of Ireland) (BirdWatch Ireland, 2011).

Figure 9.5 Manx shearwater near burrow

At sea it is normally a low flier which practices "dynamic soaring" like the fulmar. It often "rafts" (i.e. roosts on the surface in flocks) in calm weather. Birds arrive back in the Irish Sea during March and April. Densities increase to 5 birds/km^2 by June and reach 10 birds/km^2 in the adjoining Celtic Sea near the Pembrokeshire colonies. By July and August they are spread throughout the Irish Sea in numbers and they often exceed 10 birds/km^2 off Pembrokeshire and on the Irish Sea front.

In September, they concentrate even more on the Irish Sea front before departure by October. It feeds at or a little below the surface mainly on small fish, often in flocks (Begg & Reid 1997, Stone *et al*. 1994).

The Manx shearwater is a migratory species requiring conservation measures similar to Annex I species. BirdLife International listed it as a SPEC 2, i.e. a species with an unfavourable conservation status whose global distribution is concentrated in Europe. It received this listing because of its localised distribution. It is not imminently threatened but colonies have been lost on islands that were invaded by rats. It was amber listed by BirdWatch Ireland as a localised breeder and because of its SPEC 2 status (Lynas *et al.* 2007, Newton *et al*. 1999, Tucker & Heath 1994).

Other shearwater and petrel species: Several other species of these seabirds occur in small to very small numbers in the Irish Sea. These include Mediterranean, Cory's, sooty, and great shearwaters and storm and Leach's petrels. Mediterranean shearwater is closely related to Manx shearwater and breeds mainly on the Balearic Islands and occurs in the Irish Sea in very low numbers in autumn. Cory's shearwater breeds in the Mediterranean and off West Africa and it was not recorded in the Irish Sea by JNCC. The other two shearwaters breed on islands in the southern oceans and the south Atlantic, respectively. JNCC recorded them in very low numbers in the Irish Sea in the autumn prior to their return to their breeding areas in the southern summer. In contrast, off southern and western coasts of Ireland in some years, hundreds of Mediterranean shearwaters and many thousands of the other three species occur.

Storm petrels breed in large numbers off western Ireland and they have their stronghold on the Faeroes. It was recorded in large numbers off south-western Ireland in late summer by JNCC but in much lower numbers in the Irish Sea. Leach's petrels breed mainly in Iceland with smaller numbers southwards to Scotland and Mayo. JNCC recorded low numbers in the Irish Sea but they are sometimes recorded in large numbers in Liverpool Bay after autumnal westerly gales. All are low fliers and have broadly similar lifestyles to Manx shearwater. While Cory's Shearwater, storm petrel and Leach's petrel do not have secure conservation status, all six species occur in insignificant numbers in the Irish Sea in an EIA context (del Hoyo et al. 1992, Hagemeijer & Blair 1997, Hutchinson 1989, Pollock et al. 1997, Tucker & Heath 1994).

9.2.2.3 Gannet

The gannet's global distribution is centred on Britain, Ireland and Iceland. In Cos. Dublin, Wicklow and Wexford, the main breeding site is at Great Saltee with some 1,930 pairs. A new colony at Ireland's Eye in Co. Dublin is growing rapidly and has 200 apparently occupied sites. Some 70,000 pairs breed in the Irish Sea, mainly in two large colonies at Grassholm in Pembrokeshire and at Ailsa Craig in Strathclyde. This is some

18% of the biogeographical population of 390,000 pairs. The current population estimate is 32,758 pairs in all of Ireland (BirdWatch Ireland, 2011).

Figure 9.6 Adult Gannet

Other than at the breeding cliffs gannets do not normally come to land. In winter, they tend to migrate south, especially the young birds, which may reach the equator. However, considerable numbers also remain in our waters. At sea, it is often one of the highest flyers reflecting its habit of making spectacular dives to catch fish. Densities in the Irish Sea are typically 1–2 birds/km^2 but drop off markedly during November to February. The gannet was listed by BirdLife International as SPEC 2 because of its localised distribution.

It is not currently threatened and its population has increased considerably since the cessation of human exploitation of the species for food early in the last century. It was amber listed by BirdWatch Ireland as a localised breeder and because of its SPEC 2 status (Lynas *et al.* 2007, Newton *et al.* 1999, Tucker & Heath 1994).

9.2.2.4 The Cormorant and Shag

The Cormorant: The cormorant is a larger somewhat less exclusively marine version of the shag (see below). It breeds over a large part of the world from eastern North America through Europe, Asia and Africa to Australia and New Zealand.

Figure 9.7 Adult Cormorant

In the western Irish Sea, its breeding stronghold is on the Skerries, Lambay Island and Ireland's Eye, all off north Co. Dublin with about 2,062 pairs. Its conservation status is secure in Europe but amber in Ireland. JNCC recorded them on the coasts of Cos. Meath, Dublin and Wexford but not off Wicklow (references as fulmar). The current population estimate is 5,211 pairs in all of Ireland (4,548 breeding pairs in the Republic of Ireland) (BirdWatch Ireland, 2011).

The Shag: The shag is an essentially European species ranging from the Barents Sea to the Mediterranean Sea and Morocco. Its population is centred on Britain but Norway, Iceland and Ireland are also important. In Cos. Dublin, Wicklow and Wexford, the main breeding sites are Lambay Island and the Saltee Islands. About 1,273 pairs breed in Dublin and about 270 in Wexford, but only about 25 in Wicklow. A total some 5,000 pairs breed around the Irish Sea, which is some 5% of the biogeographical population of 80,000 pairs. The current population estimate is 3,727 pairs in all of Ireland (3,426 breeding pairs in the Republic of Ireland) (BirdWatch Ireland, 2011).

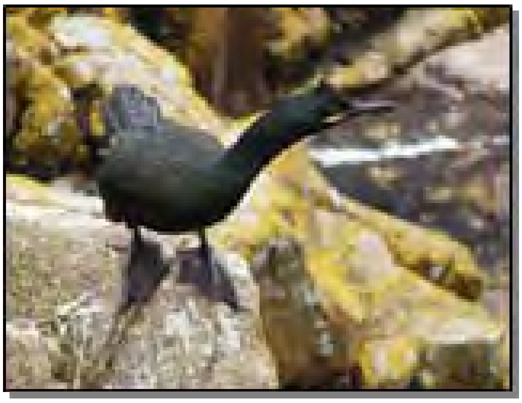


Figure 9.8 Adult Shag

Shags breed on cliffs and rocky coasts. They feed on nearby marine areas and roost on land at night. They dive to catch fish. In our area they are mainly sedentary except for some juvenile dispersal. They are normally low flyers. JNCC recorded it year round close to Irish Sea coasts with densities of up 0.5 birds/km^2 off Co. Dublin (references as fulmar). The shag's conservation status is secure in Europe and green in Ireland (Newton et al. 1999, Tucker & Heath 1994).

9.2.2.5 Skuas

Great Skua: Great skuas, often known by their Shetland name of "bonxie", are predatory seabirds related to gulls. As a breeding species, it is a European endemic with about 16,000 breeding pairs. Some 7,900 of these breed on Shetland and another 5,000 in Iceland. Smaller numbers occur on the Faeroes, Svalbard, Norway and Russia. Their population is still expanding after human exploitation reduced it to very low levels in Scotland in the late nineteenth century. In 2001, breeding by 1-2 pairs was confirmed in western Ireland (Newton 2001).

Bonxies winter on Atlantic coasts in Western Europe, New England and northern South America. They catch fish or steal them from other seabirds, scavenge, and prey on smaller seabirds. They are commonly recorded as passage migrants from Irish headlands with many hundreds or a few thousand occurring in most years. The largest numbers occur on western and south western coasts in autumn and the smallest numbers are recorded on the east coast. JNCC recorded up 0.1 birds/km^2 mainly on the southern edge of Irish Sea in autumn but higher numbers west of Cornwall and Brittany in winter.

Figure 9.9 Great skua (bonxie)

Two smaller species are the Arctic skua and the pomarine skua. They are much more widely distributed as breeders in the Arctic and they winter in South American, African, Asian and Australian waters. Their ecology and occurrence in Ireland are broadly similar to the great skua. Arctic skuas are somewhat more common than pomarine skuas in Ireland and they were the most common skua recorded by JNCC in Irish waters.

Densities of up to 0.1 birds/km^2 were recorded in the Irish Sea and off the west coast in autumn.

Long tailed Skua: The long tailed skua is the smallest skua species to visit Ireland. Although rare, it visits almost annually, mainly in autumn, on passage from its breeding grounds in the high Arctic of Eurasia to its wintering grounds in the southern ocean. The long-tailed skua is listed on Appendix II of the African-Eurasian Waterbird Agreement (AEWA), which calls on parties to undertake conservation action for birds which are dependant on wetlands for at least part of their annual cycle.

9.2.2.6 Gulls

Little gull: The little gull's breeding distribution extends to three distinct areas from Scandinavia to eastern Siberia. There is also a small population in North America. It breeds on inland marshes and winters offshore. Its main European wintering areas are around the Mediterranean, Black and Caspian Seas. The biogeographical population is only 28,000 pairs (Delany & Scott 2002).

Figure 9.10 Adult winter plumaged little gull

There were only 15 records of little gull in Ireland prior to 1950 but numbers have steadily increased since then. Nowadays, a wintering concentration off Co. Wicklow is considered to be among the largest in northwest Europe. This may involve the same birds that pass through Liverpool Bay in spring and autumn. This concentration was initially identified through observations of flocks off Co. Wicklow during wet weather with strong winds from the south or east. Since then, most records of the species have been concentrated along a 35km strip of coast between Wicklow Harbour and Dun Laoghaire.

Peak flock sizes were typically less than 300 during the 1970's and 1980's but reached 600 by the early 1990's (Madden & Ruttledge 1993). High numbers continued through the 1990's and peaks of 604 and 830 birds were recorded at Wicklow Harbour in January 1995 and January 1998, respectively. However, the occurrence of large numbers close to land has remained sporadic. During these periods, they may feed and roost in or near Wicklow Harbour (McAdams et al. 2000, Whelehan 1995). In January and February 2002, an influx of up to 500 was recorded along the Wicklow coast during a long period of windy weather (Milne 2002).

Recently, similar concentrations have been reported off western Denmark (Noer et al. 2000), which is consistent with reports of a northward extension of the wintering range. At sea, it flies slowly into the wind and low over the water, feeding on small items taken from the surface. The diet of wintering birds is unknown, but probably comprises marine invertebrates and small fish (Cramp & Simmons 1982). In the Irish Sea, JNCC recorded winter densities of up to 0.5 birds/km^2 off Co. Wicklow and in Liverpool Bay.

The little gull is a migratory species requiring conservation measures similar to Annex I species. BirdLife International listed it as a SPEC 3, on the basis of a moderate decline in its European breeding population. The main threats are natural and man induced flooding of breeding sites and recreational disturbance. It has been upgraded to green by BirdWatch Ireland because of its downgrading of non-breeding SPEC status (Lynas *et al.* 2007).

Figure 9.11 Adult winter plumaged black headed gull

Black-headed gull: The black-headed gull is a very common species that breeds from Western Europe to the Far East, with an outpost in eastern North America. It winters on coasts from Western Europe to equatorial Africa and eastwards to south East Asia. It has a biogeographical population of over two million pairs and a secure conservation status. Although a seabird, only small numbers range far from the coast. They are generally recorded in low densities in the Irish Sea away from the coast.

Common gull: Although the common gull breeds across a large swathe of the northern temperate zone from Iceland through northern Europe to Siberia and western North America, 80 – 90% of its population is concentrated in northern Europe. Most populations migrate to warmer areas such as the Mediterranean and the Persian Gulf but they are less migratory in northwest Europe. It usually breeds near coasts or inland wetlands. Its biogeographic population is about 57,000 pairs.

Figure 9.12 Adult winter plumaged common gull

In Ireland, some 970 pairs breed on the north and west coasts from Down to Kerry and a further 650 pairs breed inland in western counties. The Irish Sea population is almost 1,100 pairs, which is about 6% of the biogeographical population. Some 67,500 birds winter around all coasts of Ireland (Lack 1986). There are estuarine concentrations exceeding 1,000 birds in Cork, Donegal and Wexford. The most important of these is on the North Wexford Coastal Marshes with a five-year mean peak to 1998/99 of 2,900 (Colhoun 2001). JNCC recorded coastal concentrations in winter of up to 1 bird/km^2 mainly off Dublin and Wexford. Wintering birds mainly feed on earthworms but they exploit a variety of other habitats such as landfills and marine areas. At sea, it flies at a variety of heights.

The common gull is a migratory species requiring conservation measures similar to Annex I species. BirdLife International listed it as a SPEC 2, on the basis of a moderate decline in its European breeding population for reasons that are unclear. It was amber listed by BirdWatch Ireland because of its SPEC 2 status (Lynas *et al.* 2007, Newton et al. 1999, Tucker & Heath 1994).

Herring gull: The herring gull is a very widespread species that breeds in western and northern Europe, northern Siberia and northern North America. European populations winter mainly on the coasts of Western Europe and other areas south of the breeding grounds. It uses a broad range of habitats from rubbish dumps to estuaries to marine areas. It has a biogeographical population of almost 367,000 pairs and a secure conservation status in Europe.

Figure 9.13 First winter herring gull

However, the Seabird 2000 survey showed that the Irish population of herring gulls declined by 90% from almost 60,000 pairs 1970, and that 80% of this decline occurred since 1985. In the UK large declines since 1985 were recorded mainly in eastern Scotland but increases were recorded elsewhere. Avian botulism associated with feeding at rubbish dumps is believed to be the main reason for the decline in Ireland.

Reduction in food sources probably also played a role. These include improvements in the management of rubbish dumps, the virtual cessation of the discharge of raw sewage and the reduction of fishery discards. The current population of the Irish Sea is about 53,000 pairs, which is about 15% of the biogeographical population. Dublin, Wicklow & Wexford holds 3,000 pairs, of which about 29 pairs breed in Co. Wicklow.

JNCC recorded densities of up 1 bird/km2 in most parts of the Irish Sea but only in southern parts between November and January.

Lesser black-backed gull: The lesser black-backed gull breeds through western and northern Europe to western Siberia. It is mainly migratory and winters on western European, African and Arabian coasts. It is less than half as numerous as the herring gull with a biogeographical population of 176,000 pairs but still has a secure conservation status. It uses a broad range of habitats from rubbish dumps to estuaries to marine areas. JNCC recorded densities of up 1 bird/km2 in most parts of the Irish Sea but only in southern parts between November and January.

Figure 9.14 Adult Lesser Black-backed Gull

Great black-backed gull: The great black-backed gull breeds around low Arctic and temperate north Atlantic coasts with partial migration from more northern areas to winter on temperate and tropical Atlantic north Atlantic coasts. It has a biogeographical population of some 420,000 and a secure conservation status. It uses a broad range of habitats from rubbish dumps to estuaries to marine areas. JNCC recorded very low numbers in most of the Irish Sea including waters off Co. Wicklow.

Figure 9.15 Subadult great black-backed gull

Kittiwake: The kittiwake is by far the most abundant gull in the world with a circumpolar distribution. In Cos. Dublin, Wicklow and Wexford some 11,000 pairs breed on cliffs with the main sites at Lambay Island (4,091 pairs) and at Great Saltee (2,100 pairs). There are smaller colonies at Bray and Wicklow Heads, with a total of just over 1517 pairs in Co. Wicklow. The Irish Sea population is some 35,000 pairs, which is some 1.25% of the biogeographical population of some 2.8 million pairs.

Figure 9.16 Adult kittiwake

The species is mainly pelagic and moves west into the Atlantic during the winter. Some regularly come to roost on land, however. When feeding at the surface, it often flies low over the water. However it may fly higher on other occasions. Kittiwake densities in the Irish Sea are lowest in February and March, typically less than 1 bird/km^2. They rise to 5 birds/km^2 in June and July off Dublin and north Wicklow and go higher than this in late summer around the Irish Sea Front.

Kittiwakes feed mainly on small fish such as sandeels and clupeids, and also take crustaceans and fisheries discards. (Begg & Reid 1997, Cramp & Simmons 1982). Their conservation status is secure in Europe and green in Ireland (Newton et al. 1999, Tucker & Heath 1994).

9.2.2.7 Terns

Common tern & Arctic tern: Common terns breed in mid-latitudes across most of Eurasia and North America and winter on most tropical and southern hemisphere coasts. Some 1,300 pairs breed in Cos. Dublin and Wexford mostly at Rockabill and at Ladys Island Lake, with the balance at smaller colonies in Dublin Bay. The Irish Sea population is 3,200 pairs, which is some 6.2% of the biogeographical population of 63,000 pairs. Terns normally dive for small fish but from lower heights than gannets. They often fly relatively high.

Figure 9.17 Common tern

The Arctic tern is very similar to the common tern but as its name suggests, has a more northerly circumpolar breeding distribution. The Irish breeding population is the most southerly in Europe. It is a famous long distance migrant to Antarctic waters. Some 335 pairs breed in Cos. Dublin and Wexford. Of these 235 are at Ladys Island Lake in Wexford. The Irish Sea population is just under 2,900 pairs, which is some 0.5% of the biogeographical population of 600,000 pairs. Data for common and Arctic terns were presented together by JNCC because they are often difficult to separate at sea. Densities of up to 0.5 "commic" terns/km^2 occur in the Irish Sea in late summer, and somewhat higher densities north of Dublin Bay. Several thousand of both species also use an evening roost on Sandymount Strand in Dublin Bay from late July into September. The feeding areas of the birds using this roost are not known although it is presumed to be the shallow offshore banks in the Irish Sea. Some evidence of such use of the Kish Bank was obtained in 1999 (Newton & Crowe 1999 & 2000; Additional references as fulmar).

Both the common and Arctic terns are Annex I species on the EU Birds Directive. The conservation status of both is secure in Europe. Both were amber listed by BirdWatch

Ireland as localised breeders (Lynas *et al.* 2007, Newton *et al.* 1999, Tucker & Heath 1994).

Roseate tern: The roseate tern has a global population of about 125,000 pairs breeding mainly on tropical coasts with smaller temperate populations in Western Europe (2,150 pairs or 1.7% of the global population), North America and South Africa. These temperate breeders winter in the tropics. It is one of Europe's most threatened seabirds having suffered a large decline in recent decades. The current European population of some 2,150 pairs is concentrated in Ireland (1150 pairs) and on the Azores.


Figure 9.18 Adult roseate tern

The Irish population breeds at two sites at Rockabill off north Co. Dublin and at Ladys Island on the south Wexford coast. They are wardened by BirdWatch Ireland and NPWS. Roseate terns' habits are similar to common and Arctic terns. They were only rarely recorded at sea by JNCC indicating they do not regularly use Irish Sea waters far from the colonies. In late summer, some hundreds may use the evening roost at Sandymount Strand in Dublin Bay, and also at Dalkey Island.

In 1996 and 1999, BirdWatch Ireland surveys found hundreds using the Kish Bank in August and September. The species is listed on Annex I of the EU Birds Directive, as SPEC 3 by BirdLife International and is amber-listed by BirdWatch Ireland (Lynas *et al.* 2007, Casey et al. 1995, Hannon et al. 1997, & Crowe 1999, Newton & Crowe 2000).

Little tern: The little tern breeds in temperate areas from Ireland to Japan and winters on tropical Old World coasts. In Ireland, it breeds mainly on beaches and has declined in numbers and range as these areas become more disturbed by human use. Its Irish population is some 210 pairs and its stronghold on the east coast is now on the shingle beach near the Kilcoole Breaches in The Murrough SPA.


Figure 9.19 Adult little tern

This colony has been wardened for over a decade by BirdWatch Ireland and has been increasingly successful in recent years. For several years this typically held about 40 pairs but in 2003 and 2004 numbers increased dramatically to over 80 pairs (Maljkovic 2003).The little tern's habits are similar to other terns. The species is listed on Annex I of the EU Birds Directive, as SPEC 3 by BirdLife International and on BirdWatch Ireland's amber list (Hannon et al. 1997, Newton & Crowe 1999).

Black Tern: The black tern is a small marsh tern that feeds mainly on insects and fish found at or near the water surface. It ranges from southern Scandinavia to southern Spain, throughout Europe and parts of western Asia. It is a migratory species, breeding in May and June in fresh and brackish wetland areas throughout Europe before migrating south to overwinter in coastal areas of West and South Africa. On passage, small numbers of black tern regularly frequent Ireland in autumn and it has been reported that it has bred in Ireland, although data is sparse. The International Union for Conservation of Nature (IUCN) has categorised the species as at Least Concern under the current IUCN Red List of Threatened species (BirdLife International, 2010)

9.2.2.8 Auks

Guillemot: Guillemots have a circumpolar breeding distribution at temperate to Arctic latitudes and disperse across continental shelf waters at similar latitudes in winter. Some 57,600 pairs breed in Cos. Dublin and Wexford, with perhaps 420 in Co. Wicklow, mainly at Wicklow Head. The main site is Lambay Island with about 41,000 pairs, second only to Rathlin Island in Ireland. Great Saltee has about a third as many as Lambay. The Irish Sea population is 181,000 pairs, which is some 6.4% of the biogeographic population of 2.85 million.

Figure 9.20 Adult guillemots in summer plumage

Other than at the breeding cliffs it does not normally come to land. At sea it is normally a low flier and is flightless for some weeks after the breeding season, while moulting its wing feathers. The chicks jump from the cliffs when about one-third grown and complete their development at sea, usually accompanied by their father. They feed on small fish that they catch by diving from the surface.

They are present in the Irish Sea year round but densities of 50 to 100 birds/km2 build up from July along the entire east coast. By September these have concentrated around the Irish Sea front. From October they disperse around the coast and into the Celtic Sea (Begg & Reid 1997). The conservation status of the guillemot is secure in Europe. It was amber listed by BirdWatch Ireland as a localised breeder (Lynas *et al.* 2007, Newton *et al.* 1999, Tucker & Heath 1994).

Razorbill: Razorbills are restricted to the North Atlantic where Iceland is their stronghold. They show a partial southern migration as far as Mediterranean latitudes. Some 6,100 individuals breed in Cos. Dublin and Wexford, with perhaps 125 in Co. Wicklow, mainly at Wicklow Head. The main sites in the three counties are Lambay Island with 2,900 pairs and Great Saltee. The Irish Sea population is about 35,000 pairs, which is some 6.7% of the biogeographic population of 530,000 pairs.

Figure 9.21 Adult razorbills in summer plumage

Its habits are very similar to the guillemot. They are present in the Irish Sea year round but densities well in excess of 5 birds/km^2 build up in July east of Co. Wicklow. However, they do not share guillemots' marked preference for the Irish Sea Front later in the summer (Begg & Reid 1997; Additional references as fulmar). The conservation status of the razorbill is secure in Europe. It was amber listed by BirdWatch Ireland as a localised breeder (Lynas *et al.* 2007, Newton *et al.* 1999, Tucker & Heath 1994).

Other auks: Three other auk species occur in the Irish Sea, black guillemot, puffin and little auk. About 200 pairs of black guillemots breed on rocky coasts and harbours in Dublin and Wicklow but they are much more closely tied to the immediate vicinity of coasts than other auks. Some 295 pairs of puffins breed in Co. Dublin on Lambay and Ireland's Eye and about 1,800 pairs breed on the Saltees in Co. Wexford. The little auk is an arctic breeder that occurs in small numbers in Irish waters in winter. JNCC recorded puffins at densities of up to 0.5 birds/km2 in much of the Irish Sea during the late summer and early autumn but the other two species were rarely recorded.

9.2.2.9 Other Wildfowl

Brent goose: Brent geese breed in the high Arctic and winter on temperate coasts in North America, Western Europe and in the Far East. The 20,000 Irish wintering birds are from the pale-bellied race that breeds in North America. Up to c. 1,500 commute on a near daily basis, mainly in late winter, between Dublin Bay and agricultural grassland in The Murrough SPA south east of Kilcoole in Co. Wicklow (Colhoun 2001, del Hoyo et al. 1992, McMillan 1988). As the only North American brent geese wintering in Europe, they are accorded separate population status resulting in their low threshold for a bird unit. In winter, they normally feed on estuaries but use agricultural and amenity grassland for supplementary feeding.

Figure 9.22 Adult Brent Goose

Common scoter: Common scoter breed on low Arctic and taiga lakes from eastern Canada through northern Europe – with low numbers as far south as northern Scotland – and onto Siberia to Alaska. An atypical population of some 100 pairs uses large limestone lakes in western Ireland.

While the species has a generally secure status, the Irish breeding population is red-listed by BirdWatch Ireland. It is not known where the Irish breeding birds winter.

Figure 9.23 Male and female Scoter

Common scoters winter on shallow coastal waters, usually less than 6m deep, where they dive for shellfish. In the western Irish Sea, the biggest wintering concentrations are in Wexford Bay and off the Nanny Estuary in Co. Meath with recent five-year means of 2,200 and 670 birds, respectively. Between 20 and 70 have been recorded on the Wicklow coast, although larger numbers used Arklow Bay up to the 1960s or 1970s (O. Merne, personal communication). Just 18 birds were recorded during the Year 1 study of the Arklow Bank. JNCC recorded very low numbers in the western Irish Sea (Colhoun 2001, del Hoyo et al. 1992, Gittings & Delany 1996, Newton et al 1999, Pollock et al 1997). As part of surveys carried out at the Codling bank, low numbers were recorded between August 2001 and February 2002 – 44 birds in total.

9.2.3 Known Bird Populations in the receiving environment

Roseate terns are known to feed on the northern banks of the Kish bank and their main colony in Ireland is at Rockabill, which is approximately 35km north of the proposed wind farm. On this basis a 35 km study area was identified around the proposed Dublin Array to cater for the inclusion of known seabird colonies that may potentially be affected by the proposed development. Consideration of the passage of migratory seabirds over the study area to their overwintering colonies and the potential feeding/passage of seabirds from colonies on the east coast was also incorporated into the studies. A summarised assessment of the seabirds in the Irish Sea is presented in Table 9.2.

9.2.4 Migration routes of seabirds in the Irish Sea

Seabird migration routes through the Irish Sea are not well defined and it is not known if these involve more than local birds. Migratory concentrations do not occur in the same manner as on the west and southwest coast of Ireland. This probably reflects both smaller numbers and the lack of geographical features and prevailing onshore winds that concentrate migratory flows in the west and southwest. Perhaps the main migratory feature is the concentration of large numbers of Manx shearwaters and auks on the Irish Sea front, between Dublin and the Isle of Man, in late summer. However, this could be a relatively short range movement of British and Irish birds (Begg & Reid, 1997, Hutchinson 1989, Pollock *et al.,* 1997).

A European funded seabird project FAME (Future of the Atlantic Marine Environment) involving BirdWatch Ireland as a partner is currently tracking seabird movements around the coastlines of Europe, including Ireland, the UK, France, Spain and Portugal. This project will provide much needed knowledge on the migrating seabirds along the Irish coast. Unfortunately the results of this research were not available at the time of publishing this EIS.

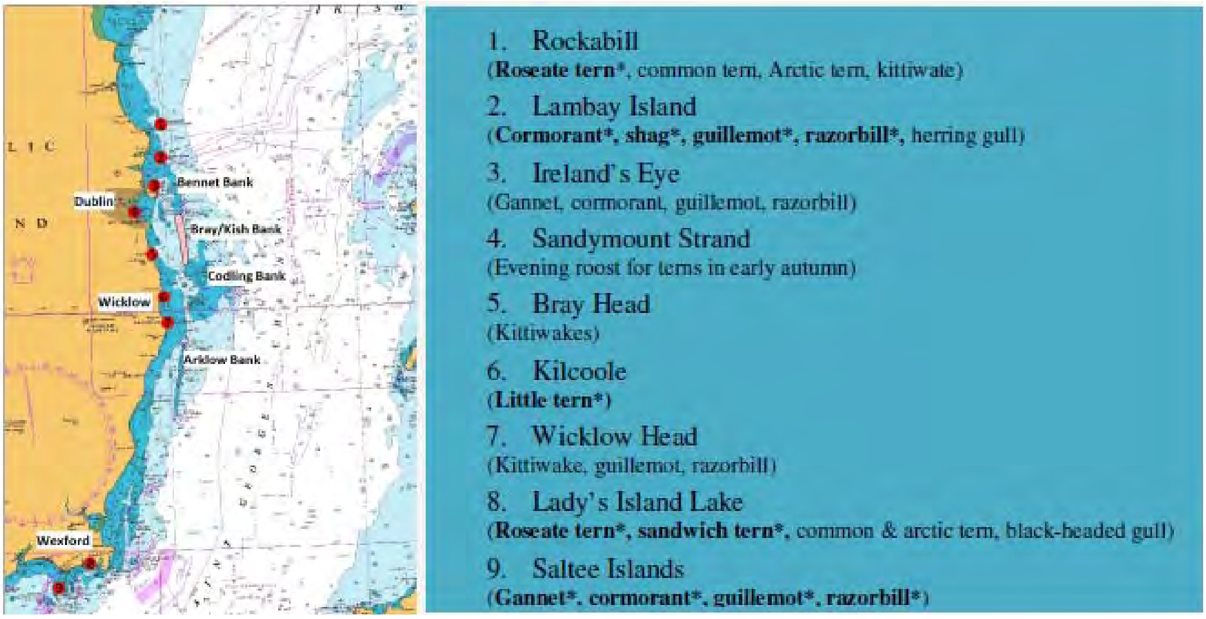


Figure 9.24 Offshore banks and seabird colonies in the western Irish Sea.
*(*Important species. All are breeding sites apart from Sandymount Strand.)*

9.2.5 Field survey

9.2.5.1 Methodology – birds baseline surveys

As noted in Section 9.1, initial baseline boat transect seabird surveys were carried out on the Kish and Bray banks on behalf of the Developers by Ecology Consulting in the period 2001-2002 and further surveys to collect up to date baseline information were undertaken by BirdWatch Ireland on behalf of the Developers between June 2010 and June 2011. A total of 29 boat transect surveys were undertaken between both sets of surveys.

The 2001-02 survey followed a transect route that had north-south running sections at the northern end of the bank, and east-west transects on the southern part of the bank, due to concerns over water depth (Figure 9.25B).

In the 2010-11 survey, the north-south sections were changed to east-west transects, covering the same area (Figure 9.25A).

The methods employed for the boat transect surveys followed the standard Seabirds at Sea methodology (Komdeur *et al*., 1992). The scan method with band transect using the snapshot technique was used, though recording is being done continuously (rather than in 10-minute blocks), recording the precise time of each observation, which can then be linked to the GPS data to give a more precise location of each bird/flock encountered. This improves the spatial resolution of the data collected.

An aerial survey was also carried out in 2001 following methods developed by NERI (Kahlert *et al*., 2000).

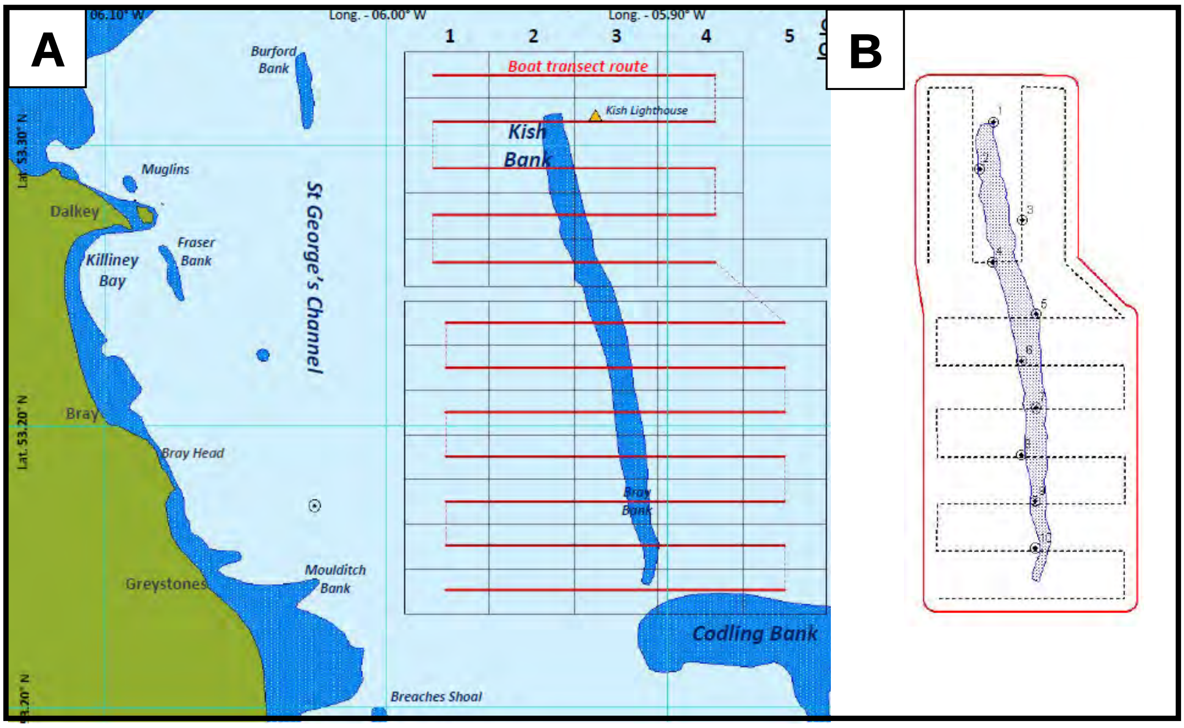


Figure 9.25 Boat transects followed during (A) 2010-2011 seabird survey and the (B) 2001-02 seabird survey.

9.2.6 Birds Recorded during 2010/2011 BirdWatch Ireland Survey

Figure 9.27 identifies the Grid Codes used to indicate where seabirds were recorded in each survey during the transect surveys undertaken by BirdWatch Ireland between June 2010 and June 2011.

Figure 9.26 shows the colour key applied to illustrate the seabird abundance recorded in each cell during the surveys, the universal colour key applied to illustrate seabird abundance over the survey area is shown below.

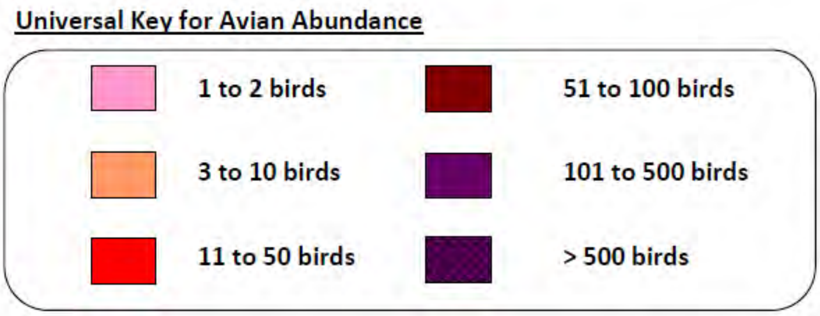


Figure 9.26 Universal colour key for Avian Abundance

Sections 9.2.6.1 through to 9.2.6.11 describe the presence and abundance of each of the seabird species identified in Section 9.2.2 which were recorded on and in the vicinity of the proposed development on the Kish and Bray banks during the course of the surveys undertaken by BirdWatch Ireland between June 2010 and June 2011. A copy of BirdWatch Ireland's report 'Kish Bank Seabird Survey – Final Report on surveys between June 2010 and June 2011' is included in Appendix N, Volume 3 of this EIS.

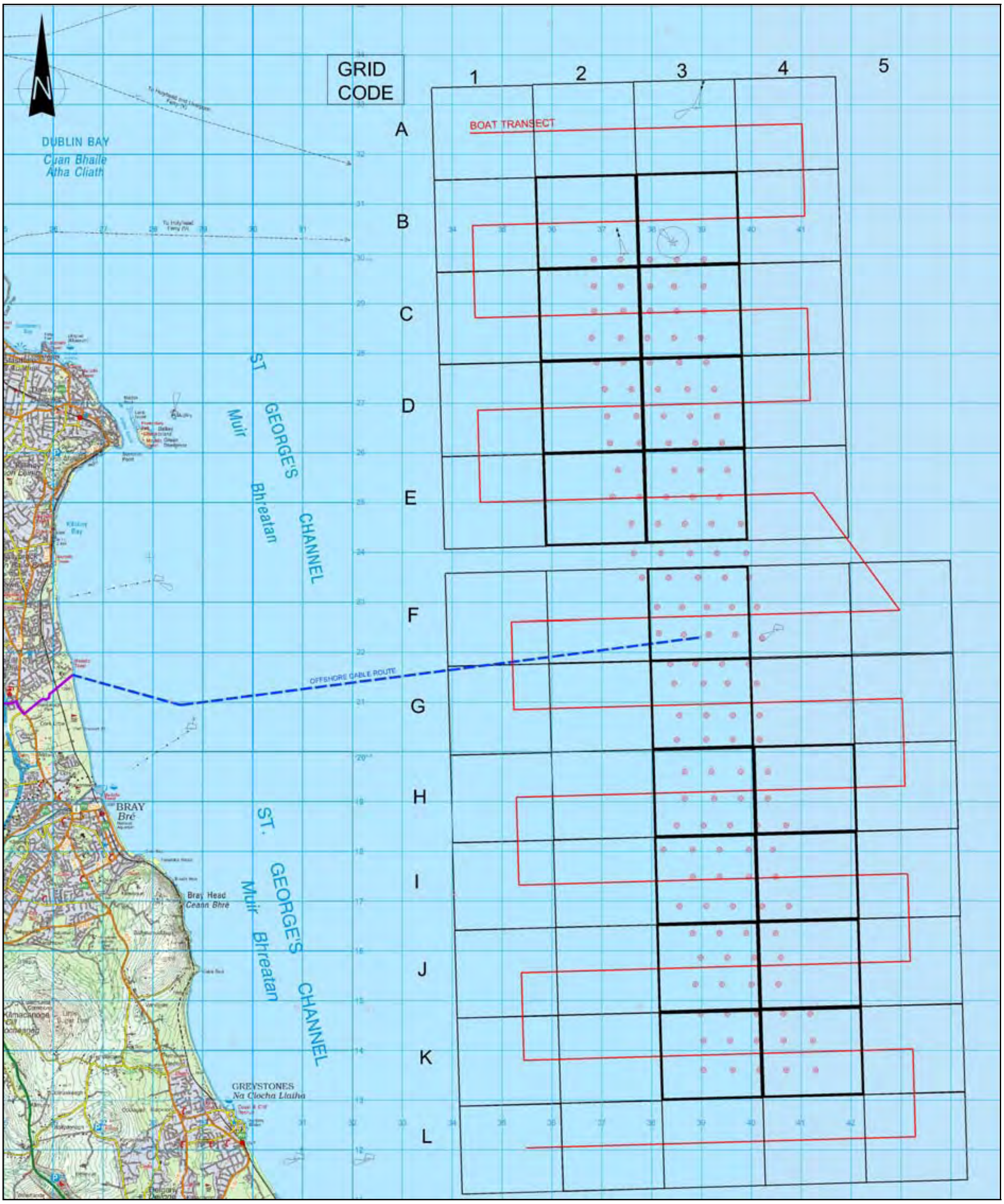


Figure 9.27 A map illustrating the boat transects covering the survey area during the 2010-11 survey and the grid code used to indicate where the seabirds were recorded. *Grids in bold correspond with BirdWatch Ireland seasonal distribution and density data (Figures 9.28 – 9.52) with transect route shown in red. (OSI License No. EN0034812)*

9.2.6.1 Divers and Grebes

Red-throated Diver: Red-throated Divers (*Gavia stellata*) were not recorded using the bank during the summer and early autumn 2011. They first appeared in November to the west of the bank and in December and January were recorded over shallow water of the bank and adjacent to Codling. Red-throated Divers are usually very wary of boat traffic and are usually detected in flight. In late March 2011, 22 Red-throated Divers were seen concentrated in foraging groups on the water at the south end of the bank. In the inshore waters of the east coast in counties Wicklow and Wexford, numbers of divers often increase in April and May in what is clearly a northward spring migration, but whether the late March peak was a wintering aggregation that had discovered a profitable foraging resource on the bank, or an early migrant group, is not known. In 2001-02, a single bird was recorded in November and two were recorded in both late March and early April.

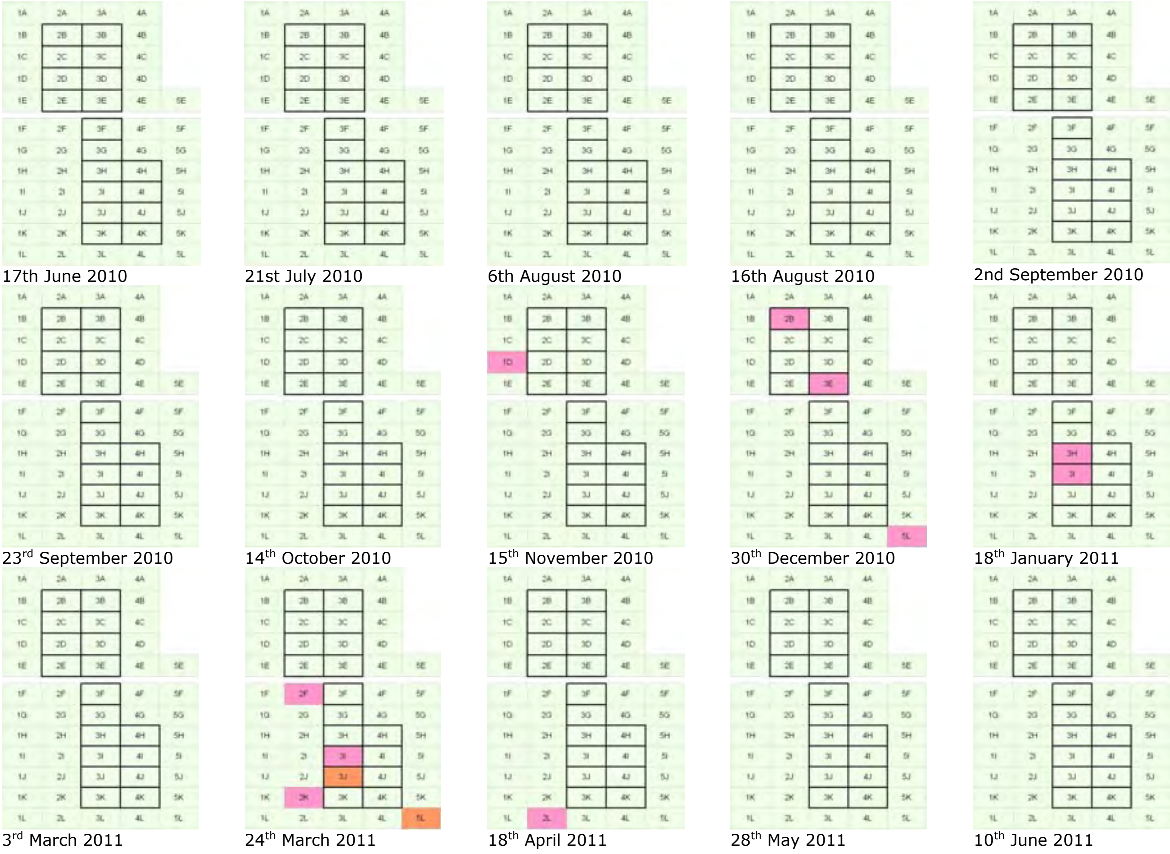


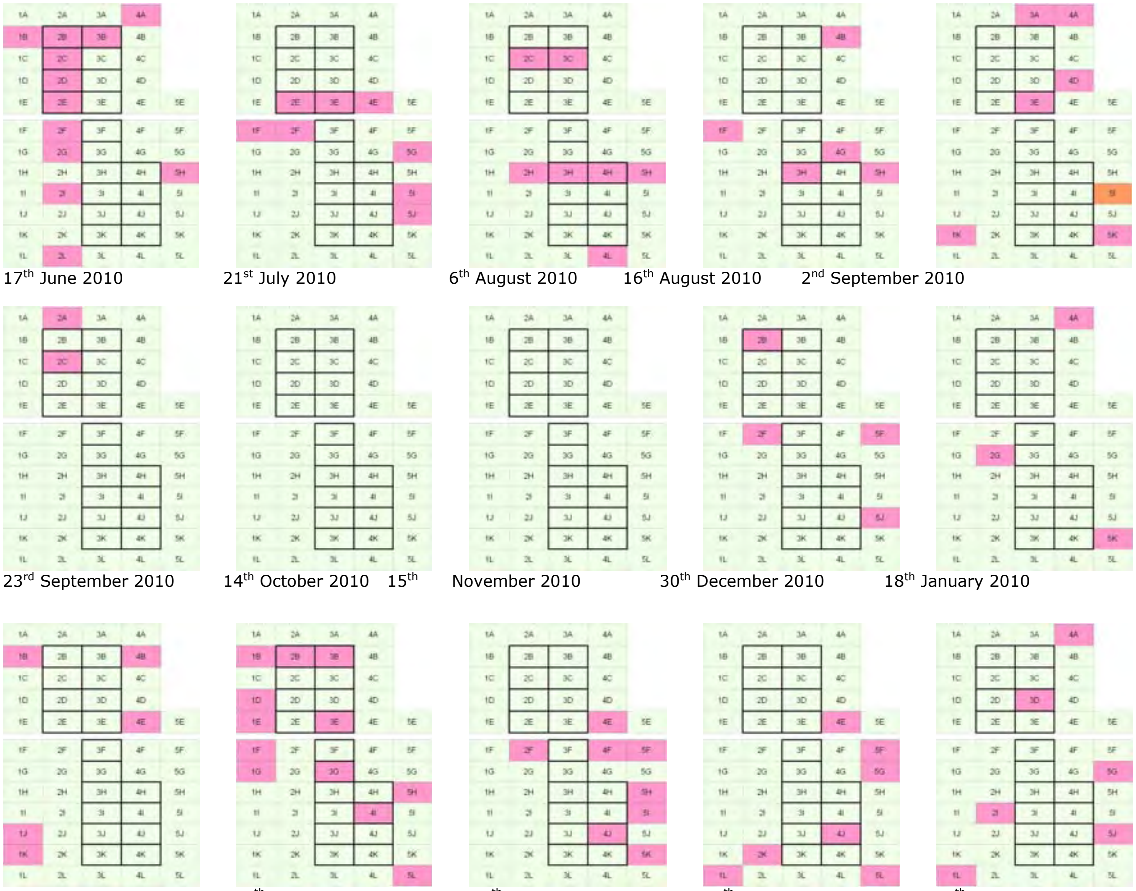
Figure 9.28 Red-throated Diver Gavia stellata:Seasonal distribution & density over the Kish Bank

Great-crested Grebe: Only a single observation of a Great Crested Grebe (*Podiceps cristatus*) flying east in mid-August, presumably a bird in post-breeding dispersal from Ireland to Wales or beyond.

Figure 9.29 A. Great-crested Grebe *Podiceps cristatus* - 16th August 2010

9.2.6.2 Fulmar and Manx Shearwater

Northern Fulmar: Recorded in 13 of 15 surveys, the Northern Fulmar (*Fulmarus glacialis*) were most numerous in spring and summer and none present in October and November. This hints that the majority were local breeding birds and the bank is not a favoured wintering area. Numbers of >10 only recorded four times in contrast to 2001-02 when 50% of 14 surveys were in double figures with a peak of 42 in early August.



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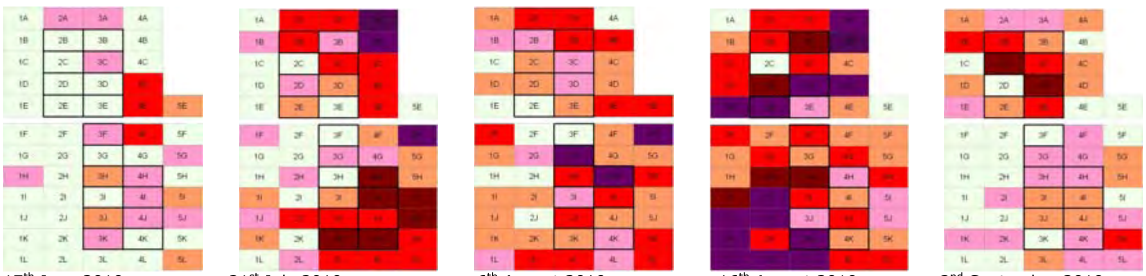
23rd September 2010 14th October 2010 15th November 2010 30th December 2010 18th January 2010

March 2011 24th March 2011 18th April 2011 28th May 2011 10th June 2011

Figure 9.30 Northern Fulmar *Fulmarus glacialis*: Seasonal distribution & density over the Kish Bank

Manx Shearwater: Modest numbers of the Manx Shearwater (*Puffinus puffinus*) were recorded in June and September-October and none after that until the first returning bird in late March (2011). Peaked in July and August and given very few breed on County Dublin Islands (see Newton 2002) the majority are likely to originate from the Pembrokeshire colonies of Skomer and Skokholm or were non-breeders. The Welsh breeding birds have been shown to use eastern Irish waters as one of their preferred foraging areas (see Guilford et al., 2008). There was no obvious preference for deeper or shallower waters in the survey box and they were regularly recorded in large multi-species foraging frenzies with auks, Gannets and Kittiwakes. The maximum count of 4,513 in August was of similar timing and magnitude to that recorded in 2001-02 surveys. The work of Guilford et al., (2008) showed that the sample of tagged Manx Shearwaters tended to frequent waters to the east of the Kish and Codling Banks and the equivalent area off Dublin Bay and northwards.



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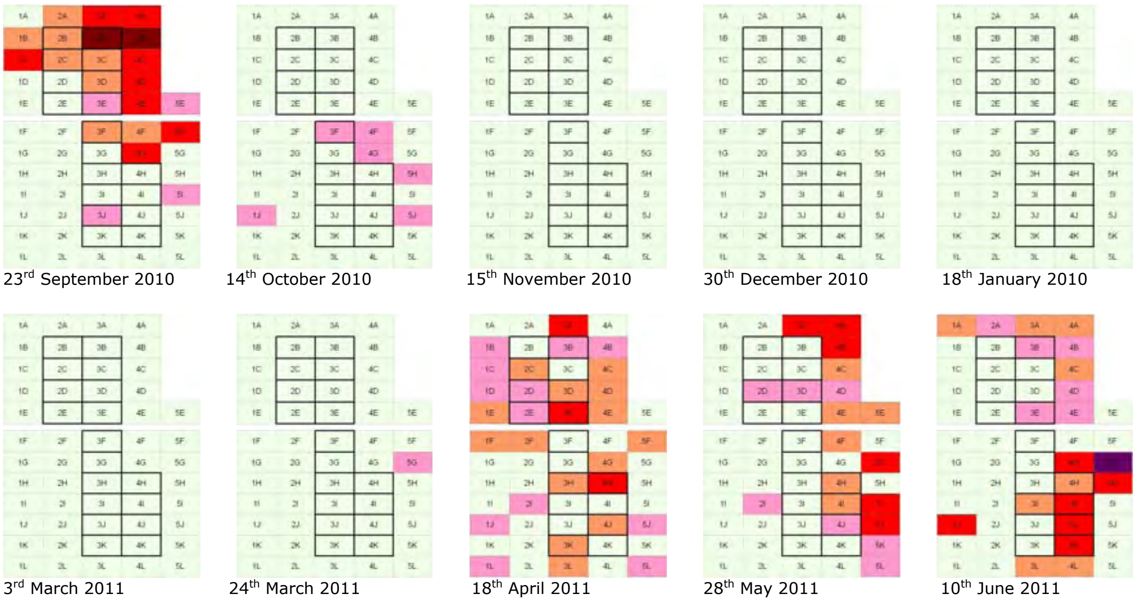
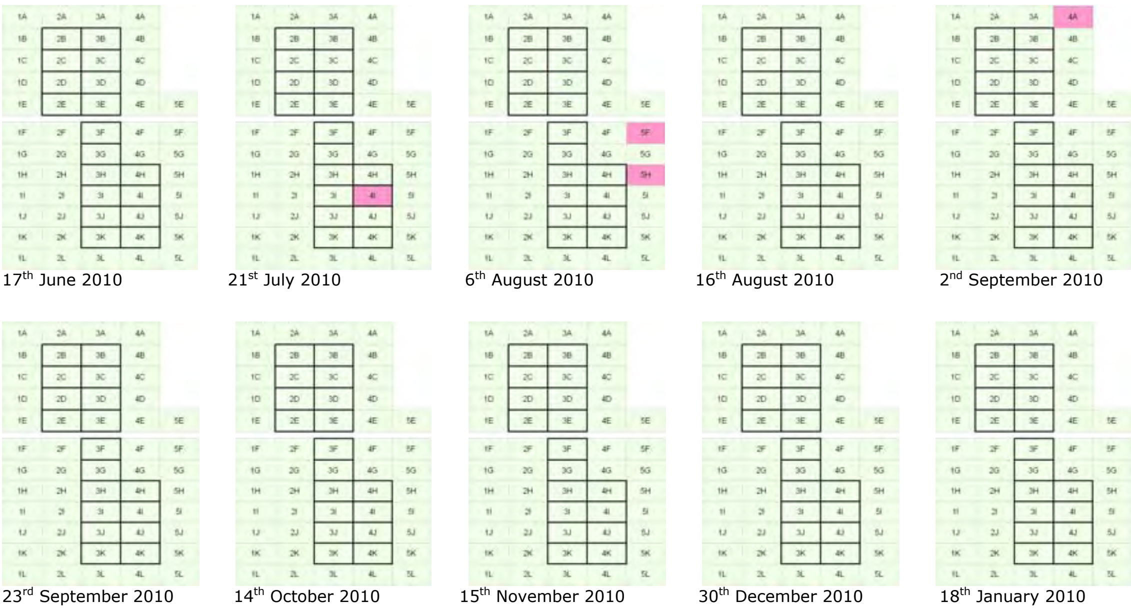


Figure 9.31 Manx Shearwater *Puffinus puffinus*: Seasonal distribution & density over the Kish Bank

9.2.6.3 Other Shearwater and Petrel Species

Balearic Shearwater: One to two individuals of this Critically Endangered species Balearic Shearwater (*Puffinus mauretanicus*) were recorded amongst larger flocks of Manx Shearwaters on three occasions from July to early September. It is interesting to note that all four birds seen 'on transect' were to the east of the bank. Sighted on one other occasion in this period 'off transect'. A single observation was recorded of two birds in the early September 2001-02 survey.



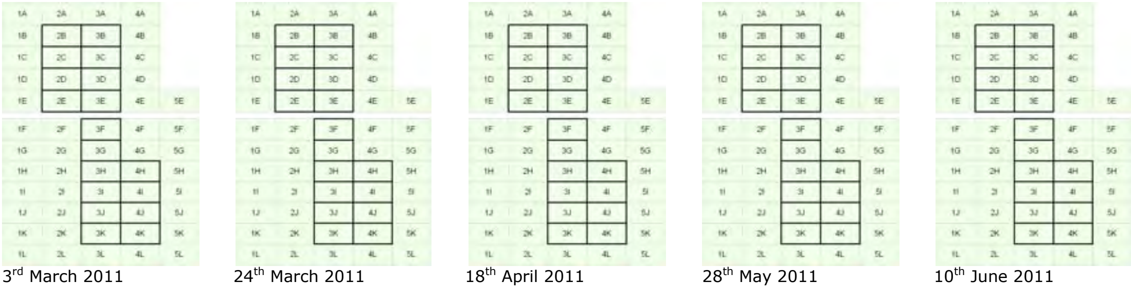


Figure 9.32 Balearic Shearwater *Puffinus mauretanicus*: Seasonal distribution & density over the Kish Bank

European Storm-petrel: European Storm-petrels (*Hydrobates pelagicus*) were recorded on five surveys (July-August 2010, May-June 2011) in the southeast part of the survey box. The maxima of 9 occurred in both early August and May. While no European Storm-petrels were recorded during five surveys in this period in 2001-02.

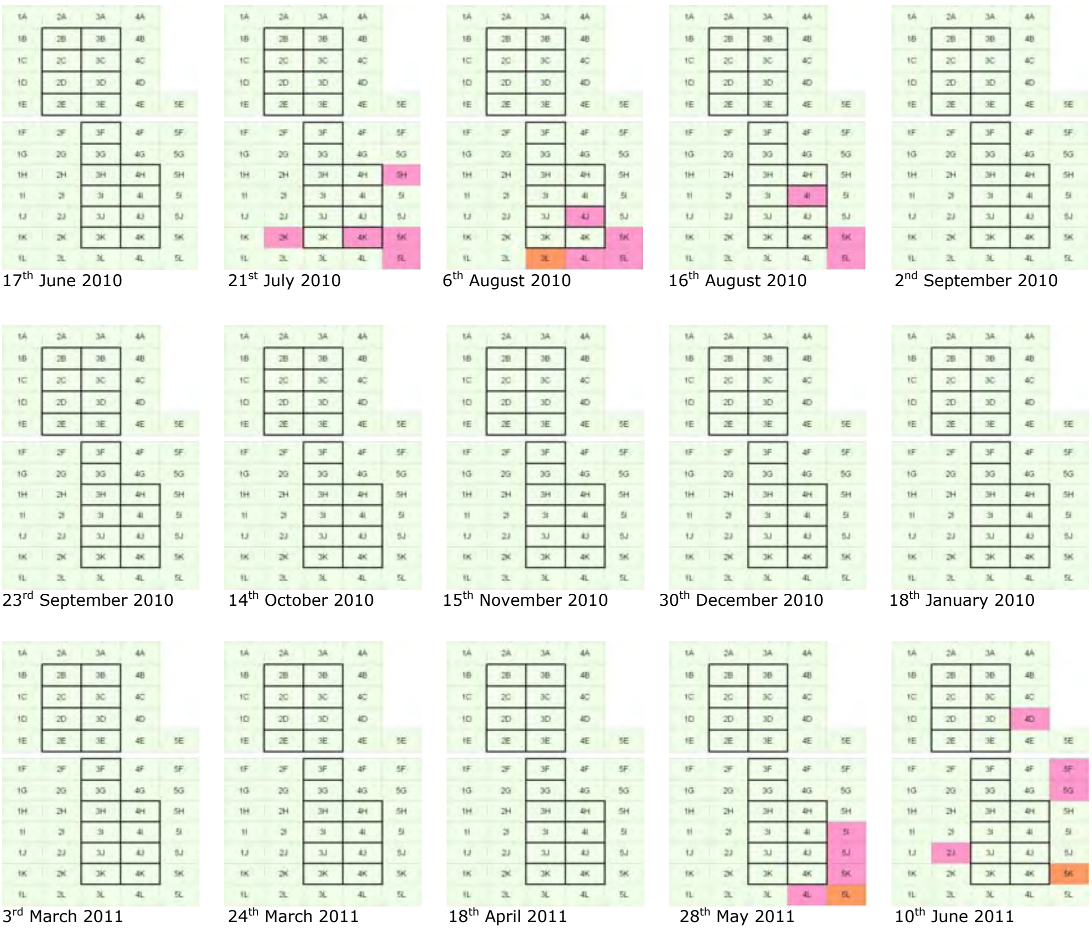


Figure 9.33 European Storm-petrel *Hydrobates pelagius*: Seasonal distribution & density over the Kish Bank

9.2.6.4 Gannet

Northern Gannet The Northern Gannet (*Morus bassanus*) was recorded in high numbers from July through to late September, but then was scarce in the late autumn and winter months. Peak numbers occurred in May 2011 when there was intense foraging along the crest of the bank. Most birds were presumably from the two breeding colonies in Dublin (Ireland's Eye and Lambay) though birds from the Welsh colony of Grassholm could also forage on the Kish Bank. There was a tendency for Gannets to be present over the shallower waters of the Kish Bank in the surveys with highest numbers overall. Numbers were substantially higher than those recorded in 2001-02.

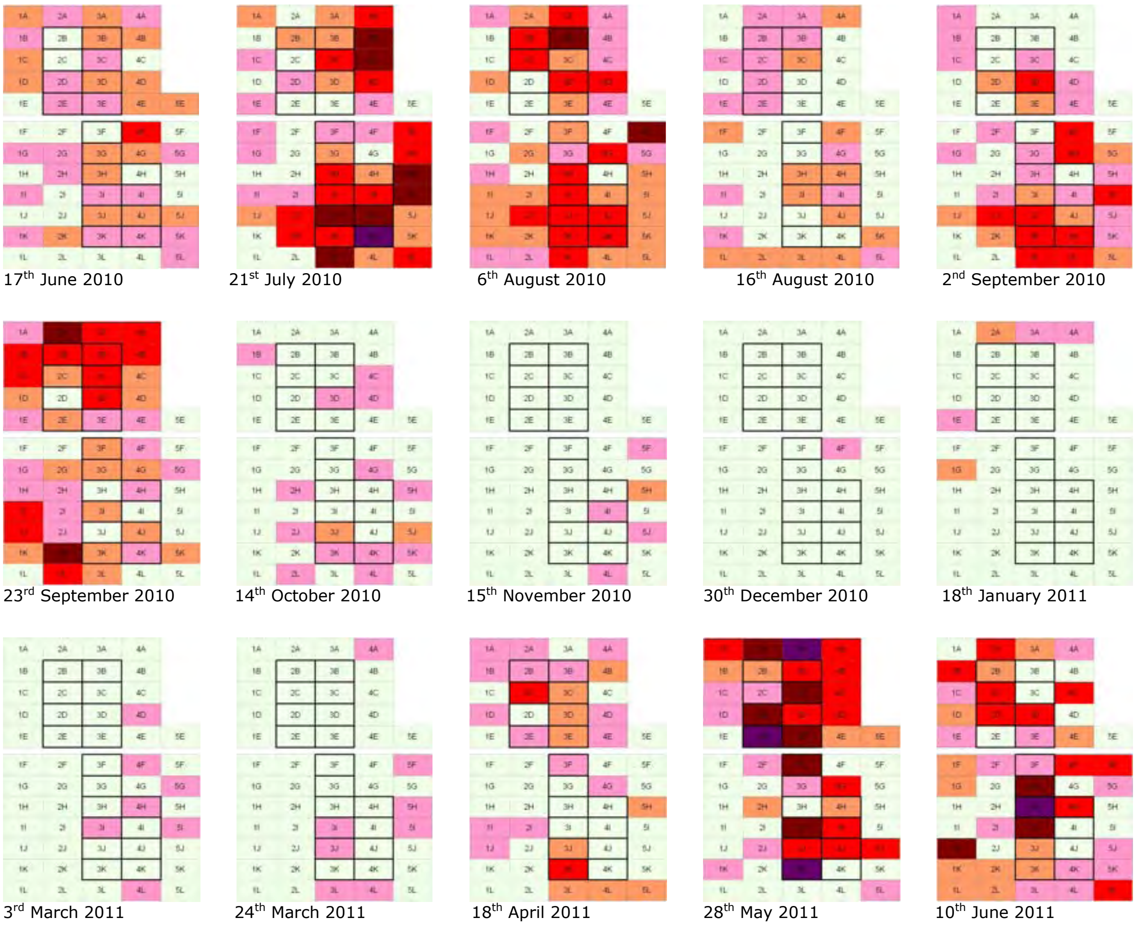
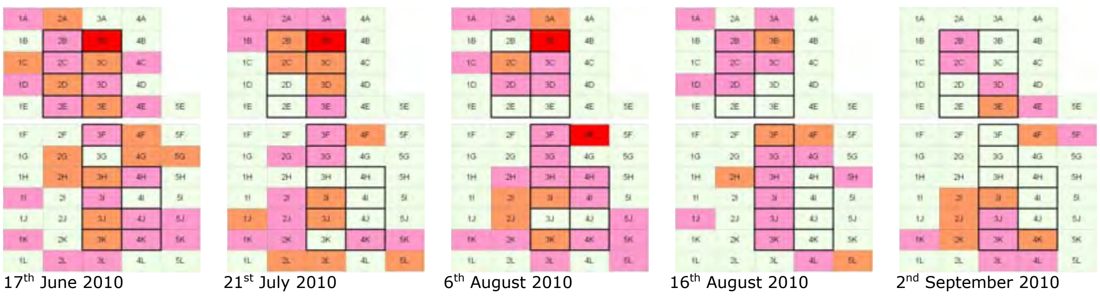


Figure 9.34 Northern Gannet *Morus bassanus*: Seasonal distribution & density over the Kish Bank

9.2.6.5 Cormorant and Shag

Great Cormorant: The Great Cormorant (*Phalacrocorax carbo*) was most frequent in summer when significant numbers were recorded day-roosting on the Kish Lighthouse. Lesser numbers in early autumn and few were present from October through to March. There was a clear tendency for Cormorants to be most frequent over the shallowest waters of the bank. In 2001-02 numbers of Cormorants on the bank were lower during the breeding season, while recording similar numbers in late summer onwards and almost absent in winter.



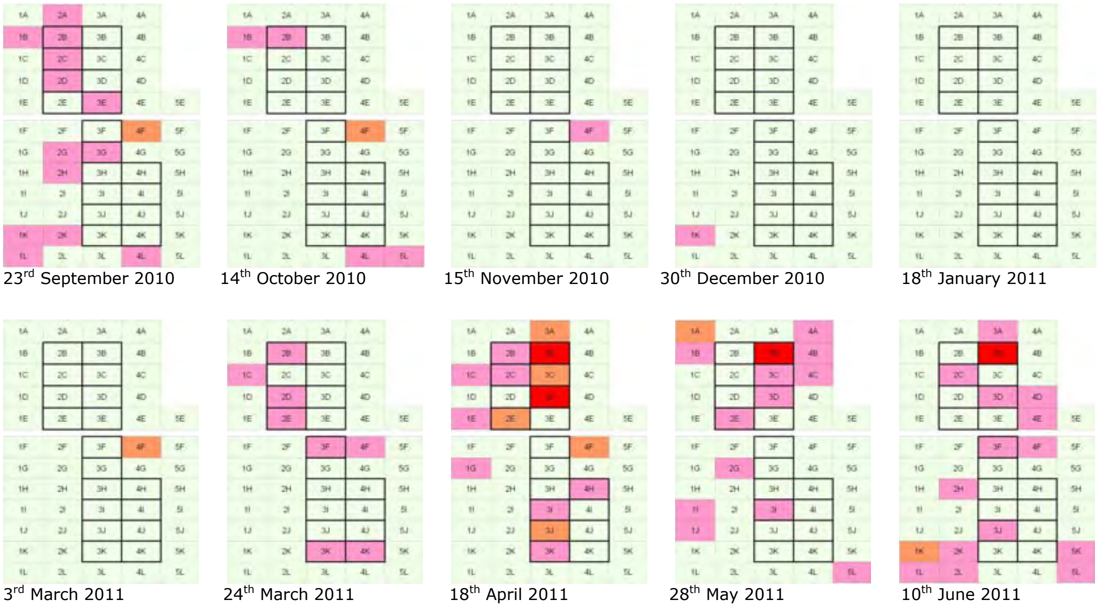
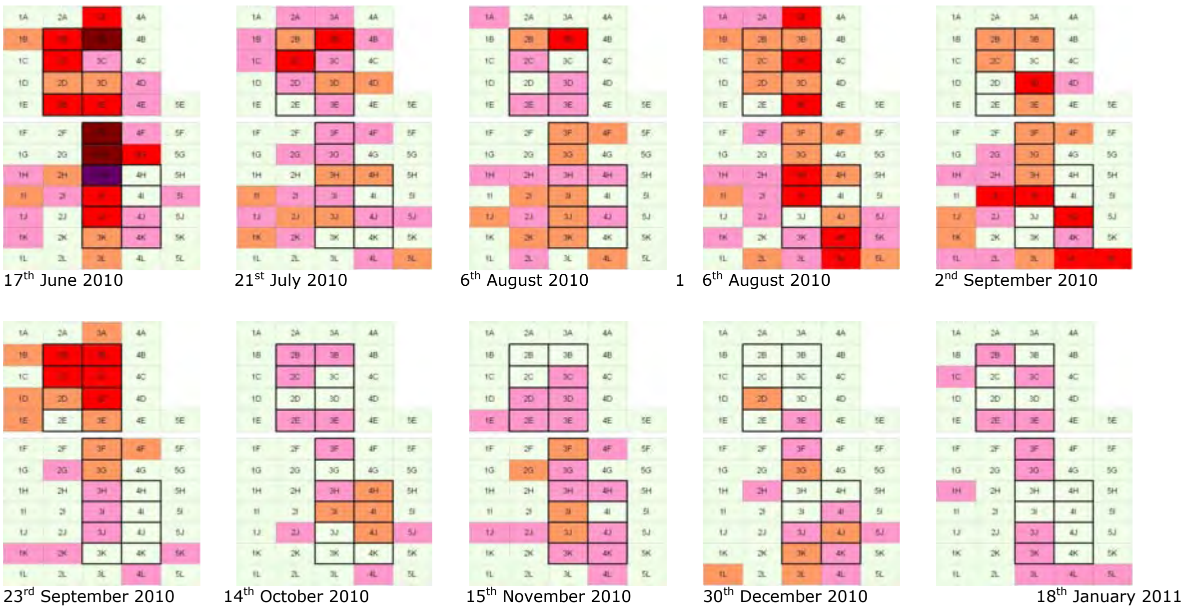
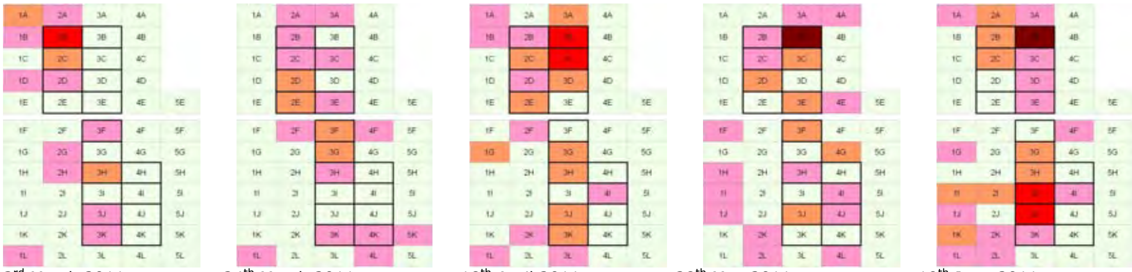


Figure 9.35 Great Cormorant *Phalacrocorax carbo*: Seasonal distribution & density over the Kish Bank

European Shag: The European Shag (Phalacrocorax aristotelis) was present on the bank in all surveys with a distinct peak in June (2010) when birds were still feeding young in the nest. Relatively few were present from October through to early March, though large numbers were night-roosting on Muglins Island, Dalkey, at this time indicating that foraging conditions were probably better in inshore waters. During summer and early autumn numbers were distinctly higher on the shallowest waters of the bank. The phenology and numbers were similar to those recorded in 2001-02 except for the near absence of Shags on the bank in June.





3rd March 2011 24th March 2011 18th April 2011 28th May 2011 10th June 2011

Figure 9.36 European Shag *Phalacrocorax aristotelis*: Seasonal distribution & density over the Kish Bank

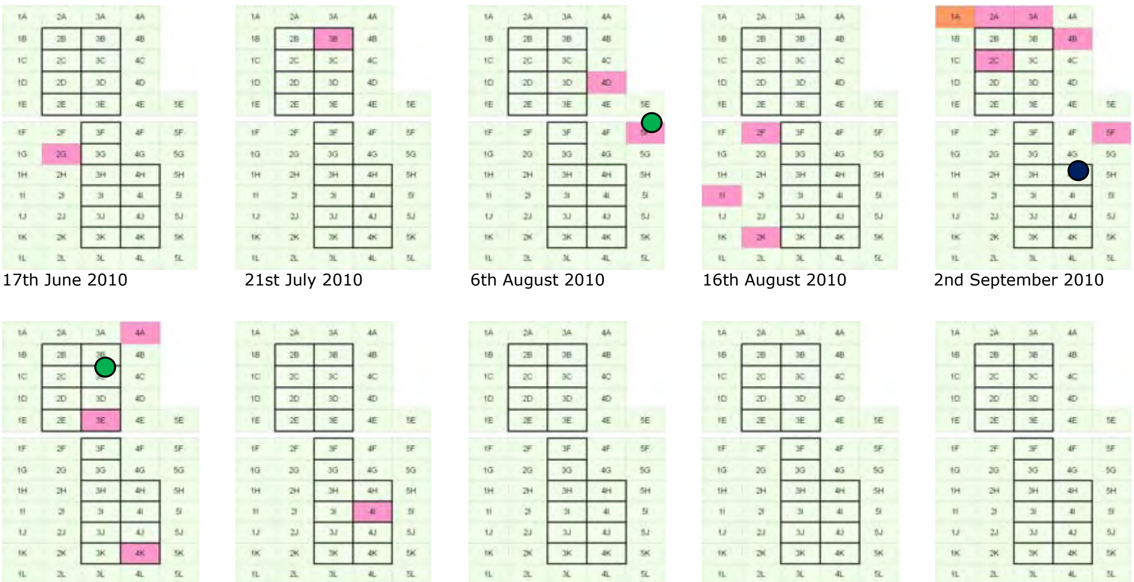
9.2.6.6 Skuas

Arctic Skua The Arctic Skua (*Stercorarius parasiticus*) is a southbound migrant recorded in summer and early autumn, peaking in early September when ten birds were recorded. The Arctic Skua is a Kleptoparasite, stealing fish from terns and subsequently the peak occurrence corresponded with the presence of large numbers of Common and Roseate Terns utilising the northern part of the bank. Both phenology and numbers were almost identical to the 2001-02 surveys.

Long-tailed Skua: A single south-bound Long-tailed Skua (*Stercorarius longicaudus)* was seen in early September; mirrored by the observation of two on the exact same date in 2001-02.

Great Skua: Two single observations of a Great Skua (*Stercorarius skua*) were seen in early August and late September; slightly more seen in 2001-02, but this difference is unlikely to be of any significance.

Also shown are records of individual: ● **Peregrine Falcon** *Falco peregrine* ● **Great Skua** *Stercorarius skua* ● **Long-tailed Skua** *Stercorarius longicaudus*



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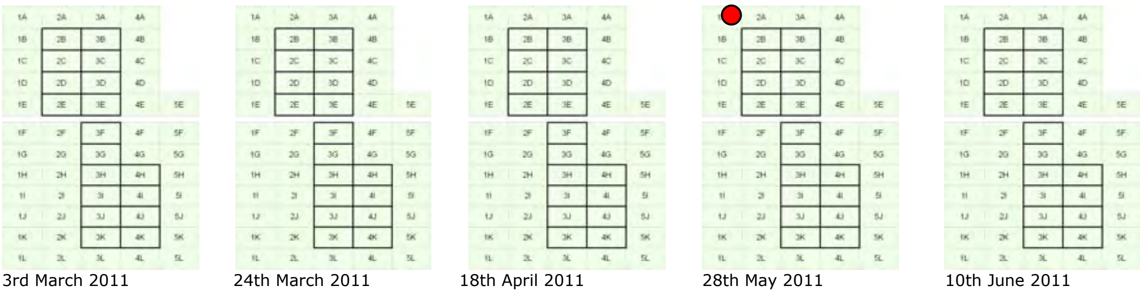


Figure 9.37Arctic Skua *Stercorarius parasiticus*: Seasonal distribution & density over the Kish Bank

9.2.6.7 Gulls

Little Gull: The Little Gull (*Hydrocoloeus minutus*) breeds well to the east of the Irish Sea and the two observations of birds in July and early August are likely to have been widely ranging non-breeders or failed breeders. The remaining observations of significantly more birds from October through to January are more typical of a winter visitor. The peak of 153 birds in November was unexpected, though mirrors the phenology of Little Gulls on the Arklow Bank to the south of the Kish. Little Gulls were recorded widely over the Kish Bank survey box and the majority of observations were of adult birds foraging in association with diving Razorbills. In 2001-02 only five birds were seen in December; thus the 2010-11 observations appear to mark a distinct change in the distribution of Little Gulls. This needs further analysis to determine if there been a shift away from their main wintering site on the Arklow Bank.

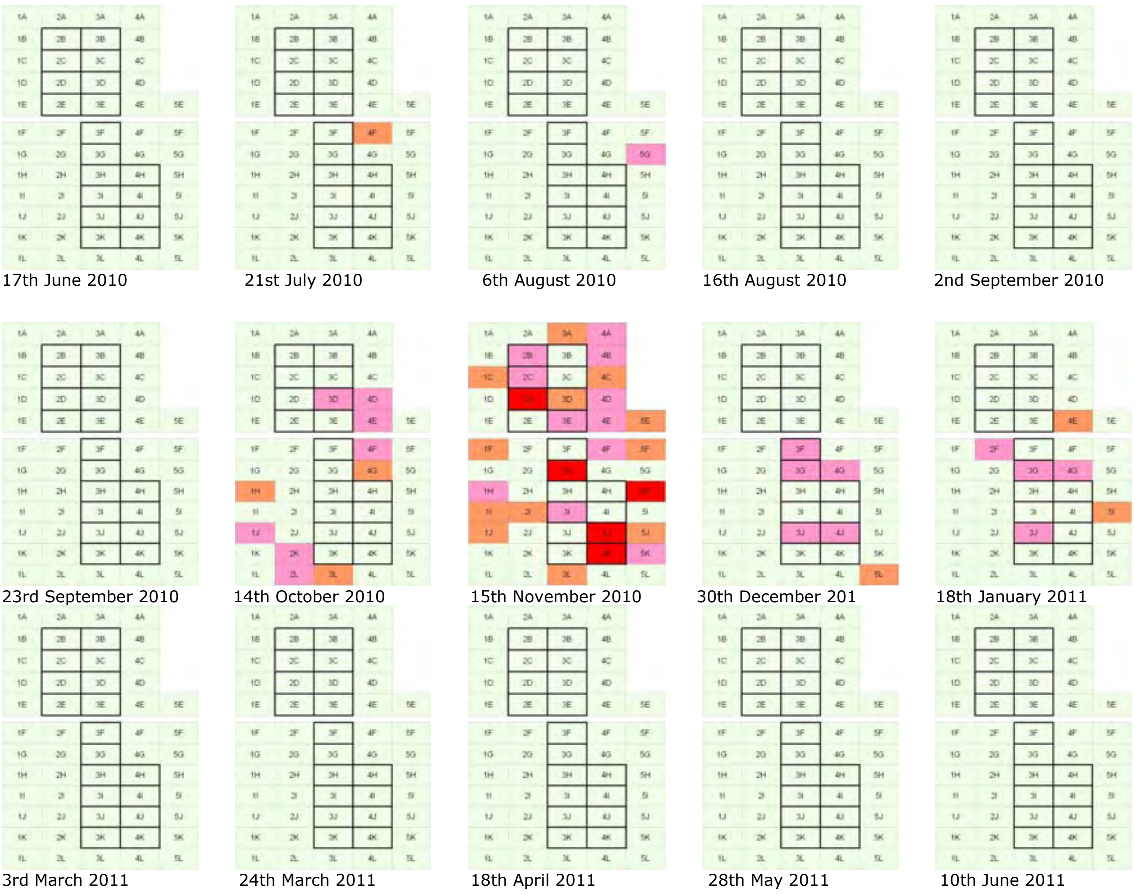


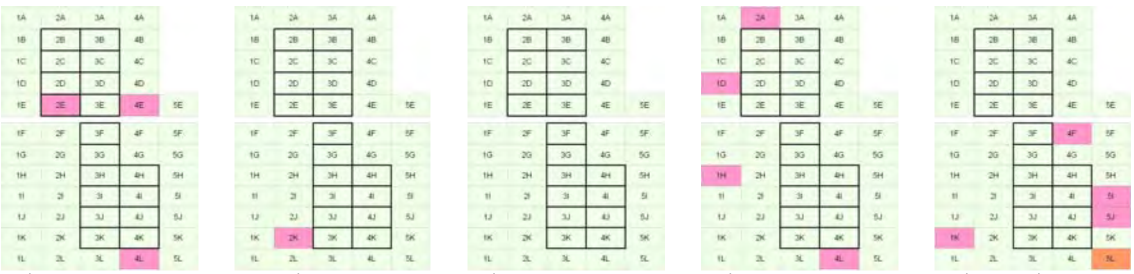
Figure 9.38 Little Gull *Hydrocoloeus minutus*: Seasonal distribution & density over the Kish Bank

Common Gull: The pattern of occurrence, as a scarce winter visitor, of the Common Gull *Larus canus* was similar to the previous two species and in line with 2001-02 observations. The observations in late March and April suggest a small spring passage of birds heading north.

17th June 2010 | 21st July 2010 | 6th August 2010 | 16th August 2010 | 2nd September 2010
23rd September 2010 | 14th October 2010 | 15th November 2010 | 30th December 2010 | 18th January 2011
3rd March 2011 | 24th March 2011 | 18th April 2011 | 28th May 2011 | 10th June 2011

Figure 9.39 Common Gull *Larus canus*: Seasonal distribution & density over the Kish Bank

Lesser Black-backed Gull: The Lesser Black-backed Gull (*Larus fuscus)* was recorded in low numbers from June through to early September; presumably the birds in June and July were from colonies on the north Dublin islands; those in mid-August and early September they were more likely southbound post-breeding birds. The complete absence from late September onwards was surprising, though a few birds appeared in March/April on spring passage to breeding colonies



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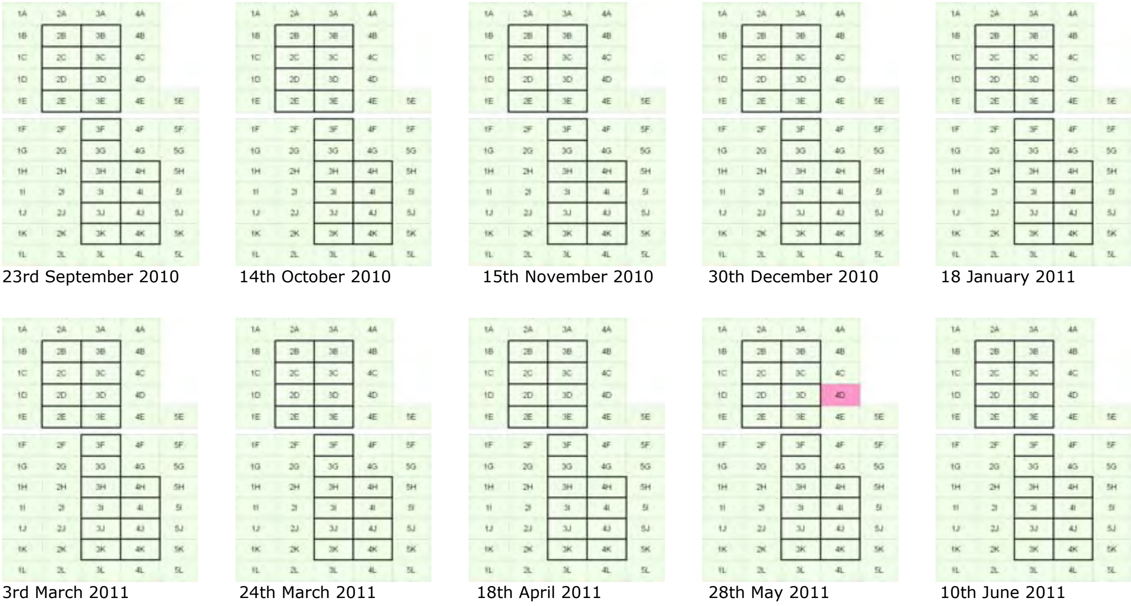
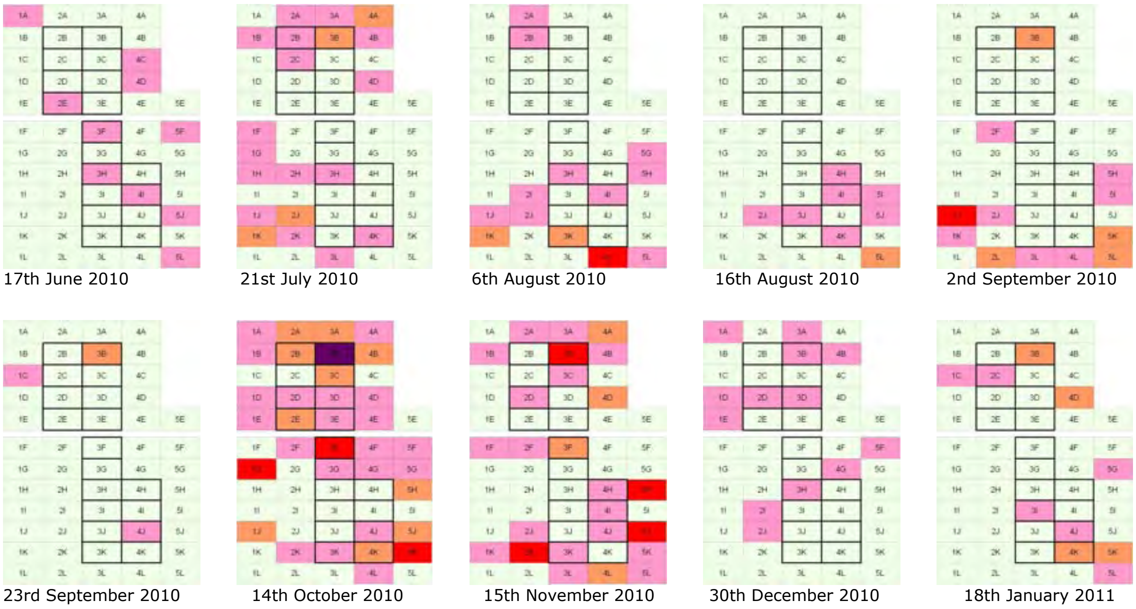


Figure 9.40 Lesser Black-backed Gull *Larus fuscus*: Seasonal distribution & density over the Kish Bank

Herring Gull: The Herring Gull (Larus argentatus) was recorded in all surveys, most numerous in October and November. The largest aggregations were associated with fishing boats though sometimes Herring Gulls could be attracted to multi-species ‘foraging frenzies’. They were also frequently recorded resting on the Kish Lighthouse, but otherwise the wide distribution in the survey box was mostly influenced by the activity of fishing boats. The species has apparently increased since 2001-02, perhaps in line with the partial recovery in the local breeding population at one of the main colonies on Lambay. In May, a pair appeared to be nesting on the Kish Lighthouse.



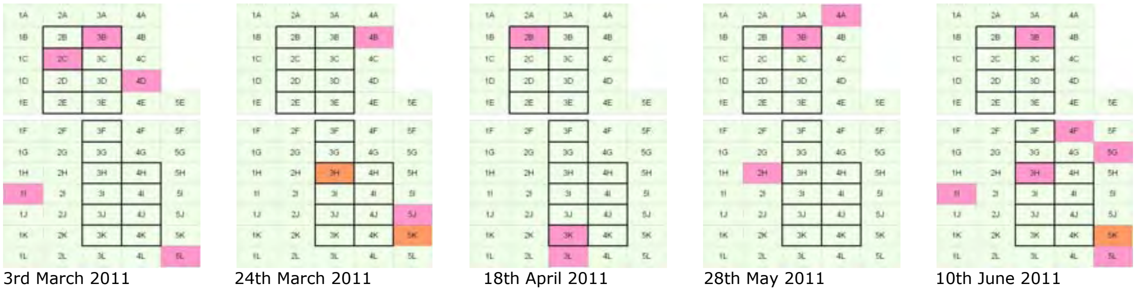


Figure 9.41 Herring Gull *Larus argentatus*: Seasonal distribution & density over the Kish Bank

Great Black-backed Gull: Similarly the Great Black-backed Gull (*Larus marinus*) was recorded in every month, and numbers remained fairly stable (10-30) though a peak of 58 was present in July. In common with Herring Gulls, they followed fishing boats for discarded bait and utilised all structures for day roosting. No obvious change since 2001-02 surveys.

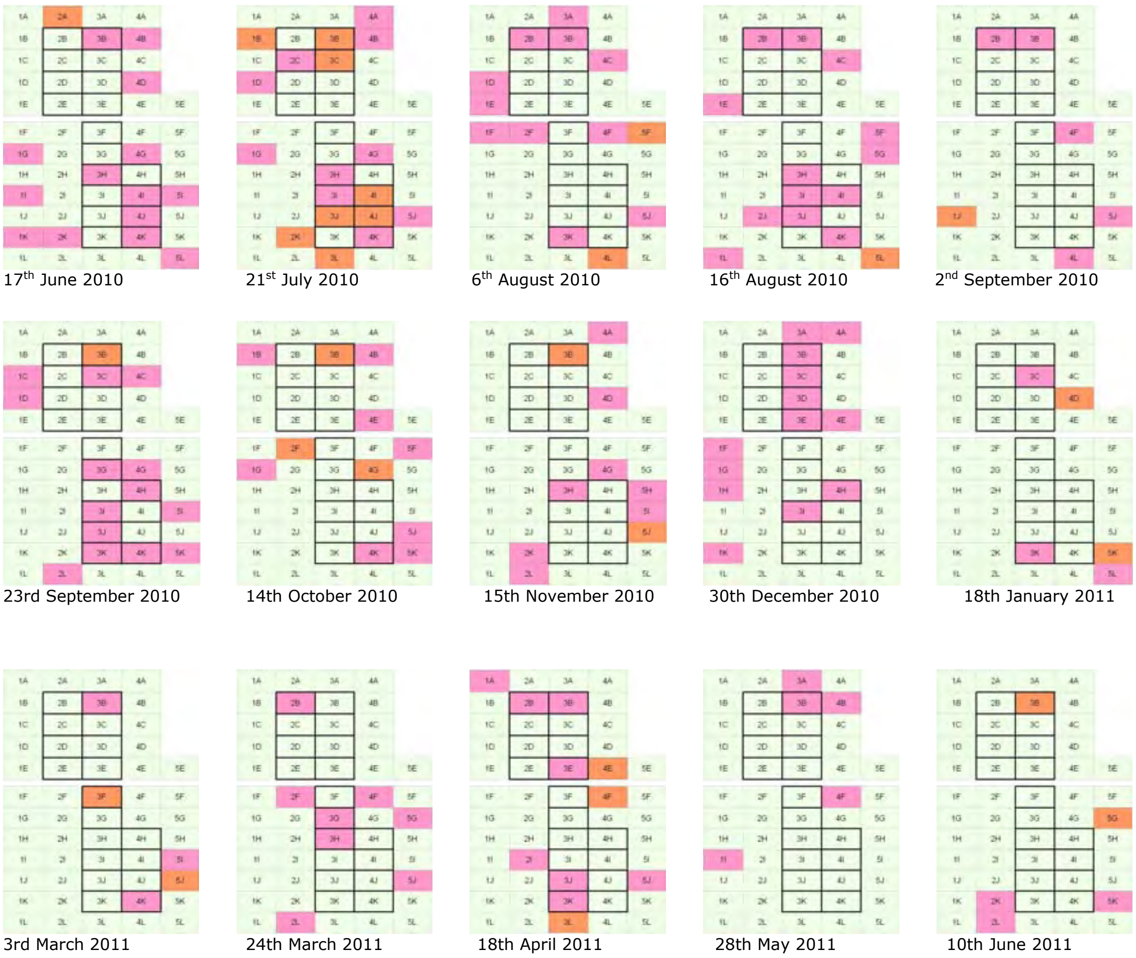


Figure 9.42 Great Black-backed Gull *Larus marinus*: Seasonal distribution & density over the Kish Bank

Black-legged Kittiwake: The Black-legged Kittiwake (*Rissa tridactyla*) were most numerous during the later parts of the breeding season, when adults are feeding well grown chicks. Numbers were much reduced in late summer, although a secondary peak in late September occurred, probably marking dispersal/migration away from the vicinity of Dublin and Wicklow colonies. Late autumn and winter numbers were at very low levels though small numbers were present in all surveys. When numbers were highest, Kittiwakes utilised all parts of the survey box, though highest densities appeared to be over the bank itself or in waters to the east; Kittiwakes were often a key species involved in the formation of 'feeding frenzies'. The Kish Lighthouse was frequently used as a day roost. In 2001-02, the peak count was recorded in early September.

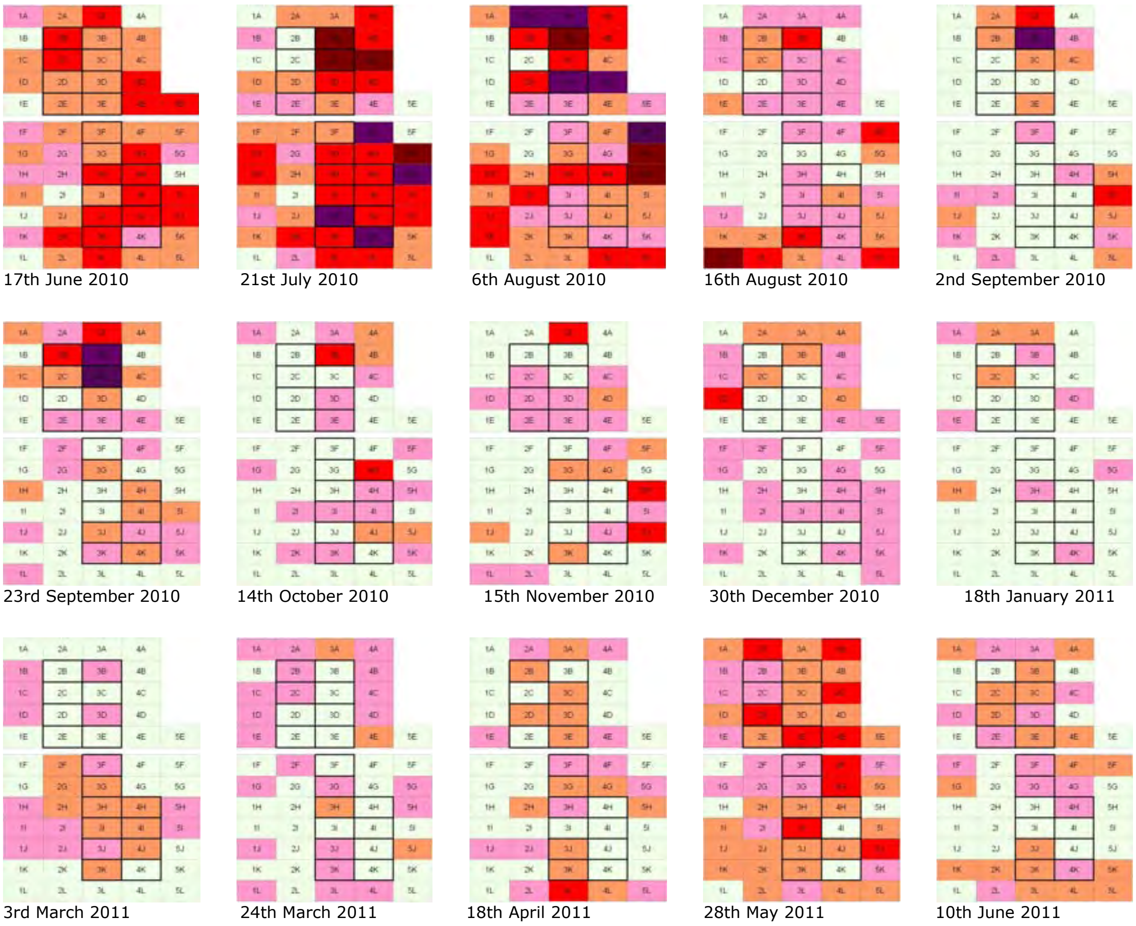


Figure 9.43 Black-legged Kittiwake *Rissa tridactyla*: Seasonal distribution & density over the Kish Bank

9.2.6.8 Terns

Roseate Tern Roseate Terns (*Sterna dougallii*) nesting on Rockabill in north Dublin do not appear to use the Kish Bank as a foraging area prior to the fledging of young. However, by mid-August adults with dependent young begin to appear on the bank and these built up to a peak of over 300 birds in early September and most had departed on southward migration three weeks later. At the time of the peak, Roseate Terns were concentrated in the northern part of the survey box, perhaps because they were foraging in relatively short forays from the Kish Lighthouse which they used as a base. In late September virtually all birds were present in the southeastern part of the survey box. Overall, both numbers and phenology were similar to 2001-02. None were recorded on the bank in the May and June 2011 surveys, during the main incubation period on Rockabill.

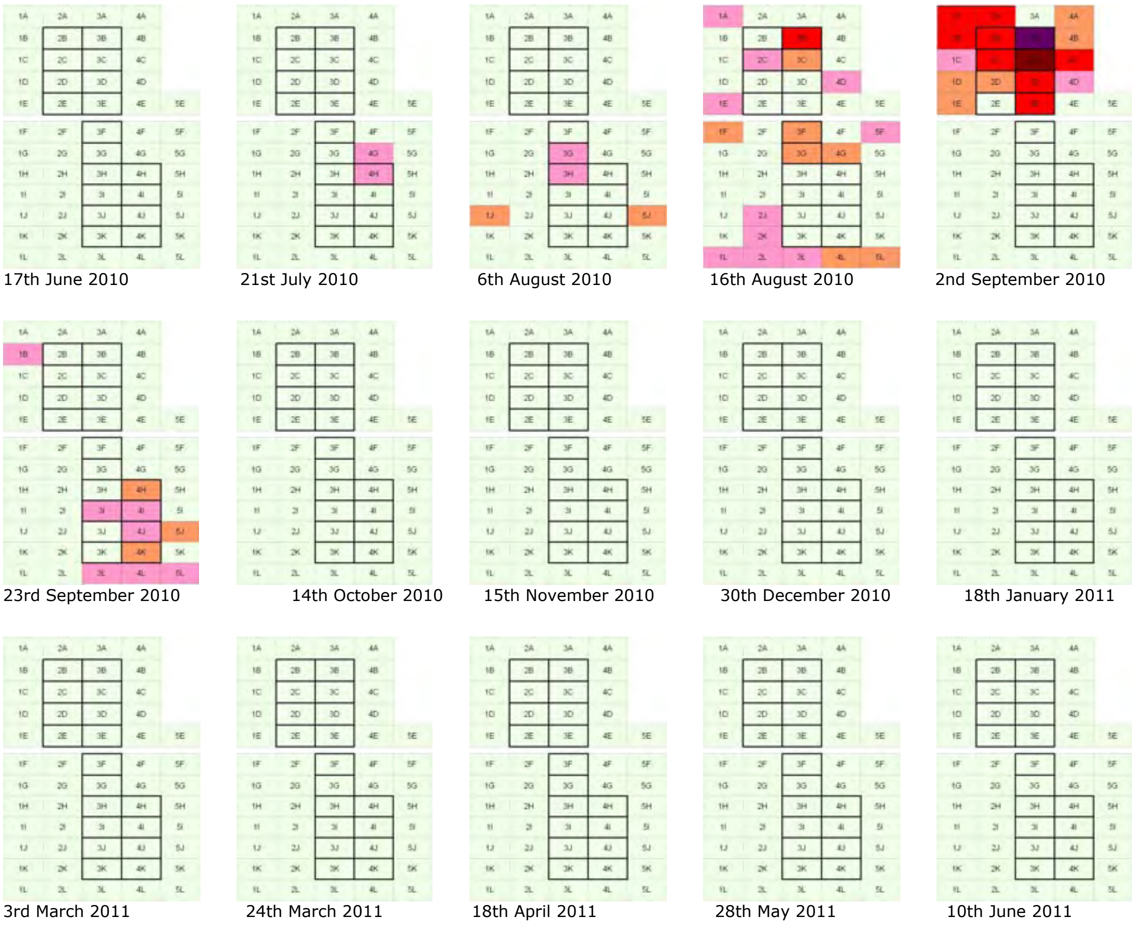
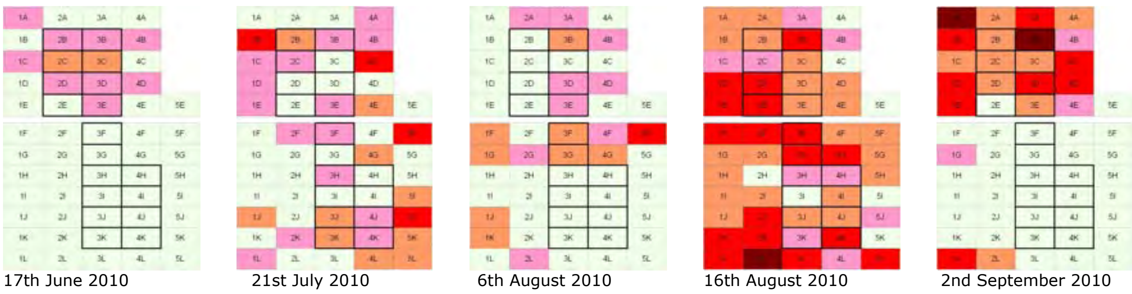


Figure 9.44 Roseate Tern *Sterna dougallii*: Seasonal distribution & density over the Kish Bank

Common Tern: Common Terns (*Sterna hirundo*) were present on the bank from June through to the end of September; there was a sudden departure and only one bird was seen on 14 October. The peak abundance of Common Terns was slightly earlier than Roseate Terns (late August), almost certainly due to the earlier fledging date of this species at nearby colonies (Dublin Port and Rockabill). At the 2010 peak, Common Terns were present in all parts of the survey box; in early September there were closely associated with the Roseate Terns in the north part and had a disjunct distribution in the north and southeast in late September. Overall, phenology and numbers were comparable between the two surveys although the reappearance of small numbers in May and June was not detected in 2001-02.



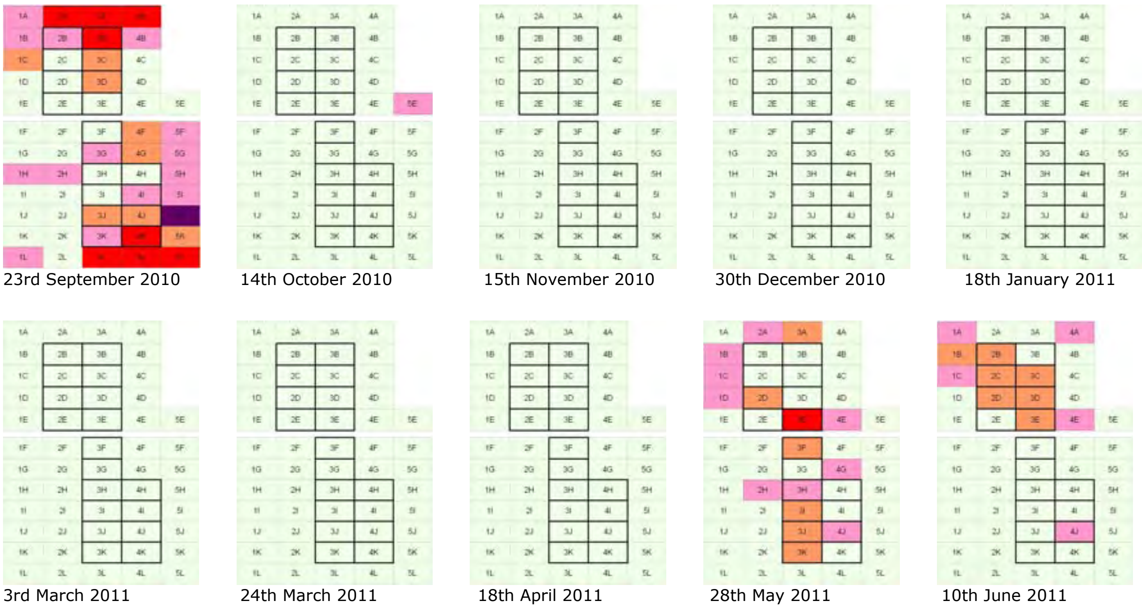


Figure 9.45 Common Tern *Sterna hirundo*: Seasonal distribution & density over the Kish Bank

Arctic Tern: Arctic Terns (*Sterna paradise*) were present in high numbers during the July and early August 2010 surveys and had a widespread distribution over the survey box. The 2001-02 phenology was somewhat different and they persisted through to late September. Arctic Terns were detected on the bank in May and June 2011.

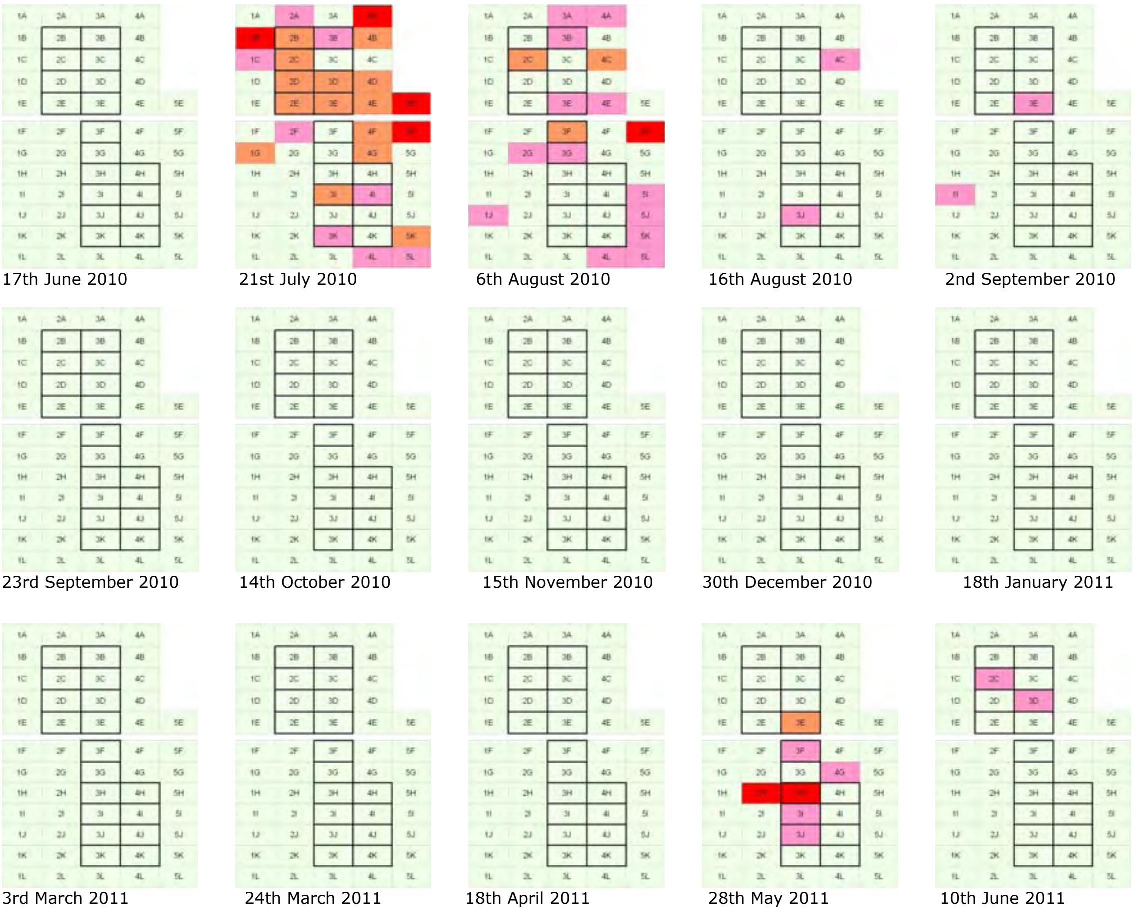


Figure 9.46 Arctic Tern *Sterna albifrons*: Seasonal distribution & density over the Kish Bank

Black Tern: One Black Tern (*Chlidonius niger*) was recorded *in* 2010 and two Black Terns were seen in September 2001. They are also regularly reported in inner Dublin Bay at this time.

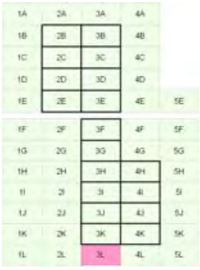


Figure 9.47 Black Tern *Chlidonias niger* - 23rd September 2010

9.2.6.9 Auks

Common Guillemot: A peak count of nearly 7,000 Common Guillemots (*Uria aalge*) was recorded in mid-late July 2010, preceding the main arrival of adult male plus offspring duos that occurred in early August and thus was likely to be mainly females; in contrast, peak numbers in 2001-02 were sustained over a 2-month period, perhaps related to a later breeding season and more prolonged moult. Common Guillemots appeared to use all parts of the survey box and further analysis would be necessary to look at the influence of tidal state on the location and behaviour of auks. The peak recorded in April 2002 was not seen in April 2011.

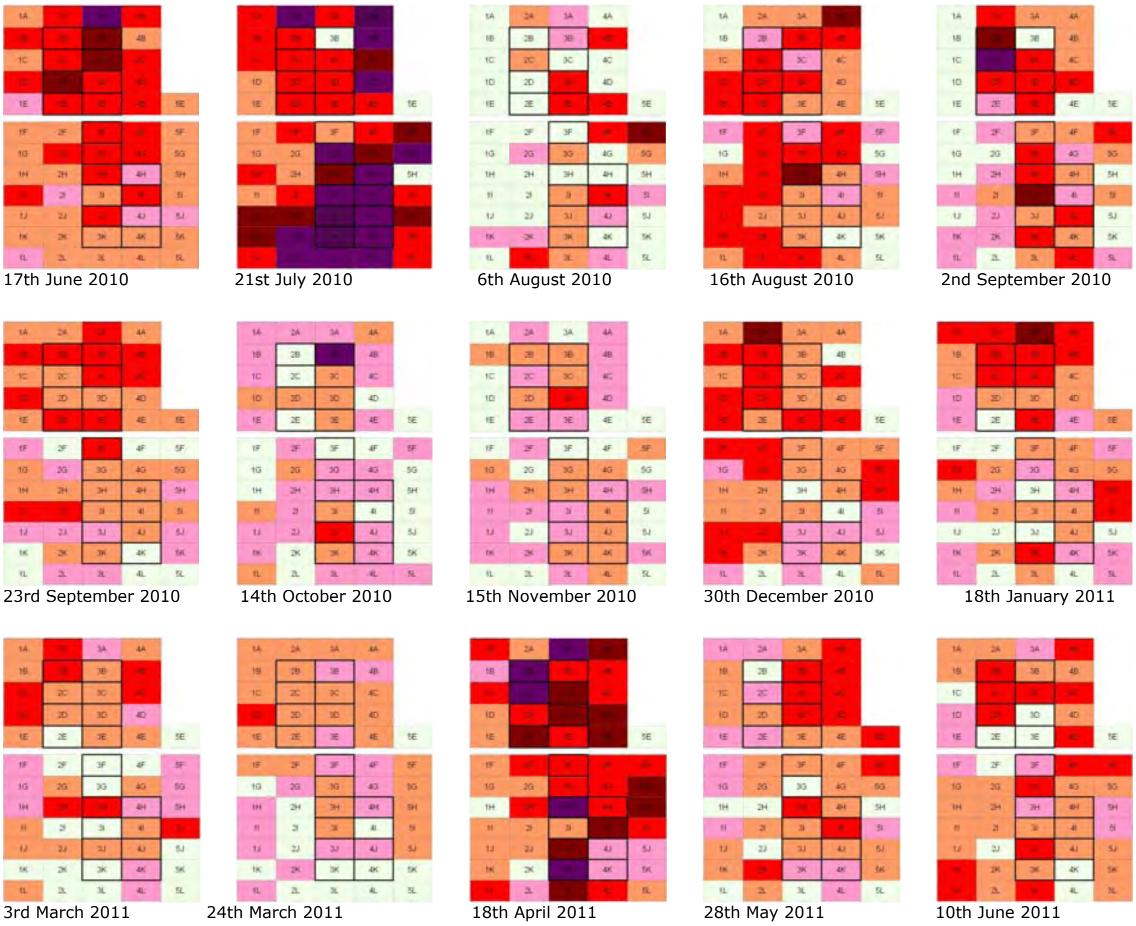
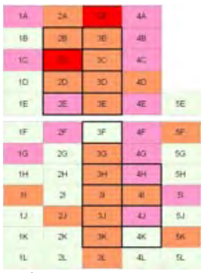
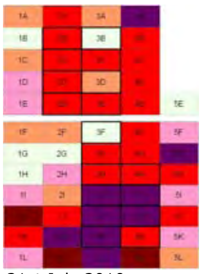
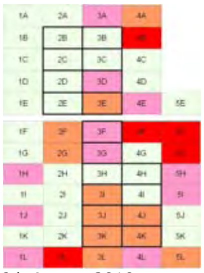


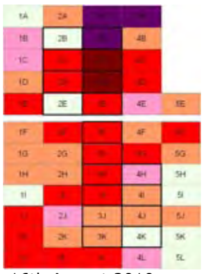
Figure 9.48 Common Guillemot *Uria aalge*: Seasonal distribution & density over the Kish Bank

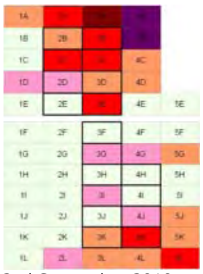
Razorbill: Razorbills (*Alca torda*) peaked at the same time as Common Guillemots, in July, prior to the appearance of significant numbers of fledged young. A subsidiary peak occurred in mid-August once most birds had departed their breeding colonies and numbers remained high throughout September indicating birds were probably moulting on the bank. Razorbills utilized all parts of the survey box over the course of the 12 month period. The phenology recorded in the 2001-02 surveys was markedly different with peak numbers in late September.

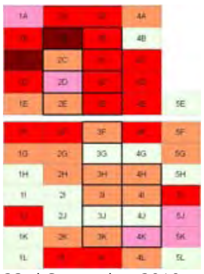

17th June 2010

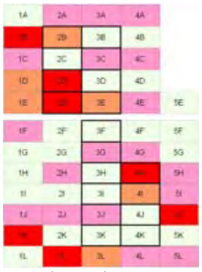

21st July 2010

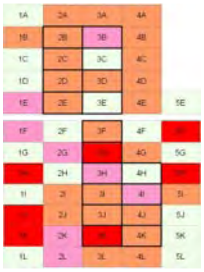

6th August 2010

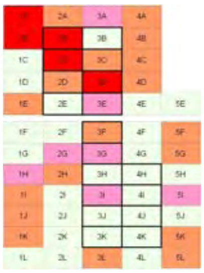

16th August 2010

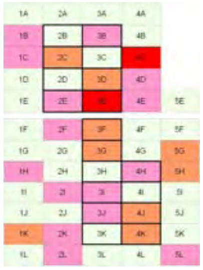

2nd September 2010

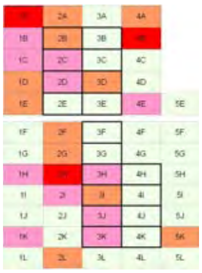

23rd September 2010

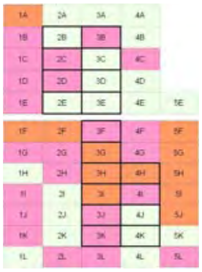

14th October 2010

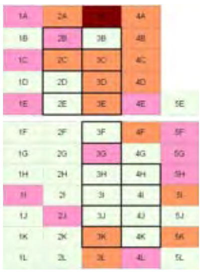

15th November 2010

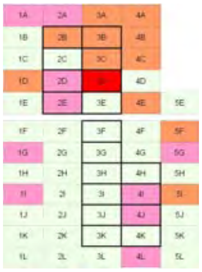

30th December 2010


18th January 2011


3rd March 2011


24th March 2011


18th April 2011


28th May 2011


10th June 2011

Figure 9.49 Razorbill *Alca torda*: Seasonal distribution & density over the Kish Bank

Black Guillemot: Small numbers of Black Guillemots (*Cepphus grille*) were recorded in all months except September, January and late March. Spatially, they were most regularly recorded in the southern part of the survey box and this could have been due to a preferred foraging habitat in the Bray-Codling Bank area or due to its proximity to Bray Head, the largest colony in the immediate area.

Atlantic Puffin: Very few Atlantic Puffins (*Fratercula arctica*) were recorded in the survey box in both the present and the 2001-02 surveys. The peak count was six (June) and they were last observed in early September. Most were recorded on the northern part of the bank, closest to the main regional colony on Lambay. Puffins are known to be highly pelagic in winter and their absence in autumn and winter was not unexpected.

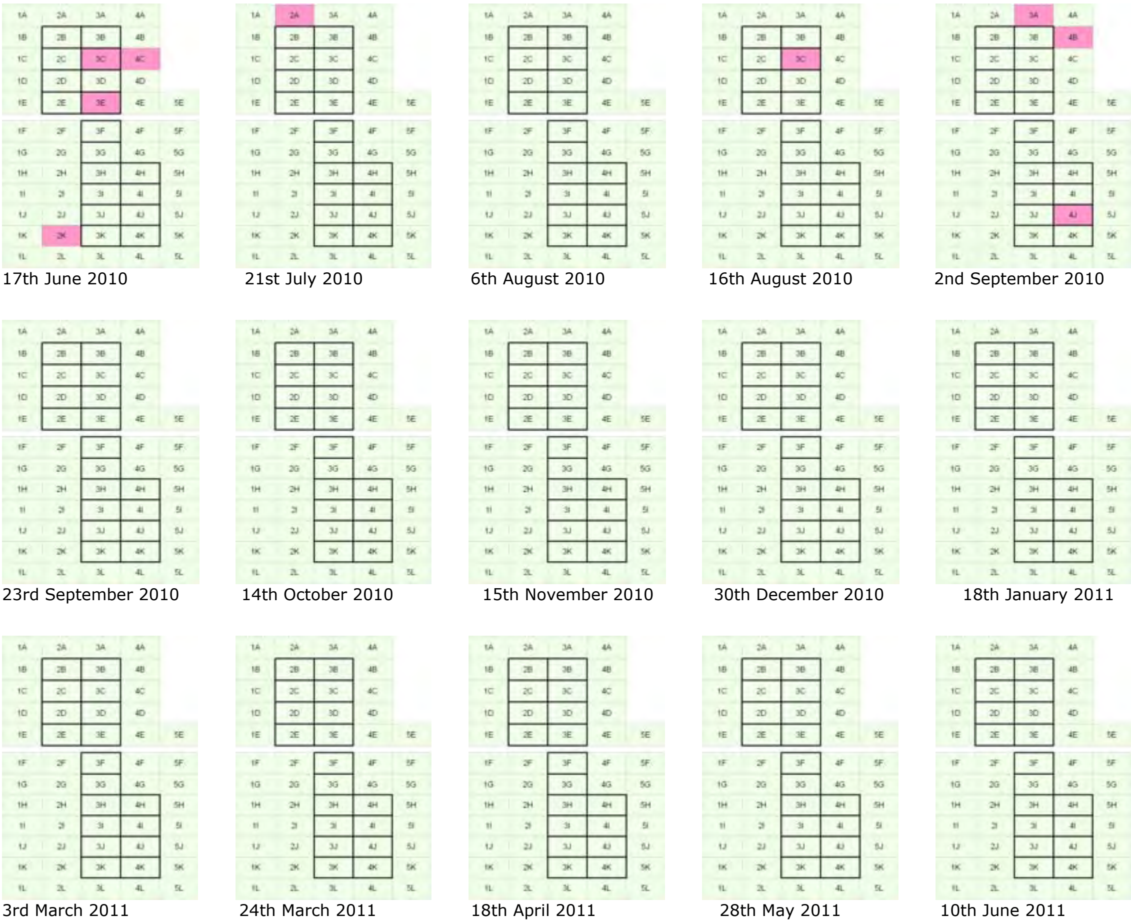


Figure 9.50_Atlantic Puffin *Fratercula arctica*: Seasonal distribution & density over the Kish Bank

9.2.6.10 Wildfowl

Common Scoter: A single flock of Common Scoters (*Melanitta nigra*) was recorded in the northeastern-most grid square in June. These birds were probably moving to a moulting site, perhaps in Wexford or southwest Wales. A single flock was also recorded in early September 2001-02.

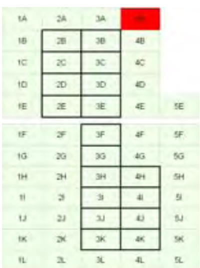


Figure 9.51 Common Scoter *Melanitta nigra* - 17th June 2010

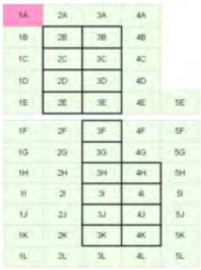


Figure 9.52 Red-breasted Merganser *Mergus serrator* - 28th May 2011

9.2.6.11 Passerines and waders

Passerines and waders are unlikely to regularly occur in the proposed wind farm site. Species such as Dunlin, swallow and meadow pipit have been recorded in small flocks during their migratory flights. Autumn migration recorded the highest numbers of starling and skylark, however species such as turnstone, ringed plover, oystercatcher, sanderling, curlew, sand martin, linnet and snow bunting were often only recorded as single occurrences. However most passerine species are night migrants and the extent of night migration across the Irish Sea is not known but it is likely to be considerably less than the volumes along the west coast of mainland Europe. Many species of wader migrate at night, at high altitude well above turbine height (Langston & Pullan, 2002).

9.2.7 Review of Survey Data

9.2.7.1 Diversity and abundance

In total, 45 bird species were recorded in the survey area. This included seven species of wader and eight species of passerine. Passerines and waders were migrants over the bank in late summer and autumn. The remainder of the species are true seabirds or waterbirds (divers, grebes and ducks) that use marine waters of the Irish Sea in the non-breeding season. A Peregrine was seen on a single occasion and it was presumed to be a bird from a local cliff-nest site hunting at sea. Between 10 and 23 species were recorded on any one survey and species diversity was highest between July and September and lowest in mid-winter from December through to the end of March. The range of species recorded was very similar to that reported in 2001-02, with minor differences in the less frequently recorded shearwaters, divers and grebes.
Total abundance recorded within the enire study area in any one survey varied between 547 and 14,447 individuals and followed a similar pattern to the species richness. The abundance was highest in July and September and lowest from October to early March. It should be noted that the windfarm area accounts for only approximately 30% of the study area.

9.2.7.2 Seasonality

Based on the seasonal occurrence on the Kish and Bray banks and environs, recorded bird species can be broadly separated into the following categories:
Resident, present year round: Fulmar, Gannet, Cormorant, Shag, Herring Gull, Great Black-backed Gull, Kittiwake, Guillemot, Razorbill, Black Guillemot. This group dominated the recorded species richness throughout the year and were most abundant in all but mid-August survey.

Migrant breeders (in Irish Sea), mostly use the bank in late summer and autumn and usually in spring: Manx Shearwater, European Storm-petrel, Lesser Black-backed Gull, Roseate Tern, Common Tern, Arctic Tern, Atlantic Puffin. These species significantly contributed to the recorded species richness and abundance.
Wintering species: Red-throated Diver, Great Crested Grebe, Little Gull, Black-headed Gull, Common Gull; some of these show degree of spring passage (e.g. Common Gull).

These species significantly contributed to the recorded species richness while they were not as abundant as the two previous groups.

Migrant breeders (in North Atlantic): mostly use bank in late summer and autumn: Arctic Skua, Great Skua, Long-tailed Skua. These species were generally recorded in low numbers.

Southerly breeders (including Mediterranean): mostly use bank in late summer and autumn: Balearic Shearwater, Black Tern. These species were recorded in low numbers.

9.2.7.3 Spatial patterns

All parts of the survey box were frequented by seabirds, but there was a tendency for species richness and bird densities to be highest in the shallowest water along the crest of the bank and in the southeast sector. This pattern is particularly notable during the summer months June-September, although adjacent areas were still heavily utilised.
Distribution of seabirds within the survey box was also influenced by the following factors:

Fixed structures: Three fixed structures are present in the survey box: the Kish Lighthouse, slightly to the northeast of the north end of the bank, the North Kish marker buoy and the East Kish marker buoy. The former is widely used during daylight hours of late spring (from April), summer and autumn as a day-roosting and loafing site by the following species: Cormorant, Shag, Herring Gull, Great Black-backed Gull, Kittiwake, Roseate Tern and Common Tern. Different species utilise different levels of the structure: the basal platform is principally used by Cormorants and Shags with some gulls, the intermediate levels by gulls and kittiwakes and some terns whilst the top (helideck) is mostly used by terns and some Kittiwakes. Counts of terns and Kittiwakes sometimes exceed 100 birds. Very few or no birds were recorded during the winter months through to March. The two buoys are principally used by Cormorants (1-10), some Shags and occasionally by a few Great Black-backed Gulls.

Fishing activity: The presence of fishing boats certainly influences the distribution and activity of the larger gulls (Herring Gull and Great Black-backed Gull). The number of fishing boats present during a survey varied between one and five, with activity more pronounced in the southern and eastern part of the survey box. The gulls, with numbers varying between 10 and 50, are primarily interested in scavenging discarded (old) bait.

9.2.7.4 Connectivity with breeding colonies

During June and July, those species that carry fish back to their young in their bills (auks and terns) could be tracked back towards their breeding colonies following a successful dive. Westward bound birds were heading to Bray Head and northward bound ones to Howth Head, Ireland’s Eye and Lambay. Such observations indicate that the banks are a foraging area, especially for Razorbills. In some instances, Shags surfacing from a dive immediately flew off purposefully towards one of the afore-mentioned colonies.

No young birds were recorded in June, but by the second half of July fledgings were recorded with their parents and percentages peaked in August. By late September, many of the terns had departed on their southerly migration and young auks had grown to near adult size and were more-or-less indistinguishable.

9.2.7.5 Flight height

Most seabirds fly relatively low at sea, usually less than 20m. Those categorised as "low" usually stay within 7 meters of the surface in calm weather although they may get up to 10-15 m in rougher weather. Medium is categorized as birds flying <20m for the majority of time, but may on occasion fly up to 50m and those birds recorded to fly >50m are categorized as high.

Four resident species (Gannet, Herring Gull, Great Black-backed Gull and Kittiwake) regularly flew at altitudes in excess of 20m. The two large gulls and Kittiwakes were recorded at mean heights of over 30m and the gulls alone in excess of 40m. However in terms of individual flight heights, five species were recorded at 50m or more: Gannet (75m), Common Gull (50m), Herring Gull (70m), Great Black-backed Gull (100m) and Kittiwake (60m).

Among the wintering birds, Common Gulls were recorded to fly at altitudes over 20m whereas Little Gulls and Black-headed Gulls fly were recorded flying below 20m.
Flight heights for the three locally breeding terns were ranged between 3-12m though occasionally flights ranged between 15-20m. Mean flight heights for auk species did not exceed 5 m, with maximum heights not exceeding 7m for Guillemots and 8m for Razorbills.

Flight heights were recorded for scarce species as follows: Red-breasted Merganser 4m, Peregrine 1m, Lesser Black-backed Gull 4-6m, Long-tailed Skua 15m, Skylark 30m, Swallow 0.8m and the Snow Bunting 0.4m.

9.2.7.6 Assessment of conservation importance

An evaluation of the percentage of the bird populations recorded within the vicinity of the two banks was carried out. The method used to evaluate the conservation importance of the bird populations in the wind farm area and its surrounds involved the standard 1% criterion (Ramsar Convention Bureau, 1998) where the population was considered to be internationally important if it exceeded 1% of the whole biogeographic population and nationally important if it exceeded 1% of the Irish population. Threshold levels were taken from Crowe *et al.* (2008), Lynas *et al.* (2008), Mitchell *et al*. 2004 and Gibbons *et al*. (1993).

Further categories of Regional and Local importance were used for species that did not reach national importance. The first of these was defined as more than 1% of the regional resource, whilst the latter included all species on the red or amber lists of the BirdWatch Ireland's 'Birds of Conservation Concern in Ireland' (BoCCI) (Lynas *et al.,* 2008) that did not reach at least regional importance in the study area.

As a comprehensive data set has been gathered, the peak counts have been used as the main basis for this evaluation (as the counts most representative of the maximum use that the birds made of the site).In addition, all birds listed on Annex I of the EU Birds Directive (2009/147/EC) and other rare/vulnerable migratory species warrant special consideration.

Species [1]	Irish Sea Status	Irish Sea Habitat [2]	Irish Sea Ecology	Flight Heights [3]	EU [4]	Bird-Life [5]	Bird-Watch [6]
Great Northern Diver (Common Loon)	Winter visitor	Coastal waters	Surface dives for fish	Low to high	Mig.	Secure	GREEN
Red-throated Diver	Winter visitor	Coastal waters & banks	Surface dives for fish	Low to medium	Anx I	SPEC 3	AMBER
Great crested Grebe	Winter visitor	Coastal waters	Surface dives for fish	Low – medium			AMBER
Fulmar*	Resident most of yr.	Pelagic & cliffs (B)	Low plunge dives for fish, offal etc.	Low – medium	-	Secure	GREEN
Manx Shearwater*	Summer visitor	Pelagic & islands (B)	Low plunge dives for fish, squid etc.	Low to medium	Mig.	SPEC 2	AMBER
Balearic Shearwater	Scarce migrant	Coastal & offshore waters & islands	Medium plunge dives for fish	Low – medium		SPEC 1	RED
European Storm-petrel	Summer visitor	Coastal & offshore waters & islands	Dives for fish	Low – medium		Secure	AMBER
Northern Gannet*	Resident – less winter	Pelagic & islands (b)	High plunge dives for fish	Low to high	Mig.?	SPEC 2	AMBER
Cormorant	Resident	Coastal waters & islands (B)	Surface dives for fish	Low to medium		Secure	AMBER
Shag	Resident	Coastal waters & cliffs (B)	Surface dives for fish	Low to medium		Secure	AMBER
Great Skua * (Bonxie)	Passage migrant	Pelagic	Food piracy, birds & fish	Low to medium	Mig.	Secure	AMBER
Arctic Skua *	Passage migrant	Pelagic	Steals from seabirds	Low to medium	Mig.	Secure	GREEN
Pomarine Skua *	Passage migrant	Pelagic	Food piracy & fish	Low to medium	Mig.	Secure	GREEN
Long-tailed Skua	Summer visitor (rare)	Coastal waters	Medium plunge dives for fish	Low – medium			
Little Gull	Winter visitor	Banks and coastal waters	Dips-to-surface feeder	Low to medium	Mig.	SPEC 3	GREEN

Table 9.2 Summary details of seabirds and water birds recorded in the study area.

Species [1]	**Irish Sea Status**	**Irish Sea Habitat** [2]	**Irish Sea Ecology**	**Flight Heights** [3]	**EU** [4]	**Bird-Life** [5]	**Bird-Watch** [6]
Black-headed Gull	Resident	Intertidal & coastal waters	Dips- to-surface feeder	Low to medium	-	Secure	RED
Common Gull	Winter visitor	Intertidal & coastal waters	Dips- to-surface feeder	Low to medium	Mig. ?	SPEC 2	AMBER
Herring Gull	Resident	Intertidal to offshore & mainly islands (B)	Follows boats, offal etc.	Low to high	-	Secure	RED
Great Black-backed Gull	Resident	Intertidal to offshore & islands (B)	Dives for fish, offal etc	Low to medium		Secure	AMBER
Lesser Black-backed Gull	Summer visitor	Intertidal to offshore & islands (B)	Dives for fish, offal etc	Low to medium	Mig.	Secure	AMBER
Kittiwake	Resident	Coastal & offshore waters & cliffs (B)	Dips- to-surface feeder	Low – high	-	Secure	AMBER
Common Tern	Summer visitor	Coastal & offshore waters & islands (B)	Medium plunge dives for fish	Low to medium	Anx. 1	Secure	AMBER
Arctic Tern	Summer visitor	Coastal & offshore waters & islands (B)	Medium plunge dives for fish	Low to medium	Anx. I	Secure	AMBER
Roseate Tern	Summer visitor	Coastal & offshore waters & islands (B)	Medium plunge dives for fish	Low to medium	Anx. 1	SPEC 3	AMBER
Little Tern	Summer visitor	Coastal waters & beaches (B)	Medium plunge dives for fish	Low to medium	Anx. 1	SPEC 3	AMBER
Black Tern	Summer visitor (rare)	Coastal waters	Medium plunge dives for fish	Low – medium		SPEC 3	
Common Guillemot*	Resident	Coastal & offshore waters & cliffs (B)	Surface dives for fish	Low	-	Secure	AMBER
Black Guillemot	Resident	Coastal waters	Surface dives for fish			SPEC 2	AMBER
Razorbill*	Resident	Coastal & offshore waters & cliffs (B)	Surface dives for fish	Low	Mig. ?	Secure	AMBER
Atlantic Puffin	Summer visitor	Coastal & offshore waters & islands	Surface dives for fish	Low – medium		SPEC 2	AMBER
Brent Goose	Winter visitor	Intertidal & nearby grasslands	Commutes over sea to wetlands	Low to medium	Mig.	SPEC 3	AMBER
Common Scoter	Winter visitor	Coastal waters	Surface dives for molluscs	Low to medium	Mig.	Secure	RED

Table 9.2 (ctd) Summary details of seabirds and water birds recorded in the study area.

Footnotes to Table 9.2

[1] ***Bolded species*** *are those which occur regularly in the Study area.*

[2] *"B" following a habitat indicates that it is used for breeding in the Irish Sea area.*

[3] *Most seabirds fly relatively low at sea, usually less than 20m. Those categorised as "low" usually stay within 5 meters of the surface in calm weather although they may get up to 10-15 m in rougher weather. Medium is categorized as birds flying <20m for the majority of time but may on occasion fly up to 50m and those birds recorded to fly >50m are categorized as high. Near breeding colonies, which is not relevant to this study, low flying species fly higher to access nest sites.*

[4] *Listing of a species on Annex I of the EU Birds Directive (79/409/EEC) requires member states to take "special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution". Similar measures must also be taken for migratory species. This normally means the designation of "Special Protection Areas" (SPAs) in key areas for the species.*

[5] *BirdLife International have assessed the conservation status of all European bird species (BirdLife International, 2004). SPEC 1 indicates a species of global conservation concern – a globally threatened species. SPEC 2 indicates a species with an unfavourable conservation status whose global distribution is concentrated in Europe. SPEC 3 indicates a species with an unfavourable conservation status whose global distribution is not concentrated in Europe.*

[6] *BirdWatch Ireland have prepared a "red amber green" categorisation of Irish birds. "**Red**" is defined as of high conservation concern, "**amber**" as of medium conservation concern and "**green**" as of no conservation concern (Lynas et al. 2008).*

9.2.7.7 Seabird Conservation Status changes - 2008

In 2008, Roseate terns had their status changed from Red to Amber on the list of Birds of Conservation Concern in Ireland (BoCCI), published by BirdWatch Ireland, as the population in Ireland now exceeds 900 pairs and no longer qualifies as a rapidly declining species. During the same revision of the conservation bird status in Ireland the herring gull has been moved to Red list along with the common scoter and the black headed gull following dramatic declines in their populations (Lynas *et al*., 2008). However, their European conservation status has remained secure. A number of birds previously on the Green list have been moved to the Amber list due to at least 50% of the breeding or non-breeding population occurring at 10 or fewer sites i.e. localised breeding (see Table 9.3).

Species	Bird-Watch[1] (1999-2007)	Bird-Watch[2] (2008-2013)	Criteria on which change was based
Roseate Tern	RED	AMBER	Population increased following past declines
Great Skua (Bonxie)	GREEN	AMBER	Rare breeding bird
Little Gull	AMBER	GREEN	Downgrading of non-breeding SPEC status
Shag	GREEN	AMBER	Localised during the breeding range
Great Black-backed Gull	GREEN	AMBER	>25% population decline during the breeding season
Lesser Black-backed Gull	GREEN	AMBER	Localised during the breeding range
Herring Gull	GREEN	RED	>50% decline in breeding population
Common Scoter	AMBER	RED	>50% decline in breeding population
Black-headed Gull	AMBER	RED	>50% decline in breeding population, >70% decline in breeding range
Kittiwake	GREEN	AMBER	Localised during the breeding range
Balearic Shearwater	AMBER	RED	IUCN globally important/SPEC 1 species

Species in bold are those which regularly occur in the study area.

Table 9.3 Summary of conservation changes of seabirds and water birds recorded in the study area and the criteria on which the change of conservation status was based *(Lynas et al, 2007)*

9.2.7.8 Identification of key species

As noted in Section 9.2.7.1., birds recorded in the receiving environment comprised 45 species between the two surveys, which included seven species of wader and eight species of passerine. In order to facilitate an assessment of the impacts of the proposed development on birds, key species were selected on the basis of survey work and desk based assessment based on their likely occurrence in the wind farm area (Table 9.5), the sensitivity of the population (Table 9.7) and their conservation status (Table 9.2).

Sea bird species recorded in low numbers, less frequently recorded species and rare species recorded in the vicinity of the proposed wind farm area which are not of conservation importance, (see 9.2.7.6 Assessment of conservation importance), will not be considered further and have not been identified as key species. The likelihood of a significant impact on their total Irish population or European population is considered to be very low.

Small single flocks of migrating birds and rare sightings, such as the single flock of common scoters (13) in transit to the east of the proposed development are not identified as key species however the potential impact on these migratory species will be considered within the potential impacts. Current seabird population estimates of both key species and those that will be addressed in the potential impacts section are presented in Table 9.4. While some species recorded numbers less than 0.1% of the national population these are considered here due to their conservation status.

[1] *Newton et al., 1999. Birds of conservation concern in Ireland. Irish birds 6:333-344*
[2] *Lynas et al, 2007. The status of Birds in Ireland: an analysis of conservation concern 2008-2013. Irish Birds 8 (2):149-166*

Species	Current ROI Population estimate* (Individuals)	Colonies Within 35km of the study area	ROI Population East coast** (Individuals)	Peak numbers recorded Survey 2011 (Individuals)	% Population Recorded in survey area	
					East Coast Population	ROI population
Roseate Tern	2,300	(R), (DI)	2,206	157	7.1	6.8
Common Tern	4,970	(R), (DI), (SDB)	1,700	658	38.7	13.2
Arctic Tern	5,470	(R), (DI) (SDB)	unknown	323	-	5.9
Great Black-backed Gull	4,486	(IE), (LI), (SI)	1,106	58	5.2	1.3
Herring Gull	11,042	(LI), (NBI), (SDB), (IE), (SI), (TM), (WH)	5,877	298	5.1	2.7
Common Gull	2,120	(NBI) (SDB)	662	21	3.2	1
Black-headed Gull	Unknown	(NBI) (SDB), (SI), (TM)	6,233	6	0.1	
Cormorant	9,096	(LI), (IE), (SI), (TM)	3,342	103	3.1	1.1
Shag	6,852	(LI), (HHC) (IE), (BH), (WH)	2,318	588	25.4	8.6
Manx Shearwater	32,545	(LI),	100?	4,513	-	13.9
Northern Gannet	65,516	(IE)	unknown	1,326	-	2
Kittiwake	72,200	(BH),(R) (HHC) (IE), (LI), (BH),(WH)	18,024	1,753	9.7	2.4
Razorbill	27,446	(WH), (IE) (LI), (BH) (HHC)	5,807	2,685	46.2	9.8
Common Guillemot	138,108	(WH), (IE), (LI), (BH) (HHC)	1,910?	6,932		5
Black Guillemot	3,367	(HHC) (IE), (LI), (R), (WH) (BH),	768	11	1.4	0.3

Colonies on the east coast applied here include Wicklow Head (WH), Ireland's Eye (IE), Lambay Island (LI), Howth Head Coast (HHC), Bray Head (BH), Rockabill (R), The Murrough (TM), Skerries Islands (SI), Dalkey Island (DI), South Dublin Bay and River Tolka Estuary (SDB) and North Bull Island (NBI).
** (BirdWatch Ireland, 2011)*
** (NPWS SPA Site synopsis; Merne, 2010; Lynas et al. 2007)*
Note: Based on current data availability - up to date numbers for all the individual colonies on the east coast were not available

Table 9.4 Current Sea bird population estimates showing the % populations recorded within the survey area.

Species	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Roseate Tern								*				
Common Tern								*				
Arctic Tern									*			
Great Black-backed Gull									*			
Herring Gull									*			
Common Gull												*
Black-headed Gull												*
Cormorant									*			
Shag									*			
Manx Shearwater								*				
Northern Gannet				*								
Kittiwake									*			
Razorbill									*			
Common Guillemot				*								
Black Guillemot				*								

<6
Present
Peak 2010/11
* **Peak 2001/02**

*Peaks from 2001/2002 identified by an **
No surveys were carried out in Feb of either survey period due to strong winds and resulting high sea forces.

Table 9.5 Recorded occurrences of key species in and around the wind farm area in 2010/2011

9.2.7.9 Key Species

	Conservation status	Key Traits
Roseate Tern	Amber	Surface feeder, Migrant breeder
Common Tern	Amber	Surface feeder, Migrant breeder
Arctic Tern	Amber	Surface feeder, Migrant breeder
Great Black-backed Gull	Amber	Surface feeder, Flight height, Resident
Herring Gull	Red	Surface feeder, Flight height, Resident
Common Gull	Amber	Surface feeder, Flight height, Wintering species
Black-headed Gull	Red	Surface feeder, Resident
Cormorant	Amber	Pursuit-diver, Resident
Shag	Amber	Pursuit-diver, Resident
Manx Shearwater	Amber	Surface feeder/Pursuit-diver, Migrant breeder
Northern Gannet	Amber	Diver, Flight/Dive height, Resident
Kittiwake	Amber	Surface feeder, Flight height, Resident
Razorbill	Amber	Pursuit-diver, Resident
Common Guillemot	Amber	Pursuit-diver, Resident
Black Guillemot	Amber	Pursuit-diver, Resident

Table 9.6 Key Species and their associated traits

9.3 Potential impacts of wind farms on birds

The potential impacts of the proposed development on birds are assessed in terms of short-term and long-term impacts. In the case of the construction and operation of a wind farm, the short-term impacts are largely temporary impacts that arise during construction, while long-term impacts are those permanent impacts that would be experienced during the operation of the wind farm. The cumulative impacts of offshore wind farms are also discussed.

The key potential impacts of wind energy developments on birds have been identified in a guidance document prepared by the European Commission (2010) entitled "An EU guidance on wind energy development in accordance with the EU nature legislation". The types of impacts mentioned that may occur include the following: Collision risk, Disturbance and Displacement, Barrier effect and Habitat loss or Degradation. These and other potential impacts are addressed here.

9.3.1 Short-term impacts

9.3.1.1 Disturbance and displacement

Disturbance can lead to displacement and exclusion, and hence loss of habitat during the construction phase of the wind farm. There will be limited disturbance to birds as a result of the construction activities, which will include the presence of boats, people and piling equipment. This disturbance will be localised to the area of development and the birds will continue to be able to utilise the area around the work site. Work will be restricted to a low number of turbines at any one time.

9.3.2 Long-term impacts

9.3.2.1 Collision risk

Bird mortality due to collision with wind turbines has been recorded at some wind farm sites in Europe, both onshore and offshore (Percival, 2003), with offshore collision mortality difficult to monitor due to the low recovery rate of the carcasses (the usual method for measuring collision mortality). However, significant collision mortality risks are primarily related to topographical bottlenecks where migrating birds fly through a relatively confined area and where densities of sensitive species, such as raptors, are found in combination with very high numbers of turbines. Data from the Arklow Bank and the recent survey carried out on the Kish Bank has shown that the vast majority of species fly at less than 7m above the sea water and of those above this height the majority were below both the rotor height on the Arklow Bank (21m) and on the Kish bank (>30m) (CWC, 2003; Newton *et al.* 2011). The majority of eiders similarly fly at altitudes of less than 10m (Petterson and Stalin, 2003; Larsen and Guillemette, 2007) and no collisions were recorded when 500,000 eider were observed to fly through the offshore wind farm at Utgrunden (Petterson and Stalin 2003). Overall there is increasing evidence that collision risks are generally low in most cases (European Commission, 2010).

Results from monitoring of the Carnsore wind farm show that the presence and operation of the wind farm is not having any significant negative effect on passing seabirds such as roseate terns breeding at nearby Lady's Island Lake with the vast majority of birds finding a safe route through the wind farm where the rotor height clearance was only 23m (Daly, 2005). It was also noted that the moving rotors of the turbines did not have any notable effects on flight patterns of terns and gulls moving between the colony and the sea.

The high numbers of species such as Manx shearwater, guillemot and razorbill recorded on the Kish Bank fly almost virtually exclusively at altitudes of less than 7m over the open sea. Terns on the Arklow Bank do tend to fly higher when they are hunting their prey items to dive on, but this is still normally at altitudes of less than 20m. The average flying altitudes of gulls and kittiwakes recorded were below 30m with the exception of the great black-backed gull and the herring gull, which were recorded above average in July and August respectively. The distribution of gull species in the area largely reflected the presence of fishing vessels and which tend to avoid wind farms; therefore, collision effects are predicted to be insignificant at the conservation level.

Notably, there is increasing evidence among various species of active avoidance behaviour (Hotkeret al., 2006, Peterson *et al.*, 2006, Masden *et al.*, 2009). Overall it is clear that birds are generally able to avoid collisions and do not simply blindly fly into wind turbines (Percival, 2003).

9.3.2.2 Direct loss of habitat

Physical habitat loss caused by the introduction of hard substrata into a soft-bottom environment seems negligible, because the proportion of soft bottom area lost is low (<1%) and the benthos as a food resource for seabirds appears hardly affected. The common scoter is the main bentic feeding bird species that could be affected by loss of habitat. However, the direct loss of habitat to the birds by the footprint of the wind turbines is less than 1% and scoters recorded during the surveys were small flocks in passage during each survey period. It is thought that their low numbers recorded are a reflection of the fact that their preferred food source is scarce in the location of the wind farm, so no significant impact is expected.

9.3.2.3 Habitat alteration

The construction of turbines introduces a new type of habitat for bentic organisms over a small area of the banks (< 1%) as opposed to the soft sediment present on the sand bank . The settlement of sessile invertebrates and algae, as well as the subsequent attraction of mobile invertebrates and fish, will result in a reef effect. Initial results from Horns Rev wind farm in Denmark have indicated that the bentic community and the sand eel population were not negatively affected. While increased utilisation by seabirds related to the increase in fish stocks in the area remain unproven (Percival, 2001) the great black-backed gulls which initially strongly avoided the wind farm and its surroundings at Horns Rev in Denmark (baseline period), showed obvious preference for the area during operation (Christensen *et al*., 2004).

9.3.2.4 Disturbance and displacement

The presence of the wind turbines has been found in some, but not all cases, to result in the disturbance to birds that use the area, leading to avoidance behaviour in some species (Pedersen and Poulsen, 1991). Birds will avoid the vicinity of wind turbines where there is alternative feeding habitat in the area and move closer to them when alternative resources are scarce (Percival, 2003). It is unknown if any displaced birds would favour other sand banks.

Displacement studies in Denmark and Sweden have shown that, at least in the first year after construction, certain seabird species including gannet, common scoter, guillemot and razorbill strongly avoided offshore wind farms; however the numbers of three species increased, namely the little gull, herring gull and great black-backed gull, a green, amber and red listed species in Ireland respectively. This increase at least for the large gulls was assumed to be either resting opportunities on the foundations of the turbines or the attraction of ship traffic.

Breeding birds have been considered to be less affected than feeding or roosting birds (H tker *at al*., 2006) particularly where there is no alternative feeding habitat in the area. These birds either just move to alternative food sources, if available, or become more tolerant of the presence of the wind turbines if not (Percival, 2003). While there is generally more evidence of displacement of birds around wind farms occurring in coastal habitats, even here many studies have shown no significant effect and are related to waterfowl as opposed to seabirds (Percival, 2003).

Less than 7% of the ROI Roseate tern population, known to be contained almost exclusively to 3 colonies in Ireland, was recorded feeding within the study area. This would imply that there are alternative feeding habitats elsewhere which potentially could accommodate any displaced birds. The disturbance and or displacement of terns should be inconsequential and consequently result in no loss of body condition (which can be considered more insidious than direct mortality for a population as a whole as there may be a delay before any population-level impact is detected (Garthe and Hüppop, (2004); Desholm, 2009)). In contrast > 40% of the east coast population of Razorbills was recorded feeding within the study area. However, aerial surveys (March – April 2002) have shown that auks were recorded throughout the study area and not confined to the Kish and Bray Banks to forage.

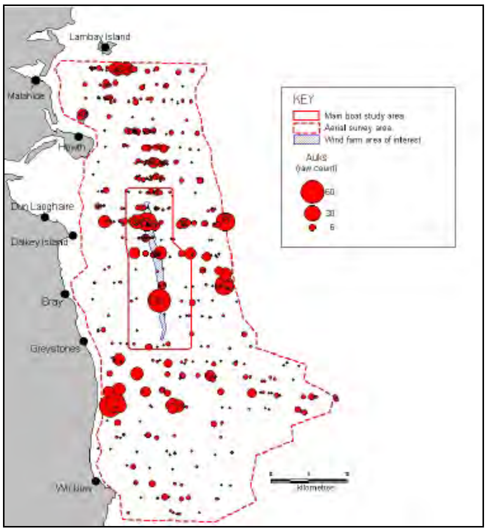


Figure 9.53 Distribution of auk sightings within the aerial survey area and the main Kish Bank study area during March and April 2002.

9.3.2.5 Barrier effect

There is no evidence that the Kish and Bray Banks are located such that the Dublin Array would act as a barrier to migrating or foraging species. It has been shown that migrating and foraging species can perceive and avoid wind farms by altering their flight routes around them or through the corridors between the wind turbines (Desholm and Kahlert, 2005). Van den Bergh *et al*. (2002) excluded a barrier effect for foraging flights of the seabirds as they showed reduced sensitivity in breeding birds or rapid habituation during the breeding season. Avoidance of wind farms has been documented among a wide range of bird species and responses are highly species-specific. At night the distance intervals are thought to be closer than during the day (Drewitt and Langston, 2006). Reviews of available literature suggest that the barrier effect has not been proven to significantly impact on the fitness of bird populations (Drewitt and Langston, 2006). Greenland white-fronted geese winter on the Wexford Slobs however their normal route is overland on a NW/SE axis which would take them away from the site (Colhoun, 2000). Very few passerines were recorded during the surveys and studies have shown that migrating passerines tend to change their flight route some 100-200 m before the turbine and pass above the turbine at a safe route.

9.3.2.6 Lighting

Lighting of wind turbines in offshore locations is necessary for reasons of safety with respect to air and maritime navigation Maritime navigation flashing lights are less likely to cause disturbance to birds than constant lights, while the colour (white or red) does not appear to be as important (Gehring *et al*., 2009). . As detailed in Sections 5.2 and 5.4 of this EIS, lighting of the wind farm is necessary to protect marine and air navigation safety. This will be in accordance with the requirements set out in document ref. OAM 09/02, "Offshore Wind Farms Conspicuity Requirements Advisory Material for the Protection of Air and Marine Navigation Safety" issued by the Irish Aviation Authority. The maritime navigation lights will be installed on all structures including the turbines and substation at a level above the highest astronomical tide and will comprise yellow lights with a distinctive flashing characteristic visible to a range of 5 nautical miles. Air navigation lights will be installed on a small number of the turbines (apprx. 8 no.) marking the perimeter of the wind farm at 90 – 100 meters above mean sea level. These will comprise high intensity white flashing lights effectively cut off so that practically no light is emitted below the horizontal.

9.3.2.7 Decommissioning

The impacts that would arise during decommissioning of the turbines would be similar to the short-term impacts described above.

9.4 Case Studies

The following case studies of other offshore wind farm developments identify impacts on seabird populations recorded during the construction and operational stage of projects. The studies show that the scale of disturbance caused by wind farms varies greatly. This variation is likely to depend on a wide range of factors including seasonal and diurnal patterns of use by birds, location with respect to important habitats, availability of alternative habitats and perhaps also turbine and wind farm specifications. Behavioural responses vary not only between different species, but between individuals of the same species, depending on such factors as stage of life cycle (wintering, moulting, breeding), flock size and degree of habituation (Drewitt *et al.* 2006). The possibility that wintering birds in particular might habituate to the presence of turbines has been raised (Langston & Pullan 2003).

9.4.1 Barrow

Barrow offshore wind farm is located in the East Irish Sea, 7km south west of Walney Island. It is comprised of thirty 3MW wind turbines, for a total generating capacity of 90MW. The wind farm started generating in March 2006 with final construction being completed in June of the same year. Pre-construction surveys identified common scoter, eiders, auks and gulls in the vicinity of the wind farm site.

Monitoring methods for bird abundance incorporated both boat surveys and aerial surveys. These surveys were performed to determine any change in bird use and passage of the wind farm site and a reference site, determine whether there is a barrier effect to movement, determine the distribution of wild-fowl and divers covering the development site and surrounding vicinity and, collision risk. Comparison of pre-construction and during construction estimates of abundance and distribution for guillemot and razorbill produced no firm conclusions. The distribution of Common Scoter and Red Throated Diver observed prior to construction indicates that the species are present in the area and that Barrow Offshore Wind Farm site is not an important site for these species. Changes in abundance were recorded for herring gull and kittiwake, with an increased abundance recorded during construction. There was no recorded change in the abundance and distribution of lesser black-backed gulls, and a slight increase in Manx shearwater abundance was accredited to natural variation.

Threre are results of two years post construction monitoring to date, (2006 –2008). Monitoring undertaken in the first year of operation was used to determine that the wind farm did not constitute a barrier that prevents the movement of Whooper swan or Pink-footed geese. Most of the pink-footed geese changed their flight height when approaching the windfarm. There were no significant changes recorded in the occurrence and distribution of common scoter, divers or other wildfowl in the vicinity of the wind farm. No collisions were observed during any of the surveys. Additionally, no birds of conservation concern were recorded either before or during construction or in the first years of operation. The preliminary findings from the studies indicate that Barrow Offshore Wind Farm does not prevent bird usage of the site after construction, and the total numbers of birds in the area seems not to have decreased. With regards to the presence of auks there was no significant pattern in the distribution of birds. As with the auks, there is no significant pattern in the distribution of the seaducks. Comparing data before and after construction shows no significant changes in the occurrence and distribution of the different species.

Relevant Observations for Dublin Array:

- Increased abundance of Herring Gull and Kittiwake during construction
- No change in abundance of lesser black-backed gulls
- No significant changes recorded in the occurrence and distribution of Manx shearwater common scoter, divers or other wildfowl in the vicinity of the wind farm
- There was also no significant pattern in the distribution of auks

9.4.2 Carnsore Point

The project comprises 14 turbines producing 12 MW on an 84 ha site at Carnsore point, the south easternmost corner of the country. Here the rotor to ground clearance was only 23 m and approximately 3 km from Lady's Island Roseate Tern breeding area. After requesting an EIS, Wexford Co. Council rejected the proposal, though not in relation to its impact on seabirds. This rejection was then appealed to An Bord Pleanála, which included the possible impact on seabirds in its assessment. The board's inspector recommended refusal of planning permission but again not in relation to seabirds. However, the board overruled the inspector and granted permission. They attached a condition that "bird surveys and monitoring of bird casualties be carried out" to evaluate the effect of the development on the area's fauna. Concerns about seabird impacts arose because the wind farm site is just to the east of a coastal lagoon called Ladys Island Lake. This holds Ireland's largest tern colony with 50 – 140 pairs of roseate terns (averaging about 10% of the north west European population), over 1,000 pairs of sandwich terns, 400 – 500 pairs of common/arctic terns and over 500 pairs of black-headed gulls (Newton & Crowe 2000). As a result, the lagoon and its islets have been designated as SPAs under the EU Birds Directive. They are also protected under the 1976 Wildlife Act.

The terns and gulls nest on two islets at the north end of the lagoon. BirdWatch Ireland carried out a study of the terns' flight lines to the sea for the EIS. This showed that terns accessed the sea mainly by flying south along the lake, but that 7 to 29% of them cut across land in a north easterly direction (although not normally through the wind farm site). In view of this result, both BirdWatch Ireland and NPWS, were satisfied that the project would not have significant effects on the terns. However, both recommended monitoring during construction and operation, a position endorsed by An Bord Pleanála. This wind farm is now operational.

Monitoring studies at the site were carried out between April and July of 2004. During the study common, arctic, sandwich and roseate terns were recorded at Carnsore point. No collisions with the turbines were observed; however the remains of a juvenile common tern were found and believed to have been the result of a collision with the rotor blades. The study concluded that there was little direct effect of the wind farm on seabird passage and the distance between the turbines is sufficient enough to allow birds to navigate between them. The monitoring study goes on to recommend that the area beneath the turbines should be regularly checked following the fledging of black-headed gulls and terns, and after a fog event, in order to assess if there are any collisions. It also recommends a need for further monitoring studies to assess the long term effect of the turbines during the breeding season. An additional monitoring study carried out in 2005 reaches a similar conclusion as the 2004 study, indicating little direct effect of the wind farm on sea bird movement.

Relevant Observations for Dublin Array:

- There was little direct effect of the wind farm on the passage of roseate terns

9.4.3 Middelgrunden

The Middelgrunden wind farm near Copenhagen has 20 turbines generating 40 MW and went into service in June 2001. In the Middelgrunden Environmental Impact Statement (EIS), the predicted impacts are rather vague and comprise as follows: Construction Impacts 1. Impacts of sediment disturbance on diving birds' ability to find food in the immediate area of the wind farm during construction, and 2. disturbance effects from noise and lighting during the construction phase. It is assumed that birds will avoid the area during construction but due to the low numbers of birds using the Middelgrunden area the impacts are not seen as significant. Operational Impacts 1. Disturbance through movement of turbines: a worst case is assumed where all birds avoid using the area in the vicinity of the wind farm (up to an unspecified distance) for foraging and roosting. In this case 200-300 birds would be affected with up to 10 pairs of breeding birds having reduced foraging area available to them. This was not considered significant. In addition it was considered that after 2-5 years mussels and other molluscs attaching themselves to the base of turbines would provide additional food for those birds that did venture into the site. 2. Collision risk: it is stated in the EIS that previous study has shown that collision risk presented by turbines is minimal as birds avoid individual turbines or the site as a whole. In addition the EIS states that studies show that larger turbines such as those at Middelgrunden present less of a risk than smaller ones do. Bearing in mind the low number of birds using the site collision risks are considered insignificant (Associated Press 2001, Voland & Hansen 2000, www.middelgrunden.dk).

9.4.4 Arklow Bank

In August 2003, Airtricity and GE began the construction of an offshore wind farm of 200 turbines or 520 MW on the Arklow Bank off Co Wicklow. The Bank, which runs roughly parallel to the coast, is 26km long, 1.6 to 1.7km wide and, at its centre, 13km from Arklow Pier. It is a sandy ridge with rocky outcrops in water of 0 to 20m depth. To date, seven turbines have been installed and they became operational in late summer 2004. The turbines towers are 73m high and the blades are 52m long, with a minimum height of 21m above the sea.

Fieldwork was done using well established JNCC methods for surveying birds and marine mammals at sea. The project's EIS and the subsequent pre-construction monitoring found that the most sensitive species were red-throated divers and little gulls. In a worst-case scenario, both species could be subject to potentially significant displacement effects and the divers could be subject to collision effects. The monitoring programme will continue through the construction period and for a minimum of five years after completion of the project to assess if these effects take place and to distinguish them from natural variability.

To date only data from the pre-construction phase of the development is available for consultation. The Developers requested a copy of the environmental monitoring reports on the post-construction and operational phases of the Arklow Bank from the Department of Arts Heritage and Local Government; however they were not available for consultation at the time of writing. Currently there has been 10 years monitoring of the seabirds reported on the Arklow Bank.

9.4.5 North Hoyle

Construction on the North Hoyle offshore wind farm began in April 2003. It is located approximately 7.5km from the North Wales coast off Prestatyn and Rhyl. It consists of thirty 2MW turbines, generating up to 60MW of electricity with 87.4% availability after the 3rd year of operation in 2007 (improved in 2008). The wind farm is generating enough electricity, on average annually, to meet the needs of 40,000 homes.

The North Hoyle site possesses a number of attributes as a location for an offshore wind farm, including an excellent wind resource and no known environmental sensitivities. No significant environmental impacts have been identified. The site is beyond the foraging range and water depths preferentially selected by most of the important seabird populations in the bay. Surveys on the North Hoyle site have not identified any bird population sizes that could require European designation. Surveys during 2000/2001 have identified wintering populations of common scoter and red-throated diver in the Liverpool Bay, however North Hoyle is of negligible importance as a feeding area for these birds during the breeding season. No significant movements of important populations through North Hoyle have been observed or would be expected. (NWP Offshore Ltd. 2002).

The River Clwyd, which lies along the cabling route, is a non-statutory wildlife site, noted for migrant and wintering populations of county importance of a number of water-bird species. The impact on bird populations on the Clwyd Estuary and Floodplain Wildlife Site will be short term, confined to the construction period, with no effect beyond the calendar year of construction. The overall conclusion is that the North Hoyle offshore wind farm will not significantly affect bird populations (NWP Offshore Ltd. 2002).

Ornithological monitoring carried out over 5 years from 2004 found that guillemots appeared to be making more use of the wind farm site since it became operational. Flight directions of scoter appear to be largely influenced by the boat. Bird species seen flying within the wind farm included cormorants, gulls, terns, gannet and scoter. The wind farm may have had an inhibitory effect, but it has not been a barrier. Little statistical evidence of changes in numbers or distribution of any species were recorded. Few birds of key species were seen flying at rotor blade heights.

Relevant Observations for Dublin Array:

- Guillemots appeared to be making more use of the wind farm site since it became operational
- Bird species seen flying within the wind farm included cormorants, gulls, terns, gannet and scoter
- The wind farm may have had an inhibitory effect, but it has not been a barrier
- Little statistical evidence of changes in numbers or distribution of any species were recorded

9.4.6 Kentish Flats

Kentish Flats wind farm was given the go ahead in March 2003. The Danish power company Elsam purchased the project from Global Renewable Energy Partners in November 2003. Geological surveys to finalise foundation design were carried out at the site in February and March of 2004, and the erection of the turbines began in 2005.

The use of the Kentish Flats wind farm site by bird species has been investigated by site specific bird surveys which will continue throughout the planning and construction phase. The assessment of impacts on bird species has concluded that significant effects on the feeding, roosting, breeding or migratory behaviour of all bird species through disturbance or collision will not be significant, due principally to the small numbers of birds recorded at the site. A possible exception is the potential for feeding diver species to be disturbed during the construction phase as a result of piling operations, if they occur in the main diver season between November and March. Suggestions for mitigation will reduce this impact so that it is not considered significant. Noise generated by cabling operations could disturb wading bird species, but mitigation is offered, suggesting avoiding the sensitive roosting and over-wintering periods. Numerous sites around the Thames Estuary coastline are designated for their conservation interest. No direct impacts on any of these sites will occur as a result of construction operation or decommissioning, with the exception of the potential impacts on the bird species just mentioned, which have been suitably mitigated (Global Renewable Energy Partners 2002).

Continued monitoring of the wind farm during its operation has shown no significant changes in bird species, abundance and behaviour using and/or passing through the wind farm. There was little evidence to suggest a disruption in the flight plan of bird species. The exceptions to this are common terns which have shown a change in their flight path used to return to their colonies. It is suggested that the wind farm is acting as an obstacle to their movement and is not an absolute barrier.

Relevant Observations for Dublin Array:

- No significant changes in bird species, abundance and behaviour using and/or passing through the wind farm
- While common terns have shown a change in their flight path used to return to their colonies there was little evidence to suggest a disruption in the flight plan of other bird species
- The wind farm may have had an inhibitory effect, but it has not been a barrier

9.4.7 Rhyl Flats

Construction on the offshore wind farm site at Rhyl Flats, which is located approximately 10km off the North Wales coast, started in 2007. The wind farm consists of 25 3.6MW turbines, generating up to 90MW of electricity.

Potential impacts on birds include disturbance to or permanent loss of foraging habitat, risk of bird collisions with operating turbines, and the creation of a barrier by the row of turbines, however, significant changes were made to the layout during 2002 (mainly for landscape reasons), and this should also reduce the barrier effect of the turbines for common scoter, which feed landward of the wind farm. It is also possible that there will be creation of new marine habitat around the turbine bases which may create new foraging habitat for birds.

The EIA concluded that there may be some general disturbance effects during construction when birds normally using the area will maintain a stand-off distance from the works, but that in general the effects during operation will be limited and are not considered to be significant, particularly as the wind farm development will not give rise to any impacts on sites designated for nature conservation interest. With the exception of cormorant (a fish eating species), few species are considered likely to forage in the area of the wind farm because of its distance from the shore and the depth of water.

Common scoter, which occurs in nationally important numbers in the study area, is the main bentic feeding bird species which could be affected by habitat loss. However, significant impacts are not predicted because bentic habitat loss will be small; their preferred food source is scarce in the location of the wind farm and numbers are low in the months when most construction activity is likely to take place (April to August). Moulting common scoter could be affected by laying of the subsea cable. However, the work period will be short.

Monitoring results which demonstrated reduced Common Scoter numbers between Oct-Dec allowed the project to extend the cable construction season into the winter. Monitoring in that period showed no impact in distribution of Scoter from construction activity.

Modelling indicates that collision risk is greatest for red-throated divers, but that no significant impacts are likely. Proposed lighting for the site has been designed to reduce the risk of attracting birds to the turbines. Bird flight lines are not expected to be significantly affected as there will be a gap of 335m between rotor blades which will reduce the risk of a barrier effect from the turbines.

Monitoring showed that of the 30,000 bird within the wind farm survey area only a few hundred fly at rotor height and are at risk of collision. Monitoring surveys focused their effort to key migration times between October and March for SPA species Red Throated Diver and Common Scoter.

As part of the EIA, the impacts of the proposed wind farm at Rhyl Flats have been assessed in conjunction with another wind farm project proposed at North Hoyle. The development of both the North Hoyle and the Rhyl Flats offshore wind farms will result in a slight increase in the extent and intensity of the effects on seascape and landscape character, compared to the development of either project on its own. It has been found however that these heightened impacts relate to altered views in the Colwyn Bay, and to terrestrial archaeology. No other potential negative cumulative impacts were predicted (NWP Offshore Ltd., 2002).

Relevant Observations for Dublin Array:

- Monitoring in that period showed no impact in distribution of Scoter from construction activity

9.4.8 Horns Rev

Horns Rev is 14 km west-south-west of Blavands Huk on the west coast of Denmark. 80 x 1.8 MW turbines are now in operation on a 27.5 km^2 site in water depths of 6.5 to 13m. The Danish Energy Agency's approval for the Horns Rev project required "a programme for monitoring environmental impacts during the construction and the following initial phase of operation" with particular attention to waterbirds and migrating birds. Of "decisive importance" was the requirement that natural variability should not mask effects. A detailed assessment of the likely impacts of this project on birds was published (Christensen et al., 2001, Noer et al. 2000). Work reported on covers two years of base-line monitoring from 1999 to 2001, and monitoring during construction of the wind farm in 2002. The last turbine at Horns Rev was put into operation in December 2002.

During base-line monitoring, nine aerial and three ship surveys were made of 1,700 km^2 surrounding the site. The most important species observed were eider and common scoter but these were concentrated on the coastal edge of the survey box in less than 6m of water. They were virtually absent from Horns Rev and the surrounding offshore waters. Black-throated or red-throated divers, gannets, kittiwakes, sandwich terns, common or arctic terns, and guillemots or razorbills were the most numerous species in the survey box. However, the authors considered that, in the absence of an adequate mathematical model to take account of various biases that might arise during data collection, they could not calculate species densities.

The distribution of the seabird species was variable and this was thought to reflect variable prey fish distributions. Large numbers of lesser black-backed, herring and great black-backed gulls were often observed associated with fishing boats. Smaller numbers of skuas (mainly arctic skuas) were also observed. Most of these species occurred in disproportionately low numbers on the 1.6% of the Horns Rev study area occupied by the wind farm site. The exceptions to this were divers and kittiwake, which occurred, in roughly proportionate numbers. However, the sample sizes for these two species were small at 8 out of 554 and 11 out of 1,118 birds on site respectively.

The potential impacts were considered to be physical effects on habitats, disturbance/avoidance effects and collision risk. The impacts on habitats were considered to be insignificant in that the turbines' "footprint" will only be 0.3% of the 27.5 km^2 site and thus be too small to be measurable. Equally it was predicted that any reef habitat development around the turbine bases will not have a measurable impact on bird populations. It was considered that the laying of the connecting cable, which passed through protected areas as it nears the coast, would have negligible effects – provided it was laid outside the common scoter moulting season of July to September.

Because of the low numbers of birds using Horns Rev, it was considered that even if there was complete avoidance of the site, the impact would be negligible. Analysis of bird usage out to 4km from the site, a very conservative worst case avoidance scenario, indicates that 7 to 10% of divers, kittiwakes, terns and auks from the entire study area, and 13% of gannets, would be affected. Apart from birds simply avoiding the wind farm, the other potential source of disturbance is use of helicopters for access and maintenance. Helicopters are known to cause significant disturbance impacts in some situations.

It was judged that the risk of collisions between wind turbines and seabirds is poorly documented. It was considered that actively hunting species such as gannets and skuas would be most likely to approach the turbines if they were pursuing fish and seabirds, respectively. Notwithstanding the poor knowledge base, it was considered that the collision risk would not have a negative impact on species populations.

Monitoring during the year of construction showed that although there were slight differences in bird exploitation of the wind farm area and the 2km and 4km zones around it, the bird numbers within and close to the wind farm area were not consistently and significantly reduced (Techwise 2003). Divers and auks did occur in significantly lower numbers at distances of more than 2.5km from the construction activities, while herring gull showed a significant attraction to the wind farm area and the 2km and 4km zones around it. In any case, very low numbers of birds were recorded at the wind farm site during base-line monitoring, and so any birds affected unlikely to be of any biological relevance compared to the size of the total population of the species known to occur in the Greater Horns Rev area.

The most important findings after seven years monitoring at Horns Rev and Nysted wind farms indicate negligible effects on overall bird populations, with gulls and terns showing a preference for the wind farm area following construction (Petersen *et al.* 2004) while the remaining birds species showed avoidance to the wind farms. Although there was considerable movement of birds around wind farms, however, between 71-86% of flocks avoided the wind farm between turbine rows. Changes in flying directions, for most of the species, were verified at 0.5 km from wind farms at night and at 1.5 km in the day. This avoidance represents an effective habitat loss, but the proportion of feeding area lost due to the presence of these two wind farms, in relation to the total feeding area, is relatively small and is considered of little biological importance. Avoidance behaviour reduces the risk of collision with turbines. The displacement of birds because of wind farm installations makes the collision risk at the two installations low. The predicted collision rates of common eiders at Nysted were 0.02 %, which means 45 birds over a total of 235,000 passing each autumn in the area. Monitoring has also confirmed that water-birds (mainly eider) reduce their flight altitude, below rotor height, at the Nysted wind farm.

Studies at the Danish wind farms at Tunø Knob and Horns Rev have shown a decrease in the number of eiders and common scoters in the years following construction (Guillemette et al., 1998; Guillemette et al., 1999; Petersen et al., 2006; Petersen and Fox, 2007). Within a few years the number of eiders at Tunø Knob increased again but in 2006, four years after the completion of the wind farm at Horns Rev, common scoters still did not use the wind farm area. In early 2007, wintering scoters began to feed inside the area, indicating that habituation may occur as the birds gain experience.

Relevant Observations for Dublin Array:

- During construction there were slight differences in bird exploitation of the wind farm area and the 2km and 4km zones around it, the bird numbers within and close to the wind farm area were not consistently and significantly reduced
- Divers and auks did occur in significantly lower numbers during construction
- Water-birds (mainly eider) reduced their flight altitude, below rotor height
- Changes in flying directions were observed for most of the species, however this avoidance represented an effective habitat loss, but the proportion of feeding area lost due to the presence of the wind farm, in relation to the total feeding area, is relatively small and was considered of little biological importance
- The most important findings after seven years monitoring at Horns Rev and Nysted wind farms indicate negligible effects on overall bird populations, with gulls and terns showing a preference for the wind farm area following construction
- Monitoring surveys have indicated that habituation may occur as the birds such as scoters gain experience.

9.4.9 Codling Bank

The Codling wind park would be a 220 turbine offshore wind farm at the Codling Bank, 13km off the east coast of Ireland between Greystones and Wicklow. The site would be constructed over 3-7 phases, lasting between spring and autumn of a single year. A recommendation was made for survey work comprising monthly boat surveys until construction started, twice-monthly surveys during construction and monthly surveys for another 3 years post construction. Pre-construction monthly surveys were carried out between April 2001 and March 2003 (Coveney Wildlife Consulting Ltd. 2002).

The Codling Bank area is not considered to be of particular sensitivity for birds (Coveney Wildlife Consulting Ltd. 2002). The nearest protected area for breeding or overwintering birds lies on the coast at the Murrough, more than 13km from the wind farm. Nevertheless comprehensive boat and aircraft bird surveys were carried out over an area of more than 580 km^2 to allow a full picture to be formed of the importance of the Codling Bank and the wider area for bird populations of the Irish Sea.

The key species identified in the study area include Manx shearwater, guillemot, razorbill, shag and gannet. The most important potential impacts were considered to be disturbance of the birds through construction activity and through movement and noise from wind turbines during the operating period, subsequent displacement of birds from the wind farm area, and collision risks with turbine blades. Collision risks for migrating birds were considered along with resident species.

Collision risks on birds have been broadly estimated through observation of flight heights. At highest tides the minimum distance of rotor blades over the sea surface would be 30m. Collision risks would be negligible or zero for the four most important species in the Study Area: during monthly surveys 100% of flying Manx shearwaters, guillemot, and shags, and 99% of razorbills, flew at heights below 7m. More detailed analysis of collision risks for species that were observed flying over 7m during surveys (but not necessarily above 30m) - namely kittiwakes and gannets - showed that these species were unlikely to be at significant risk of collision with turbine blades.

Although the project has been granted a Foreshore Lease, it has not been built to date.

Codling Wind Park has also lodged an application with the Department of Agriculture, Fisheries and Food for an extension to the consented Codling Wind Park Development. The extension proposal comprises an additional 200 turbines (up to 1000MW) and is located approximately 13km off the east coast of Ireland in water depths of between 11 and 18 metres.

Relevant Observations for Dublin Array:

- Collision risks were considered negligible or zero for the four most important species in the Study Area: namely Manx shearwaters, guillemot, shags and razorbills and not significant for kittiwakes and gannets
- Potential impacts were considered to be the disturbance of the birds through construction activity and through movement and noise from wind turbines during the operating period, and subsequent displacement of birds from the wind farm area

9.4.10 Blyth Harbour

Two turbines located 1 km off Blyth Harbour in Northumberland, went into operation late in 2000. This is a different project from the nine turbine Blyth Harbour breakwater installation. The environmental statement for the offshore project considered that there would be no significant impacts on coastal birds and their shoreline habitats. These habitats have been designated or proposed for designation as a Special Protection Area under the EU Birds Directive, and as a wetland of international importance under the Ramsar Convention. The Environmental statement does not include any direct assessment of impacts on the sites marine birds. The turbines at Blyth can generate enough energy to supply over 2,000 homes, saving 4520 tonnes of carbon dioxide from entering the atmosphere each year.

Collision rates for wintering waterfowls, gulls and passerines on coastal areas in Northwest Europe range from 0.01 to 1.2 birds/turbine. No significant population decline has been detected and the collision rate of common eider has dropped substantially in the subsequent years to construction (Drewitt *et al.,* 2006). Direct observations from Blyth Harbour, UK, have demonstrated that collisions with rotor blades are rare events in this wind farm located within a Site of Special Scientific Interest and Special Protection Area, under the Birds Directive.

Relevant Observations for Dublin Array:

- No significant population decline has been detected and the collision rate of common eider has dropped substantially in the subsequent years to construction
- Direct observations have demonstrated that collisions with rotor blades are rare events in this wind farm

9.4.11 Burbo Bank

The Burbo Bank offshore wind farm currently comprises of twenty five 3.6MW turbines for a total generating capacity of 90MW. It is situated on the Burbo Flats in Liverpool Bay at the entrance to the River Mersey. Liverpool Bay is under consideration for designation as an SPA as a result of internationally important populations of Common Scoter and Red Throated Diver. DONG Energy is proposing to develop an extension to the existing and operational Burbo Bank and submitted an EIA scoping report in 2010. The proposed Burbo Bank Extension offshore wind farm development consists of an area of 40 km2 and an estimated capacity of 169 to 234 MW, and is located adjacent to the west of the Operational Wind Farm.

Baseline surveys were carried out (2001-2002, 2005-2006) to determine the effects of the wind farm on seabirds regularly using the area, birds passing through the area in flight, shorebirds passing through the area between protected intertidal areas and other potentially significant species that may be impacted. Species which were considered based on their importance in the region included common scoter, red-throated diver, common tern, cormorant, red-breasted merganser, little gulls, guillemots and razorbills. For each species the potential impacts of collision risk, flight path disruption, habitat loss, disturbance and lighting were assessed. The risk of all these impacts was deemed to be low for all species, with the exception of the red-throated diver. The high sensitivity of the species has led to the significance of these impacts being regarded as medium level, rather than low. The overall findings of the scoping report indicated that the wind farm will have no significant impact on birds within, or passing through, the bay.

Construction began in April 2006 with power being generated for the first time in July 2007 and monitoring was carried out during this period. Post construction work was carried out for one year (2007-2008) and effort was directed towards four key species (Red Throated Diver, Common Scoter, Common Tern and Cormorant). The data presented in pre-construction, construction and post-construction reports show that general numbers of birds using the Operational wind farm survey area is low, indicating that the Operational wind farmsite is of lower value than other areas of Liverpool Bay. Little change in bird activity was observed during and after the construction of the Operational wind farmsite, which suggests that impacts on bird numbers and activity levels were minimal (albeit from an already low level). However, it should be noted that this observation is based on the 1st year only of the post-construction monitoring survey. According to post-construction survey data, the highest count for Red-throated Diver in the study reference area was nine, in April 2007. Birds were mainly observed on the water or being flushed by the survey vessel. Flight heights were low (<5 m). Common Scoter individuals were also observed to utilise the study reference area in preference to the Operational wind farmsite itself with none observed within the wind farm itself. The birds observed were in small groups (up to 9) and always in flight. Common scoters usually aggregate when feeding into large groups. This behaviour indicates that birds were possibly commuting through the reference area and, hence, it may not be a key feeding area. It can be concluded that usage of the project site by Red-throated Divers and Common Scoter is higher than at the operational wind farmsite. However, in relation to the rest of the wider area the usage is lower.

Relevant Observations for Dublin Array:

- Little change in bird activity was observed during and after the construction of the Operational wind farmsite, which suggests that impacts on bird numbers and activity levels were minimal

9.4.12 Tunø Knob

The Tunø Knob offshore wind farm comprises ten 5MW turbines for a total generating capacity of 50MW. It is situated 6km from the Danish coastline. A well designed BACI study was conducted at Tunø Knob, some aspects of which lasted up to 4 years, however the baseline period for the bird counts lasted only two months (mid-feb to mid-April 1995) and largely addressed only one species (the Eider). As the study was restricted to the winter it failed to include possible offshore foraging trips of breeding birds, the moulting period of seaducks and migration periods. The findings did however record Eider numbers in the wind farm area to have declined by 75% contrasting with the control area and with population trends in the larger region, which showed no significant trends during the study period. For the Common Scoter, numbers in the wind farm area declined by 90%, but a similar trend was evident in other areas in the region. However, the extent to which the wind farm caused the population changes was questionable as during the same period, the abundance and age composition of blue mussels *Mytilus edulus*, which formed an important part in the diet of both bird species, changed significantly in the area. This change was sufficient to account for a high proportion of the overall variation in bird populations between years (Guillemette et al, 1998). It was concluded that the change in eider numbers between years could not be explained by the presence of the wind turbines and within a few years the number of eiders at Tunø Knob increased again.

The results of monitoring have indicated short distance disturbance effects rather than natural variability where the detection of such would have required more than a one year baseline study (Tingley, 2003).

Relevant Observations for Dublin Array:

- The results of monitoring have indicated short distance disturbance effects

9.5 Likely Impacts of the Dublin Array wind farm on Seabirds

The assessment of the likely impacts that the Dublin Array project will have on seabirds is based on the results of the baseline field surveys and desk studies presented in this chapter of the EIS. Since the number of case studies on the impacts of offshore wind farms is limited, and the selected key species are different to the species recorded as key on the Kish and Bray Banks, monitoring may show the effects to be considerably less than those potential effects identified.

One off catastrophic impacts, such as the collision of a large number of migrating seabirds as a result of extreme weather will not be considered here as the probability is extremely low and the turbines would be shut down in these cases of extreme weather.

All effects are assessed on the assumption that good construction practices will be adhered to avoiding for example pollution and oil spills as will be required in any Foreshore Lease that may be granted.

9.5.1 Predicted Impacts

Table 9.2 details the habits and vulnerability of the various species found in the area of the proposed Dublin Array wind farm. Various key species have been identified from these and the potential impacts on these species need to be assessed. The EIA regulation states that an impact should only be considered as material to the decision making process if it considered to be significant (CAAS, 2002). This section assesses the likely predicted impacts of the proposed development on key species in the area using an environmental impact matrix to identify the significance of risk for each of the key species. The assessment is based on both the baseline survey data and a desk study. The criteria for determining the significance of the potential impacts are summarised in Tables 9.7, 9.8 and 9.9 based on Percival (2003).

Sensitivity	Definition
Very High*	Cited interest of SPAs, SACs or proposed NHAs (Species is listed as a qualifying interest of the site)
High**	Other species that contribute to the integrity of an SPA: A local population that represents >1% of the national population of a species; An ecologically sensitive species e.g. listed as red on BirdWatch Ireland's list of species of conservation concern (Lynas *et al*. 2008)
Medium	Regionally important population of a species, either because of population size or distributional context; Other EU Birds Annex I species not covered above; A moderately sensitive species e.g. listed as amber on BirdWatch Ireland's list of species of conservation concern (Lynas *et al*. 2008) and not covered above
Low	Other bird species protected under the Wildlife (1976) and Wildlife Amendment (2000) Acts

** The Bray and Kish Banks are not at the time of writing of this EIS protected under any conservation designation by the state.*
***Species have also been designated as Medium where >1% of the Irish population was recorded to visit the proposed development.*

Table 9.7 Definition of terms relating to the sensitivity of the ecological components of the site.

Key species	Sensitivity	Basis of Baseline sensitivity
Manx Shearwater	High	A local population that represents >1% of the national population of a species (BirdWatch Ireland, 2011)
Cormorant	Medium	A moderately sensitive species e.g. listed as amber on BirdWatch Ireland's list of species of conservation concern (Lynas *et al*. 2008)
Shag	Medium	A moderately sensitive species e.g. listed as amber on BirdWatch Ireland's list of species of conservation concern (Lynas *et al*. 2008)
Great black-backed gull	High	A local population that represents >1% of the national population of a species (BirdWatch Ireland, 2011)
Kittiwake	High	A local population that represents >1% of the national population of a species (BirdWatch Ireland, 2011)
Arctic tern	Medium	A moderately sensitive species e.g. listed as amber on BirdWatch Ireland's list of species of conservation concern (Lynas *et al*. 2008)
Common tern	Medium	A moderately sensitive species e.g. listed as amber on BirdWatch Ireland's list of species of conservation concern (Lynas *et al*. 2008)
Roseate tern	High	A local population that represents >1% of the national population of a species (BirdWatch Ireland, 2011)
Guillemot	High	A local population that represents >1% of the national population of a species (BirdWatch Ireland, 2011)
Razorbill	High	A local population that represents >1% of the national population of a species (BirdWatch Ireland, 2011)
Northern gannet	Medium	A moderately sensitive species e.g. listed as amber on BirdWatch Ireland's list of species of conservation concern (Lynas *et al*. 2008)
Herring gull	High	An ecologically sensitive species e.g. listed as red on BirdWatch Ireland's list of species of conservation concern (Lynas *et al*. 2008)
Common Gull	Medium	A moderately sensitive species e.g. listed as amber on BirdWatch Ireland's list of species of conservation concern (Lynas *et al*. 2008)
Black-headed Gull	High	An ecologically sensitive species e.g. listed as red on BirdWatch Ireland's list of species of conservation concern (Lynas *et al*. 2008)
Black Guillemot	Medium	A moderately sensitive species e.g. listed as amber on BirdWatch Ireland's list of species of conservation concern (Lynas *et al*. 2008)

Table 9.8 Baseline sensitivity of the key species

Magnitude	**Definition**
Very High	Total loss or very major alterations to key elements and features of the baseline conditions such that post development character composition and attributes would be fundamentally changed and may be lost from the site altogether. >80% of population/habitat loss
High	Major alteration to key elements and features of the baseline conditions such that post development character, composition and attributes would be fundamentally changed 20-80% of population/habitat loss
Medium	Loss or alteration to one or more key elements and features of the baseline conditions such that post development character, composition and attributes would be changed 5-20% of population/habitat loss
Low	Minor shift away from the baseline conditions. Change arising from the loss/alteration would be discernable but underlying character, composition and attributes of baseline conditions would be similar to pre development circumstances/patterns 1-5% of population/habitat loss
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximately to the 'no change' situation. <1% of population/habitat loss

Table 9.9 Definition of terms relating to the magnitude of potential impacts

Based on information on the key species and the magnitude of the potential impact an assessment is made based on each phase of the lifespan of the proposed wind farm. This assessment is based on the sensitivity of species (Table 9.7 and Table 9.8) and the magnitude of the impact (Table 9.9) in order to determine the significance of the impact.

	Key Species Sensitivity			
Magnitude of potential impact	Low	Medium	High	Very High
Very High	Medium	High	Very High	Very High
High	Low	Medium	Very High	Very High
Medium	Very Low	Low	Medium	Very High
Low	Very Low	Very Low	Low	Medium
Negligible	Very Low	Very Low	Very Low	Low

The interpretation of these significance categories is as follows:

- *Very Low and Low are not normally of concern, though normal design care should be exercised to minimise impacts.*
- *Medium represents a potentially significant impact that requires careful individual assessment. Such an impact could warrant planning refusal, but it may be of a scale that can be resolved by revised design or appropriate mitigation.*
- *Very High and High represent a significant impact on bird populations and could warrant refusal of planning permission*

Table 9.10 Matrix of magnitude of potential impacts and key species sensitivity

9.5.2 Pre-Installation and Construction

Pre-installation exploration activities (e.g. sediment coring and geophysical surveys) are not thought likely to cause significant impacts to birds in the vicinity (Hiscock *et al.,* 2002). The red-throated diver is a species judged most likely to be disturbed by construction and maintenance on the basis of their known sensitivity to boat disturbance, as a result of increased vessel activity in the area (installation of the foundations and turbines). A peak of 16 birds was recorded over the bank in March and it is thought it may have been an early migrant group. However, impacts resulting from such areas are therefore likely to be minimal and short-term with the disturbance much reduced during the operation of the wind farm.

The construction of the wind farm is likely to cause temporary disturbance to birds feeding in the vicinity of the construction site, as only a small fraction of the entire site will be under construction therefore possibly disturbance to migrating birds is reflected by a maximum of a 'Low' potential impact identified in Table 9.11. However, an increase in gull species is predicted as a result of the increase in ship activity, and this is reflected by a 'Very Low' potential impact as a result of disturbance. Similarly the area of the site impacted by construction is not expected to have any effects on the immediate changes to the food source on the bank and therefore the potential impact during this period of construction is expected to be very low. A summary of predicted impacts on birds during the construction phase is shown in Table 9.11.

Key Species	Baseline Sensitivity	Basis of Assessment	Magnitude of Impact			Significance of Impact
			Disturbance Feeding sites	Disturbance Migration routes	Indirect effects from changes to food source	
Manx Shearwater	High	The area of the site impacted by construction opposed to the total area of the sandbank available to feed and the widely recorded distribution of the species within the site is not expected to have significant effects on feeding or the quantity of food found during this period of construction. This species fly at <7m for the majority of time and there have been no recorded incidences where wind farms have impacted upon migration routes.	Low	Low	Very Low	Low
Cormorant	Medium	The area of the site impacted by construction opposed to the total area of the sandbank available to feed and the widely recorded distribution of the species within and outside of the site is not expected to have significant effects on feeding or the quantity of food found during this period of construction. This species fly at <7m for the majority of time and is a resident.	Very Low	N/A	Very Low	Very Low
Shag	Medium	While this species peaks on the shallow waters of the sandbanks the area impacted by construction opposed to the total area of the sandbank available to feed is not expected to have significant effects on feeding or the quantity of food found during this period of construction. This species fly at <7m for the majority of time and is a resident.	Very Low	N/A	Very Low	Very Low
Great black-backed gull	High	An increase in gull species is predicted as a result of the increase in ship activity, based on previous surveys of wind farms and this is reflected by a 'Very Low' magnitude of impact during construction. This population of great black-backed gulls recorded on the bank are residents.	Negligible	N/A	Negligible	Very Low
Common Gull	Medium	An increase in gull species is predicted as a result of the increase in ship activity, based on previous surveys of wind farms and this is reflected by a 'Very Low' magnitude of impact during construction. This population common gulls recorded on the bank are residents.	Negligible	N/A	Negligible	Very Low
Black-Headed gull	High	An increase in gull species is predicted as a result of the increase in ship activity, based on previous surveys of wind farms and this is reflected by a 'Very Low' magnitude of impact during construction. This population of black headed gulls recorded on the bank are residents.	Negligible	N/A	Negligible	Very Low
Kittiwake	High	An increase in gull species is predicted as a result of the increase in ship activity, based on previous surveys of wind farms and this is reflected by a 'Very Low' magnitude of impact during construction. This population of kittiwakes recorded on the bank are residents.	Negligible	N/A	Negligible	Very Low
Arctic tern	Medium	The highest densities of this species were recorded in deeper waters outside of the proposed wind farm area. The area impacted by construction is not expected to have significant effects on feeding or the quality or quantity of food found. Case studies have recorded Arctic terns both entering wind farms and manoeuvring to avoid the turbines. Flight heights ranged between 3-12m though occasionally flights ranged between 15-20m	Low	Low	Very Low	Very Low

Table 9.11 Significance of predicted impacts during construction based on information on the key species (Table 9.2 & Table 9.6) and the magnitude of the potential impact (Table 9.9) and case studies.

Key Species	Baseline Sensitivity	Basis of Assessment	Magnitude of Impact			Significance of Impact
			Disturbance Feeding sites	Disturbance Migration routes	Indirect effects from changes to food source	
Common tern	Medium	The highest densities of this species for the most part were recorded in deeper waters outside of the proposed wind farm area, while overall the species recorded a wide distribution within the site. Therefore the area impacted by construction is not expected to have significant effects on feeding or the quality or quantity of food found. Case studies have recorded foraging common terns changing their flight path used to return to their colonies and also flying between turbines. On this basis it is similarly thought that on migration the construction of turbines would not have a significant impact. Flight heights ranged between 3-12m though occasionally flights ranged between 15-20m	Low	Low	Very Low	Very Low
Roseate tern	High	The low impact expected on feeding or the quantity of food found during this period of construction is based on the area of the site impacted by construction opposed to the total area of the sandbank available to feed. The recorded distribution and density of the species on the northern part of the bank in both deeper and shallower waters within the study area along with information from case studies which have shown little direct effect of the wind farm on the passage of roseate terns and a reduced sensitivity in breeding sea birds or rapid habituation during the breeding season would suggest a low impact in relation to disturbance to feeding sites. Majority of flight heights ranged between 3-12m	Low	Low	Very Low	Low
Guillemot	High	The low impact expected on feeding or the quantity of food found during this period of construction is based on the area of the site impacted by construction opposed to the total area of the sandbank available to feed. The recorded widespread distribution within the study area and the density of the species on the southern part of the bank in both deeper and shallower waters within the study area along with information from case studies which have shown a reduced sensitivity in breeding sea birds or rapid habituation during the breeding season would suggest a low impact in relation to disturbance to feeding sites. This population of guillemots recorded on the bank are residents.	Low	N/A	Very Low	Low
Black Guillemot	Medium	The low impact expected on feeding or the quantity of food found during this period of construction is based on the area of the site impacted by construction opposed to the total area of the sandbank available to feed. Their current sightings on the south of the bank may be simply due to the proximity to their coastal nesting site. Information from case studies have shown a reduced sensitivity in breeding sea birds or rapid habituation during the breeding season would suggest a low impact in relation to disturbance to feeding sites. This population of guillemots recorded on the bank are residents.	Low	N/A	Very Low	Low

Table 9.11 (ctd) Significance of predicted impacts during construction based on information on the key species (Table 9.2 & Table 9.6) and the magnitude of the potential impact (Table 9.9) and case studies.

Key Species	Baseline Sensitivity	Basis of Assessment	Magnitude of Impact			Significance of Impact
			Disturbance Feeding sites	Disturbance Migration routes	Indirect effects from changes to food source	
Razorbill	High	The low impact expected on feeding or the quantity of food found during this period of construction is based on the area of the site impacted by construction opposed to the total area of the sandbank available to feed. The recorded widespread distribution within the study area and the density of the species on the southern part of the bank in both deeper and shallower waters within the study area along with information from case studies which have shown a reduced sensitivity in breeding sea birds or rapid habituation during the breeding season would suggest a low impact in relation to disturbance to feeding sites. This population of razorbills recorded on the bank are residents.	Low	N/A	Very Low	Low
Northern gannet	Medium	The low impact expected on feeding or the quantity of food found during this period of construction is based on the area of the site impacted by construction opposed to the total area of the sandbank available to feed. The recorded widespread distribution within the study area and the density of the species outside of the proposed windfarm site in the deeper waters along with information from case studies which have shown a reduced sensitivity in breeding sea birds or rapid habituation during the breeding season would suggest a low impact in relation to disturbance to feeding sites. This population of gannets recorded on the bank are residents.	Low	N/A	Very Low	Very Low
Herring gull	High	An increase in gull species is predicted as a result of the increase in ship activity, based on previous surveys of wind farms and this is reflected by a 'Very Low' magnitude of impact during construction. This population of herring gulls recorded on the bank are residents.	Negligible	N/A	Negligible	Very Low

Table 9.11 (ctd) Significance of predicted impacts during construction based on information on the key species (Table 9.2 & Table 9.6) and the magnitude of the potential impact (Table 9.9) and case studies.

9.5.3 Cable Installation

Effects from offshore cable laying operations in the wind farm area would be short term and localised to the sea bed resulting in the magnitude of the potential impacts being low to negligible. Such operations are not thought likely to cause significant impacts on seabirds (Soker *et al.,* 2000) and the seabed is expected to recover to a similar state within the short term. Therefore the predicted impacts are thought to be very low (Table 9.12).

Key Species	Baseline Sensitivity	Disturbance Feeding sites	Disturbance Migration routes	Indirect effects from changes to food source	Significance of Impact
Manx Shearwater	High	Very Low	Very Low	Very Low	Very Low
Cormorant	Medium	Very Low	N/A	Very Low	Very Low
Shag	Medium	Very Low	N/A	Very Low	Very Low
Great black-backed gull	High	Very Low	N/A	Very Low	Very Low
Kittiwake	High	Very Low	N/A	Very Low	Very Low
Arctic tern	Medium	Very Low	Very Low	Very Low	Very Low
Common tern	Medium	Very Low	Very Low	Very Low	Very Low
Roseate tern	High	Very Low	Very Low	Very Low	Very Low
Guillemot	High	Very Low	N/A	Very Low	Very Low
Razorbill	High	Very Low	N/A	Very Low	Very Low
Northern gannet	Medium	Very Low	N/A	Very Low	Very Low
Herring gull	High	Very Low	N/A	Very Low	Very Low
Common gull	Medium	Very Low	N/A	Very Low	Very Low
Black-headed gull	High	Very Low	N/A	Very Low	Very Low
Black guillemot	Medium	Very Low	N/A	Very Low	Very Low

Table 9.12 Significance of predicted impacts during cable installation construction based on information on the key species (Table 9.2 & Table 9.6) and the magnitude of the potential impact (Table 9.9) and case studies.

9.5.4 Operation

The majority of seabirds identified as key species virtually exclusively fly at altitudes of less than 7m. The significance of the potential risk of birds colliding with the turbines ranged from low to very low depending on the key species (Table 9.11). While gannets and divers are considered to be the most susceptible to collision as a result of their flight and dive height, studies from Horns Rev and Utgrunden wind farms have shown that these species actively avoid the wind farm therefore reducing the likelihood of collision. Similarly at Blyth Harbour direct observations have demonstrated that collisions with rotor blades are rare events. Also collision risks were considered negligible or zero for the four most important species on the Codling Bank: namely Manx shearwaters, guillemot, shags and razorbills and not significant for kittiwakes and gannets. This combined information has resulted in the magnitude for all key species being determined as low or negligible.

The magnitude of the disturbance to feeding sites is thought to be medium for a number of species based on the percentage of the Irish population recorded feeding in this area i.e. the Manx shearwater, shags, terns and razorbills. Some species where the percentage of the population is less than 5% is considered to be of low magnitude. A reduced sensitivity is expected in breeding birds or rapid habituation during the breeding season where alternative feeding sites are not available and this may see the magnitude for terns such as the Roseate tern being reduced and consequently the potential impact being subsequently determined as low. Similarly the common and Arctic terns are also predicted to enter the wind farm and to show great deviation manoeuvres to avoid the turbines.

Gannet and Shag are found along our coast all year, although some Gannets migrate south to southern Europe and the west coast of Africa. The Herring gulls appear to be resident in Ireland. Adults are generally non-migratory. Kittiwakes are migratory spending most of the winter in the north Atlantic far offshore and thus the proposed development is not along its migratory route. The Arctic tern is a summer migrant from Antarctic waters. There is no evidence that the proposed Dublin Array would act as a barrier to migrating species and based on the magnitude of the potential impact all species have been predicted to have a low to very low impact in relation to migration.

An increase in gull numbers is predicted to include the little gull, Herring gull and great-black-backed gull due both to resting opportunities on the foundations of the turbines and/or the attraction to increased ship traffic.

In relation to the disturbance of flight paths at wind farms there was little direct effect of the wind farm on the passage of roseate terns at Carnsore Point wind farm, however at the Kentish Flats wind farm the common terns have shown a change in their flight path used to return to their colonies. There was little evidence to suggest a disruption in the flight plan of any other bird species at the Kentish Flats and monitoring surveys at Horns Rev have indicated that habituation may occur as the birds such as scoters gain experience. Therefore the magnitude of impact on all key species is low resulting in the predicted impacts to be low and very low which also reflects the key species baseline sensitivity see Table 9.13 below.

As already stated, Low ratings are not normally of concern, though normal design care should be exercised to minimise impacts.

Medium represents a potentially significant impact that requires careful individual assessment through monitoring. Such an impact could potentially warrant planning refusal, however it may be of a scale that can be resolved by appropriate mitigation or the significance reassessed as more case studies come on line.

Very High and High represent a significant impact on bird populations and could warrant refusal of planning permission. No high or very high ratings were estimated for the proposed wind farm development in this assessment.

Key Species	Baseline Sensitivity	Basis of Assessment	Magnitude of Impact					Significance of Impact
			Collisions	Habitat Loss due to turbines	Disturbance to Feeding sites	Disturbance to Migration routes	Disturbance to Flight patterns	
Manx Shearwater	High	The area of the site impacted by wind farm opposed to the total area of the sandbank available to feed and the widely recorded distribution of the species within the site is not expected to have significant effects on feeding. This species fly at <7m for the majority of time and case studies have shown little direct effect of the wind farm on the passage of Manx shearwater as there have been no recorded incidences collisions or where wind farms have impacted upon migration routes or flight paths. Also case studies have revealed reduced sensitivity in breeding sea birds or rapid habituation during the breeding season was recorded during case studies of wind farms.	Very Low	Negligible	Low	Low	Low	Low
Cormorant	Medium	The area of the site impacted by operation opposed to the total area of the sandbank available to feed and the widely recorded distribution of the species within and outside of the site is not expected to have significant effects on feeding or the quantity of food found. Scour protection, which will be placed around all turbine foundations, will provide cover for fish resulting in an increase in food sources for cormorant. This species fly at <7m for the majority of time and therefore is at low risk to collisions. Case studies have recorded this species flying through wind farms and therefore the wind farm is considered to have a low magnitude of impact in relation to flight patterns.	Very Low	Negligible	Low	N/A	Very Low	Very Low
Shag	Medium	While this species peaks on the shallow waters of the sandbanks the area impacted by the turbines opposed to the total area of the sandbank available to feed is not expected to have significant effects on feeding or the quantity of food found during the operation of the wind farm. Scour protection, which will be placed around all turbine foundations, will provide cover for fish resulting in an increase in food sources for shag. This species fly at <7m for the majority of time and collision risks are considered very low.	Very Low	Negligible	Low	N/A	Very Low	Very Low
Great black-backed gull	High	An increase in gull species is predicted as a result of the increase in ship activity, based on previous surveys of wind farms and this is reflected by a 'negligible' magnitude of impact during operation. This population of great black-backed gulls recorded on the bank are residents.	Low	Negligible	Negligible	N/A	Negligible	Low
Kittiwake	High	An increase in gull species is predicted as a result of the increase in ship activity, based on previous surveys of wind farms and this is reflected by a 'Negligible' magnitude of impact during construction. This population of kittiwakes recorded on the bank are residents.	Low	Negligible	Negligible	N/A	Negligible	Low

Key Species	Baseline Sensitivity	Basis of Assessment	Magnitude of Impact					Significance of Impact
			Collisions	Habitat Loss due to turbines	Disturbance to Feeding sites	Disturbance to Migration routes	Disturbance to Flight patterns	
Arctic tern	Medium	The highest densities of this species were recorded in deeper waters outside of the proposed wind farm area. The area impacted by operation is not expected to have significant effects on feeding or the quality or quantity of food found. Case studies have recorded Arctic terns both entering wind farms and manoeuvring to avoid the turbines. Flight heights for ranged between 3-12m though occasionally flights ranged between 15-20m therefore collision risk is very low.	Very Low	Negligible	Low	Low	Very Low	Very Low
Common tern	Medium	The highest densities of this species for the most part were recorded in deeper waters outside of the proposed wind farm area, while overall the species recorded a wide distribution within the site. Therefore the area impacted by construction is not expected to have significant effects on feeding or the quality or quantity of food found. Case studies have recorded foraging common terns changing their flight path used to return to their colonies and also flying between turbines. On this basis it is expected that the wind farm would have a low impact on flight pattern and migration routes. Flight heights for ranged between 3-12m though occasionally flights ranged between 15-20m therefore collision risk is considered to be very low.	Very Low	Negligible	Low	Low	Low	Very Low
Roseate tern	High	The low impact expected on feeding or the quantity of food found during this period of construction is based on the area of the site impacted by construction opposed to the total area of the sandbank available to feed. The recorded distribution and density of the species on the northern part of the bank in both deeper and shallower waters within the study area along with information from case studies which have shown little direct effect of the wind farm on the passage of roseate terns and a reduced sensitivity in breeding sea birds or rapid habituation during the breeding season would suggest a low impact in relation to disturbance to feeding sites. Flight heights ranged between 3-12m though occasionally flights ranged between 15-20m therefore collision risk is considered to be very low.	Very Low	Negligible	Low	Low	Low	Low
Guillemot	High	The low impact expected on feeding or the quantity of food found during operation is based on the area of the site impacted by turbines as opposed to the total area of the sandbank available to feed. The recorded widespread distribution within the study area and the density of the species on the southern part of the bank in both deeper and shallower waters within the study area along with information from case studies which have shown a reduced sensitivity in breeding sea birds or rapid habituation during the breeding season would suggest a low impact in relation to disturbance to feeding sites. The population of guillemots recorded are residents. Collision risk is very low as this species fly at <7m for the majority of time.	Very Low	Negligible	Low	N/A	Low	Low

Key Species	Baseline Sensitivity	Basis of Assessment	Magnitude of Impact					Significance of Impact
			Collisions	Habitat Loss due to turbines	Disturbance to Feeding sites	Disturbance to Migration routes	Disturbance to Flight patterns	
Razorbill	High	The low impact expected on feeding or the quantity of food found during operation is based on the area of the site impacted by turbines opposed to the total area of the sandbank available to feed. The recorded widespread distribution within the study area and the density of the species on the southern part of the bank in both deeper and shallower waters within the study area along with information from case studies which have shown a reduced sensitivity in breeding sea birds or rapid habituation during the breeding season would suggest a low impact in relation to disturbance to feeding sites. This population of razorbills recorded on the bank are residents. This species fly at <7m for the majority of time therefore collision risk is considered to be very low.	Very Low	Negligible	Low	N/A	Low	Low
Northern gannet	Medium	The dive heights of Gannets and the fact it is an active pursuant of fish and seabirds place it within the potential height for collision however case studies haven't recorded any collisions and the European Commission have stated that there is increasing evidence that collision risks are generally low in most European cases. The low impact expected on feeding or the quantity of food found during this period of construction is based on the area of the site impacted by construction opposed to the total area of the sandbank available to feed. The recorded widespread distribution within the study area and the density of the species outside of the proposed wind farm site in the deeper waters along with information from case studies which have shown a reduced sensitivity in breeding sea birds or rapid habituation during the breeding season would suggest a low impact in relation to disturbance to feeding sites. This population of gannets recorded on the bank are residents.	Low	Negligible	Low	N/A	Very Low	Very Low
Herring gull	High	An increase in gull species is predicted as a result of the increase in ship activity, based on previous surveys of wind farms and this is reflected by a 'Very Low' magnitude of impact during construction.	Low	Negligible	Negligible	N/A	Low	Low
Common gull	Medium	An increase in gull species is predicted as a result of the increase in ship activity, based on previous surveys of wind farms and this is reflected by a 'negligible' magnitude of impact during operation. This population of common gulls recorded on the bank are residents.	Negligible	Negligible	N/A	Negligible	Low	Negligible
Black-headed gull	High	An increase in gull species is predicted as a result of the increase in ship activity, based on previous surveys of wind farms and this is reflected by a 'negligible' magnitude of impact during operation. This population of black-headed gulls recorded on the bank are residents.	Negligible	Negligible	N/A	Negligible	Low	Negligible

Key Species	Baseline Sensitivity	Basis of Assessment	Magnitude of Impact					Significance of Impact
			Collisions	Habitat Loss due to turbines	Disturbance to Feeding sites	Disturbance to Migration routes	Disturbance to Flight patterns	
Black guillemot	Medium	The low impact expected on feeding or the quantity of food found during operation is based on the area of the site impacted by turbines as opposed to the total area of the sandbank available to feed. Information from case studies which have shown a reduced sensitivity in breeding sea birds or rapid habituation during the breeding season would suggest a low impact in relation to disturbance to feeding sites. The population of guillemots recorded are residents. Collision risk is very low as this species fly at <7m for the majority of time.	Very Low	Negligible	Low	N/A	Low	Low

Table 9.13 Significance of predicted impacts during operation based on information on the key species (Table 9.2 & Table 9.6) and the magnitude of the potential impact (Table 9.9) and case studies

9.5.5 Maintenance and Decommissioning

Routine maintenance vessel activity from the harbour to the wind farm are not thought likely to cause any significant ecological effects on birds in the vicinity, providing standard operating procedures for vessels are followed (Hiscock et al. 2002). Impacts resulting from any such activities required for the Dublin Array wind farm are therefore likely to be minimum and short term.

Decommissioning of a wind farm involves the removal of the foundations, towers, turbines, blades and associated cabling. These activities would be likely to cause similar or reduced impacts to those predicted for the construction phase.

9.6 Cumulative impacts

Currently there is one offshore (Arklow Bank) and one coastal wind farm (Carnsore point) in operation along the western Irish Sea. Carnsore Point studies have demonstrated that there are no significant impacts with a rotor ground clearance of 23 m on the Roseate tern population 3km from the wind farm. The Codling Bank has also been approved for the first phase of development. Both the Codling Bank and Arklow Bank extensions have predicted that there will be no significant impacts; the Arklow Bank is currently being assessed through ongoing monitoring. As detailed in correspondence in Volume 3, Appendix A, a request was submitted to the Department of the Environment, Heritage and Local Government, for copies of the monitoring reports we understand have been submitted to them in relation to monitoring completed to date. However, they advised that they did not have any reports on file. Consequently, we have been unable to access the monitoring reports from the Arklow Bank wind farm to assess if the monitoring has shown any differences and if there have in fact been significant differences. Other wind farms in operation within the southern and eastern section of the Irish Sea include North Hoyle and the Rhyle Flats off North Wales and the Burbo Bank off Liverpool. Each of these wind farms has predicted no significant impact in relation to birds.

Reviews of available literature suggest that the barrier effect has not been proven to significantly impact on the fitness of bird populations (Drewitt and Langston, 2006) and the known effects of each of the individual wind farms mentioned are low or negligible.

The Offshore Renewable Energy Development Plan (OREDP) stated that up to 1500 MW and 3300 MW respectively could potentially be developed without likely significant adverse effects on the environment in the areas where the Dublin Array is proposed (East Coast (North) and East Coast (South)). Also that only after the installation of 5 and 7 or more arrays respectively within each of these areas would significant adverse effects be caused.

However, cumulative effects also need to be considered on a species by species basis, depending on whether species are localised or widespread in the Irish Sea. Cumulative effects on broader ranging species such as Manx shearwater and guillemots may be more likely if there are many wind farms. However, the only way of monitoring individual projects and broader scale is surveying the whole of the Irish Sea.

9.6.1 Reduction of Carbon emissions

Every unit of electricity generated from the wind, whether on land or at sea, saves a unit generated from coal, oil or gas - depending on what type of power plant it replaces. Therefore each unit of electricity generated by wind energy saves emissions of greenhouses gases, pollutants and waste products. If Ireland is to meet its Kyoto Protocol commitments and to achieve the more ambitious EU targets of a reduction in Greenhouse Gas emissions of 20% by 2020, as well as a target of renewables to account for 16% of overall energy consumption by 2020 then an increase in the number and distribution of wind farms will be required. The Dublin Array alone will reduce carbon emissions by 1.3 million tons per annum.

9.7 Mitigation measures

9.7.1 Collision risk

Flashing lights are preferable to constant lights to reduce the likelihood of collisions by birds, particularly migratory species within the Dublin Array. The risk of birds colliding with wind turbines, either the tower and nacelle or the rotating blades can partially be mitigated against through increasing the height of the tower and the distance of the tip of the blades to the sea as the majority of seabirds fly <20m above sea level and the lowest point of the blades will be > 30 m. Fog horns are considered unnecessary, as it would not be possible to assess if they had any effect in the conditions in which they would be operational.

9.7.2 Habitat loss

All best practices will be employed to avoid pollution, particularly by oil and litter. Best practices during construction will be employed to minimise habitat loss, sediment disturbance and pollution.

9.7.3 Disturbance and displacement

Construction will be on a low number of turbines at any one time on a continuous basis with the exception of the northern 25% of the site from mid-August to mid-September to facilitate the Roseate tern visiting the Kish Bank for feeding following their breeding season.

The use of fast boats and helicopters will be kept to a minimum to reduce disturbance on birds. Except in emergencies such use will also be kept to set routes, especially outside the wind farm area.

Given these mitigation measures, it is predicted that there would be no significant effects on roseate terns from construction of the project.

9.8 Residual impacts

With the implementation of the recommended mitigation measures, the residual impacts would be expected to remain the same as the likely/predicted imacts presented in Tables 9.11 and 9.13 of this Chapter for the Construction and Operational Phases of the project.

9.9 Monitoring

The monitoring programme is proposed from one year prior to and through construction and for a three year period afterwards. This programme includes provision for regular review as our knowledge of the wind farm area and its effects improve. The aim of the programme is to detect any significant changes in the patterns of bird usage of the wind farm area that are caused by the wind farm and to distinguish these from other factors such as natural variability.

Having considered the various assessments and guidelines of the possible effects of offshore wind farms it is considered that the best way of assessing any effects on birds is to maintain a regular programme of boat surveys. Therefore monitoring would include a regular programme of monthly boat surveys of the study and wind farm areas, through the construction and during and post construction for a period of three years. Bi-monthly surveys will be carried out during the critical tern periods in May, August and September. The boat surveys will allow the on-going bird usage of the study to be assessed. Applying the same methodology as was applied for the previous baseline surveys will ensure comparability of results.

This programme will also contribute to measuring any cumulative impacts that may arise should other wind farms be developed in the area. During the monitoring period, if patterns of bird usage in the wind farm area and the rest of the study area are similar, or vary in a similar manner, this can be taken as strong but not conclusive evidence of a lack of significant effects. If monitoring shows differences between the wind farm and the rest of the study area, then more detailed observations of the behaviour of the individual species showing differences will be required to understand what is happening. It should be noted, however, that initial observations of differences will only indicate there is an effect but not what is causing it.

10 MARINE MAMMALS AND TURTLES

10.1 Introduction

The proposed Dublin Array offshore wind farm development on the Kish and Bray banks will involve the installation of up to 145 wind turbines and associated infrastructure including an offshore substation and inter-turbine array cables as well as the export cable from the offshore substation to shore. This chapter of the EIS addresses the potential impacts of the proposed development on the species of marine mammals and turtles which are known to use the waters on and around the banks. Potential impacts of the proposed development during construction, operation and decommissioning are discussed and mitigation measures proposed by the Developers are addressed.

This Chapter of the EIS has been prepared by Ecological Consultancy Services Ltd. (EcoServe) and subsequently updated and edited by MRG Consulting Engineers to include additional data regarding the impacts of marine noise on marine mammals.

In order to establish initial baseline conditions for marine mammals in the area of the proposed development, the Developers commissioned Ecology Consulting Ltd to record sightings of marine mammals from the boat and aerial surveys undertaken by them in 2001/2002 as part of the original baseline seabird surveys for the project. Further dedicated marine mammals surveys were conducted by Ecological Consultancy Services Ltd.(EcoServe) between June 2010 and June 2011 in order to establish more comprehensive and up-to-date data on marine mammals and turtles in the area. These surveys form the basis of the impact assessment included in this chapter of the Environmental Impact Statement.

10.2 Description of existing environment

10.2.1 Conservation

An overview of the main statutory obligations, instruments and legislation applying to the conservation and protection of the marine environment including marine mammals and turtles in the context of the proposed Dublin Array Offshore Wind Farm development on the Kish and Bray banks are presented below:

10.2.1.1 Conservation designations

A number of conservation designations exist in Ireland that are relevant to providing protection for marine mammals and turtles. A summary of these designations are presented here.

Special Areas of Conservation (SACs) are designated under the European Union's Habitats Directive (92/43/EEC), which was transposed into Irish law by the European Communities (Natural Habitats) Regulations 1997 (S.I. 94/1997) as amended. SACs are designated for the protection of habitats, plants or animals listed under Annex I and II of the Directive. A total of approximately 13,500 km^2 has been designated as SAC in Ireland and its surrounding waters.

Natural Heritage Areas (NHAs) are designated under the Wildlife Acts 1976 to 2010 for the protection of Ireland's natural heritage, including habitats, species or geological features. To date, 148 NHAs have been designated throughout Ireland, though these are limited to areas supporting two habitat types: Raised Bog and Blanket Bog. In addition to the 148 designated NHAs, there are 630 non-statutorily proposed NHAs (pNHAs), which have no statutory protection and will not have any until they are statutorily proposed.

All Irish waters were declared a **Whale and Dolphin Sanctuary** by the Irish government in 1991. The protection this sanctuary provides is enforced through the existing legislation and protects all cetaceans in Ireland's 200-mile exclusive economic zone.

In addition to the protection afforded to marine mammals by the designation of protected areas, for example SACs for species listed under Annex II of the Habitats Directive, marine mammals and turtles are protected throughout Ireland and its waters by a number of pieces of legislation.

The Wildlife Acts 1976 to 2010 and the European Union's Habitats Directive are the principal pieces of legislation that protect marine mammals and turtles in Irish waters. All cetacean and seal species are listed under the 4th Schedule of the Wildlife Act as being protected species. Marine turtles were afforded protection under the Wildlife Act by the Wildlife Act 1976 (Protection of Wild Animals) Regulations 1990. All cetacean and turtle species are listed under Annex IV of the Habitats Directive as a species requiring strict protection. In addition, the harbour porpoise, bottlenose dolphin, grey seal, harbour seal, loggerhead turtle and green turtle are listed under Annex II of the Directive as species of community interest whose conservation requires the designation of Special Areas of Conservation (SACs).

Cetaceans are also protected in Irish waters by the Whale Fisheries Act 1937 and the Whale Fisheries Act, 1937 (Extension to Mammals of the order Cetacea) Order, 1982.

The **Irish Red Data Book** is a comprehensive review of rare and threatened mammals, birds, amphibians and fish in Ireland. It is a summary of the currently available information about those vertebrates in Ireland that have been listed as rare or threatened to some degree or have become extinct in the past 300 years. It describes the process employed in selecting the species, presents an account of the status of each species and considers the conservation issues which the Red Data Book Selection raises. Its main purpose is to provide basic information about these animals for all those engaged in wildlife conservation (Whilde, 1993). The NPWS has recently published up-to-date Red Lists for a number of groups, including reptiles (turtles), but not for marine mammals.

10.2.1.2 Conservation Requirements in Designated Areas

Consideration of the potential impacts of this project has been undertaken in the context of the EU Habitats Directive. An Appropriate Assessment (AA) was carried out under the EC Habitats Directive (92/43/EEC) for this project in order to assess whether the development is likely to have significant effect on any internationally important sites for nature conservation (see Article 6.3 and 6.4 below). These internationally important sites include Special Protection Areas (SPAs) and Special Areas of Conservation (SACs). By doing this from the outset, the manner in which nature conservation issues are dealt with will be compatible with whatever designations may apply in the future. For offshore developments that require a foreshore licence, the Habitats Directive is implemented by Section 31 of the Natural Habitats Regulation (94/97).

Article 6(3) of the Habitats Directive establishes the need for appropriate assessment;

> *"Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the 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."*

Article 6(4) discusses alternative solutions, overriding public interest and compensatory measures;

> *"If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted."*

In certain cases, mitigation measures and avoidance measures cannot remove an adverse effect on the SPA or SAC. In accordance with the precautionary principle where it is uncertain whether adverse effects will occur, the following steps must be taken;

- Consider alternative solutions that do not have an adverse impact; and
- Declare Imperative Reasons of Overriding Public Interest (IROPI Test); and
- Develop and agree compensation measures.

If it can be demonstrated in an auditable fashion that there are no feasible alternative solutions, the competent authority will consider whether there are imperative reasons of overriding public interest that require the plan to proceed. If it is decided that a plan must go ahead for imperative reasons of overriding public interest, compensation for its effects must be identified and agreed. The compensation measures could include recreation or restoration of comparable habitat at a new or existing site, and may occur in another country if necessary.

The IROPI Test is for reasons of a social or economic nature however, where the European site concerned "hosts a priority natural habitat type and/ or a priority species the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission to other imperative reasons of overriding public interest" (Article 6 paragraph 4).

10.2.1.3 Conservation designations for marine mammals and turtles within study area

The Kish and Bray banks are not subject to any conservation designations for the protection of marine mammals or turtles, or any other habitat or species (e.g. SAC or NHA). A number of marine mammal species have been recorded within the study area in the course of the current study, including harbour porpoise, bottlenose dolphin (Annex II & IV), grey seal and harbour seal (Annex II) and Risso's dolphin (Annex IV). No turtles were recorded in the course of the current study.

10.2.1.4 Conservation designations for marine mammals and turtles in the surrounding area

To date, the Lower Shannon Estuary SAC is the only area designated for the conservation of bottlenose dolphins in Ireland, while Roaringwater Bay and Islands SAC and the Blasket Islands SAC have been designated for harbour porpoises. There are currently no SACs designated for cetaceans on the Irish side of the Irish Sea, though it is expected that areas will be designated for harbour porpoises by the National Parks and Wildlife Service (NPWS) in the future.

There are no SACs designated for harbour seals on the Irish east coast, though the species does occur on some of the islands off Dublin. Grey seals are listed as a qualifying feature for Lambay Island SAC and occur on other islands off Dublin.

No SACs have been designated for turtles in Irish waters.

10.2.2 Marine Mammals and Turtles in Irish waters

Marine mammals in Irish waters comprise cetaceans (i.e. whales, dolphins and porpoises), pinnipeds (true seals, eared seals and walrus) and otter. Otters (*Lutra lutra*) are predominately freshwater species, and, while they do occur in the marine environment, do no move far from the coast and are therefore not considered further in this chapter.

The order Cetacea is divided into two sub-orders: the mysticetes and the odontocetes. Mysticetes, also known as baleen whales, are generally large oceanic whales. This order includes the humpback whale (*Megaptera novaengliae)* and the Minke whale (*Balaenoptera acutorostrata*). The odontocetes, also known as toothed whales, are generally much smaller than the mysticetes. This is the sub-order to which the dolphin and porpoise belong. Odontocete cetaceans tend to be more common in shallow coastal waters.

There are four species of cetacean that occur regularly in the Irish Sea. These are harbour porpoise (*Phoecena phocoena*), bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis*) and Risso's dolphin (*Grampus griseus*). Fifteen species of cetaceans were recorded between 1975 and 1998 in waters of the Irish Sea within 60 km of the coast (Evans, 1998). The most common odontocetes were the harbour porpoise, bottlenose dolphin, common dolphin and Risso's dolphin, while the most commonly recorded mysticete was the Minke whale. More recent records from the Irish Whale and Dolphin Group indicate ten species of cetacean recorded in the Irish Sea in the period 1986-2011, with the same species being most commonly recorded (IWDG, 2011). Of the pinnipeds, the grey seal (*Halichoerus grypus*) and the common or harbour seal (*Phoca vitulina*) occur regularly in the Irish Sea.

When compared to other seas around Ireland and Britain, the Irish Sea does not contain a large population of marine mammals. The Small Cetacean Abundance in the North Sea and Adjacent Waters (SCANS) project, which was an international investigation conducted in 1994 by the Sea Mammal Research Unit (SMRU) in the University of St. Andrew's, Scotland to investigate cetacean abundance in the North Sea and in waters around the UK, did not include the Irish Sea in its survey since it considered that cetacean numbers were low. The population estimate for harbour porpoise in the SCANS area was 341,366 (CV=0.14; 95% CI = 260,000 – 449,000) (Hammond *et al*., 2002). The availability of data on cetacean populations in the Irish Sea has improved in recent years, with a number of reports becoming available (e.g. Brerton *et al*., 2001, Wall & Murray, 2010). In particular, the Small Cetaceans in the European Atlantic and the North Sea (SCANS II) project was completed in 2005. SCANS II included the Irish Sea as a discrete sampling block and carried out an aerial survey so as to assess small cetacean abundance and density. This survey put the Irish Sea harbour porpoise population, by far the most common marine mammal in the Irish Sea, at 15,230 (CV=0.35) (SCANS II, 2006).

A total of five turtle species have been recorded in Irish waters (Table 10.1), of which the leatherback turtle is the most commonly occurring. The other species only occur in very small numbers on rare occasions (Penrose & Gander, 2011). Only the leatherback turtle is regularly recorded in the Irish Sea, with very few records of the loggerhead and Kemp Ridley's turtle. No records of the green turtle and the hawksbill occurring in the Irish Sea were found (NBN, 2011).

Common name	Scientific name
Leatherback turtle	*Dermochelys coriacea*
Loggerhead turtle	*Caretta caretta*
Kemp Ridley's turtle	*Lepidochelys kempii*
Green Turtle	*Chelonia mydas*
Hawksbill turtle	*Eretmochelys imbricata*

Table 10.1 Turtle species recorded in Irish waters

10.2.3 Field surveys

10.2.3.1 Survey Methodology, 2001-2002 Marine Mammal Baseline Survey

Ecology Consulting Ltd was contracted to carry out a marine mammal survey in the period 2001-2002 in tandem with the seabird surveys. Marine mammal sightings were recorded from boat transect surveys (which covered an area of 159 km²), boat fixed point surveys (from 10 locations), and aerial surveys (which covered an area of 1,226 km²). The survey used the same methodology that was used for the birds survey, which was based on distance sampling protocols.

The boat transect survey area included the location of all potential wind turbines (i.e. the Kish and Bray banks themselves) and the entire area up to 4 km from the banks. A 2 km interval between transects was used, covering a total boat survey transect length of 98 km. A total of 14 boat transects were undertaken between September 2001 and September 2002. The fixed-point surveys were performed at 10 points along the banks. These observation points were distributed evenly from the north of the Kish Bank to the south of the Bray Bank. A total of seven boat fixed point surveys were undertaken between September 2001 and May 2002, each lasting for a 30 minute interval. The study area for the aerial survey was chosen to include all of the boat survey area, as well as the area that extended approximately 16 km north, 22 km south and 8 km east and west of this area.

Marine mammal sightings were made during the aerial survey on 15th March 2002 and 9th April 2002. The number of species occurring within the main study area (up to 4 km from the banks) and in the wider survey area as a whole was noted. Generally, the observed numbers of marine mammal species were low, with no important concentrations noted during the aerial survey. The marine mammal populations were determined using data that was adjusted to take coverage and distance from transect into account.

10.2.3.2 Survey Methodology, 2010-2011 Marine mammal and turtle baseline survey

EcoServe carried out additional surveys in the period 2010-2011 to provide more up-to-date data on the marine mammal and turtle distribution in the development area through dedicated surveys. These were boat-based transect surveys, with the Irish Whale and Dolphin Group (IWDG) providing concurrent passive acoustic monitoring.

Where weather permitted, monthly boat-based transect surveys were carried out from June 2010 to June 2011. This resulted in eight surveys being carried out (June-September 2010, January-March and June 2011). Ten 3.3 km transects running east-west across the study area of the banks, with a 2 km spacing were surveyed, giving a total transect length within the study area of 33 km. Four 3.3 km long control transects to the north, south, east and west of the Kish and Bray banks were also surveyed. One observer was stationed on each side of the survey vessel and details of any marine mammal or turtle activity observed was recorded on prepared forms. Casual sightings made while off-transect were also recorded.

In order to provide additional information on cetacean activity within the study area, and to help assess the effectiveness of the visual survey, a passive acoustic hydrophone was deployed from the vessel by IWDG personnel during the visual survey. Acoustic detections (clicks, whistles, etc) were monitored by an on-board operator, and recordings made to allow for future analysis. The hydraphone was attached to a 200 meter long towing device with two high frequency hydraphone elements (HP-03) situated 250 mm apart in a fluid-filled tube towards the end of the array. The hydrophone was connected to a MAGREC HP-27 buffer box, which was connected to a National Instrument DAQ-6255 USB soundcard, and in turn run through a laptop computer. The National Instruments sound card allowed for the detection of high frequency harbour porpoise clicks, which are outside the capability of the computer’s soundcard. PAMGUARD software was used during the survey and also IFAW´s LOGGER and Rainbow Click. The track line of the acoustic survey effort was recorded using an external GPS receiver, which provides NMEA data to the set-up through the LOGGER application which is linked to PAMGUARD.

The passive acoustic survey was discontinued after the September 2010 survey, as it was found the visual survey was providing higher marine mammal detections in all cases and so the acoustic survey was deemed unnecessary.

10.2.4 Marine Mammals and Turtles Recorded in the Receiving Environment

The most common marine mammal recorded during the 2001-2002 survey was the harbour porpoise, with 57 noted in the March survey and 49 noted in the April survey. In both surveys 2 harbour porpoises were noted within the main study area. 17 dolphins were noted in March, with 4 located within the main study area, while 24 were noted in April, with 7 located within the main study area. The next most common sightings were of seal species.

A total of 57 sightings of marine mammals were recorded during the five months surveyed in 2010-2011, comprising 82 individuals. Of these, 39 sightings, comprising 57 individuals, were made while on transect (Figure 1); the remainder being casual observations in between transects (Figure 2). Only those sightings made while on transect were included in the following data analysis.

No turtles were recorded in the course of the survey.

The marine mammal most commonly recorded during the 2010-2011 survey was the harbour porpoise. A total of 32 sightings were made in the eight months surveyed, comprising 46 individuals (max. 3, min. 1). The highest number of sightings was nine 9 recorded in February, while the lowest was in August and March (0) (Figure 3). The highest number of individuals recorded was 13 in February (Figure 4). While sea conditions were not ideal for visual survey in August, no detections were made on the hydrophone, suggesting that porpoises were not present in the area or were present only in low numbers and not vocalising.

The relative abundance of harbour porpoise (porpoises per km) was found to be highest on T10; the southernmost transect (0.42 porpoises per km). However, on average the relative abundance across the ten study area transects was 0.13 porpoises per km, while on the four control transects it was 0.12 porpoises per km.

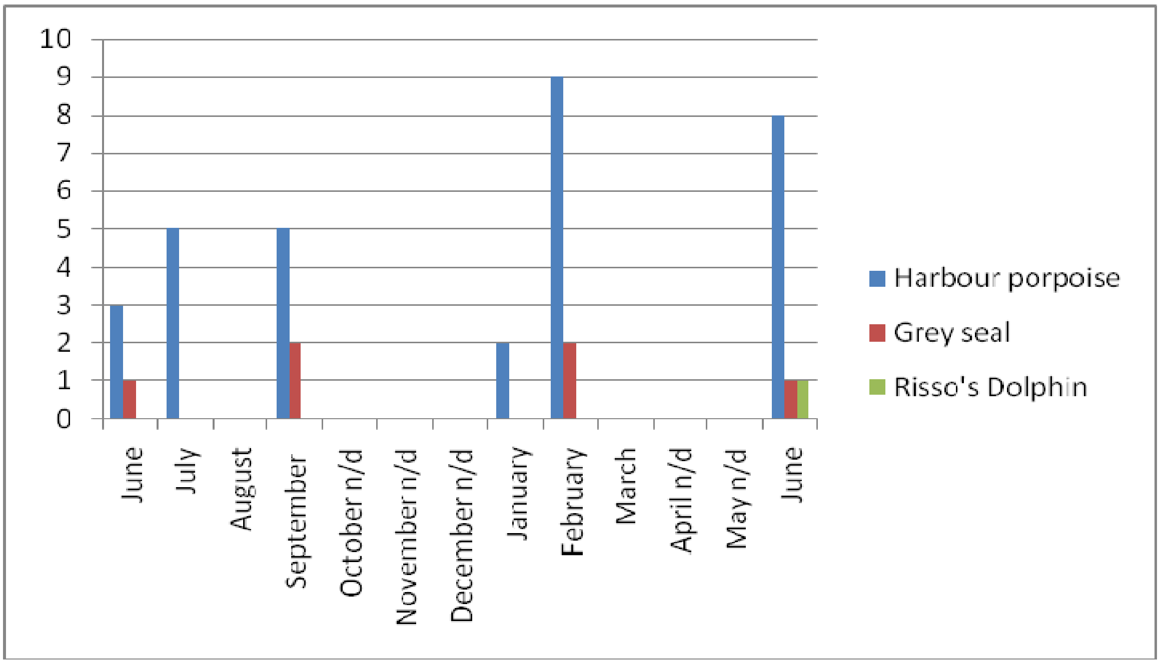


Figure 10.1 Number of sightings recorded per monthly survey 2010-2011

(n/d = no data)

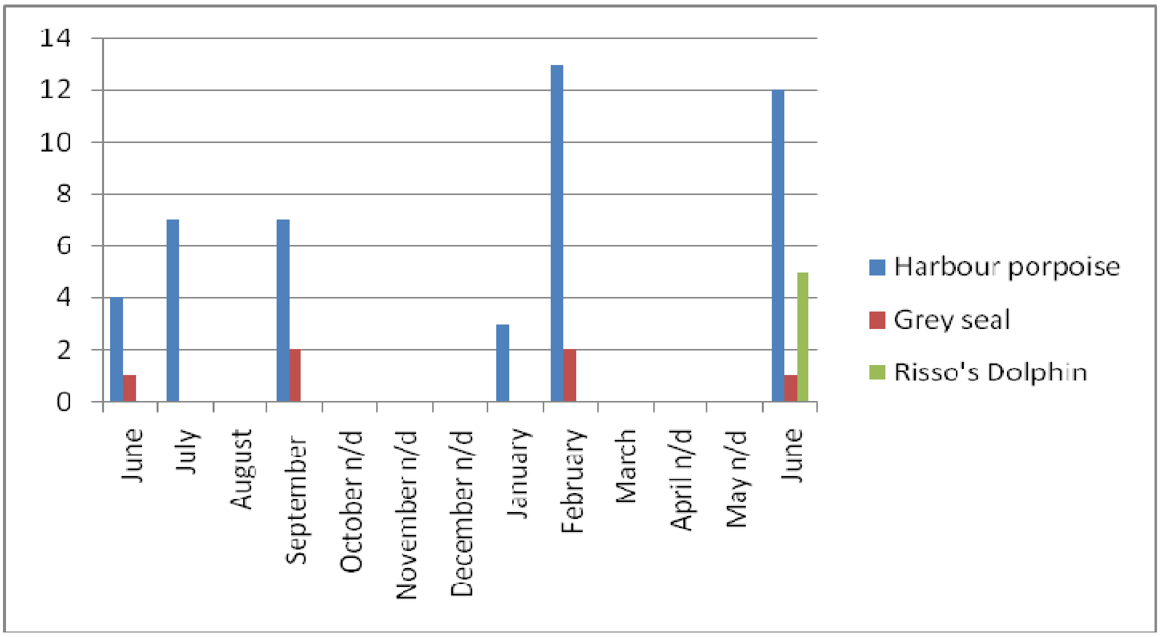


Figure 10.2 Number of individuals recorded per monthly survey 2010-2011

(n/d= no data)

Grey seals were observed on 4 occasions during the survey period with a total of six animals recorded. A single animal was recorded in June 2010, two animals in September and February and one animal in June 2011. The June 2010 and September sightings occurred on the western Control (CW), while the June 2011 sighting occurred on the southern control (CS). The two February sightings took place in the middle of the study area, Transects 7 and 8.

Other species of marine mammal observed in the course of the survey included a minke whale (off transect T1 – CN)) and a pod of 5 Risso's dolphins recorded in June

2011 on Transect 9. In addition, a group of 3 unidentified dolphins was recorded in September 2010 while on transit between transects. While the sighting was too brief to allow a confirmed identification at the time, it is suspected that they were bottlenose dolphins, as a group of 3 bottlenose dolphins had been frequently sighted along the coast of Wicklow and Dublin during the second half of 2010 into 2011 (IWDG, 2011).

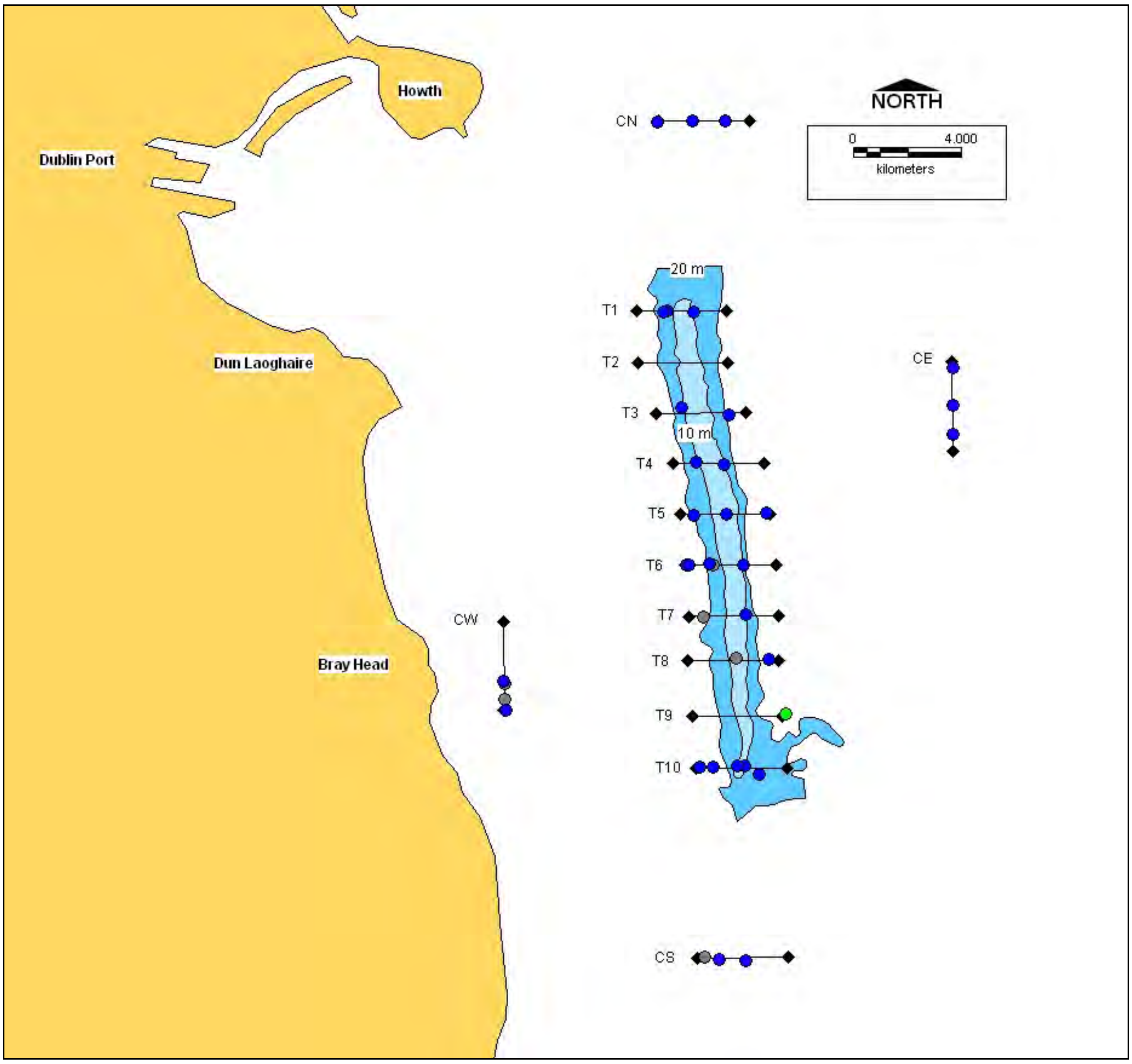


Figure 10.3 Distribution of 'on transect' sightings during 2010-2011 boat-based marine mammal surveys

(• = harbour porpoise, • = grey seal, • = Risso's dolphin.)

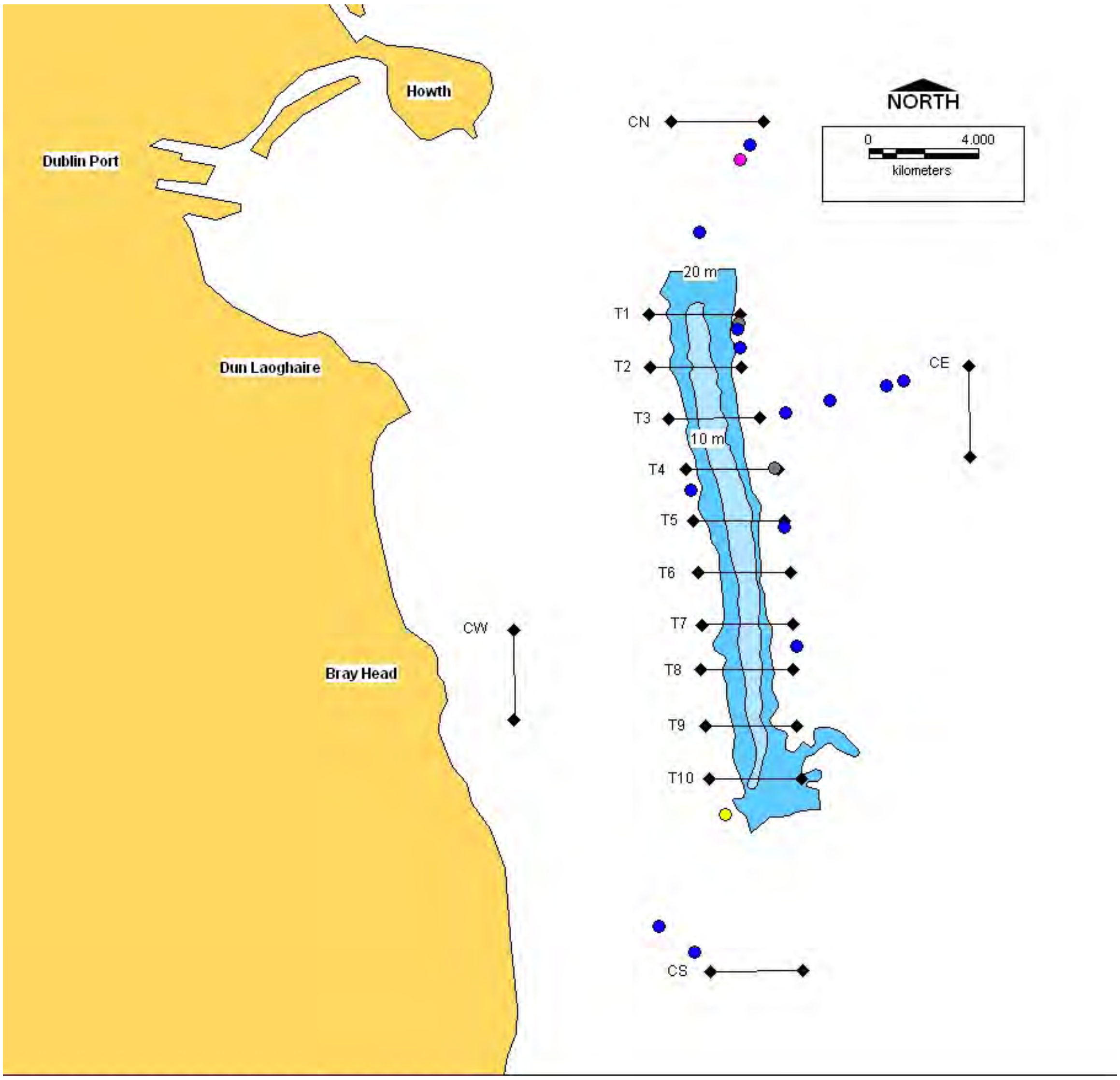


Figure 10.4 Distribution of 'off transect' sightings during 2010-2011 boat-based marine mammal surveys

(● = harbour porpoise, ● = grey seal, ● = unidentified dolphin, ● = minke whale)

10.2.5 Review of Key Marine Mammal and Turtle Species in Receiving Environment

The following presents a review of the importance of the receiving environment on the Kish and Bray banks to key marine mammal and turtle species on the basis of the baseline surveys and other available survey data.

10.2.5.1 Harbour Porpoise

The harbour porpoise is by far the most common cetacean species in the Irish Sea, where they are thought to be present all year round. While harbour porpoises are mainly considered an inshore species (they have a preference for shallow water), they can also occur in deep Atlantic waters.

The harbour porpoise was the most common cetacean species recorded in both surveys performed for this development. The harbour porpoise was also by far the most common cetacean recorded in similar surveys that were performed for the Codling Bank wind farm project (Coveney Wildlife Consulting, 2002) and the Arklow

Bank wind farm project (Coveney & Phalan, 2001), where sightings of porpoises numbered 84 (in 11 out of 12 visits) and 89 (in 16 out of 18 visits) respectively. Ferry surveys carried out by the IWDG on the Dublin-Holyhead route also lists the harbour porpoise as the most commonly sighted species (Wall & Murray, 2010).

The SCANS and SCANS II projects provided good data on the harbour porpoise population in Irish waters. The Irish Sea harbour porpoise population was calculated to be 15,230 (CV=0.35) in 2005, while the Celtic Sea population was calculated as 36,280 (CV=0.57) in 1994 and 80,616 (CV=0.50) in 2005 (the Celtic Sea survey area boundary varied somewhat between surveys) (Hammond *et al*., 2002, SCANS II, 2006). The harbour porpoise population in Irish coastal waters outside the Irish Sea was calculated to be 10,716 (CV=0.37; CI 95%=5,010 - 21,942) in 2005 (SCANS II, 2006).

There are no defined calving sites for harbour porpoises in the Irish Sea. However, it has been noted (Coveney Wildlife Consulting, 2002) that mother-calf pairs are frequently seen in the Solway Firth (NE Irish Sea) suggesting the Solway is used for calving. Of harbour porpoise sightings around Skerries on the north Dublin coast by the Irish Wildlife Trust, 15% were mother-calf pairs suggesting that this area is also used for calving. Considering all waters around Ireland and the UK, the most important harbour porpoise populations are found off southwest Ireland and the Celtic Sea and the central North Sea which supports an estimated 268,000 individuals (Hammond *et al*., 2002). The results of the 2010-11 marine mammal survey suggests that harbour porpoises are no more common in the area of the Kish and Bray banks than in the surrounding area and therefore the banks are not of particular importance for the harbour porpoise in the Irish Sea.

10.2.5.2 Other Cetaceans

Other cetacean species that are known to regularly occur in the Irish Sea are the bottlenose dolphin, common dolphin, minke whale and Risso’s dolphin. The bottlenose dolphin is believed to have a regular distribution in the Irish Sea and is recorded as far north as the Isle of Man, however, the highest concentrations were recorded in the southern Irish Sea, (Evans, 1998). The SCANS II survey estimated the bottlenose dolphin population in the Irish Sea to be 235 (CV=0.75; CI 95%=61- 902), though sightings were limited to the eastern Irish Sea. Sightings of bottlenose dolphins along the east coast of Ireland have increased in recent years (IWDG, 2010), though it cannot yet be said that they have become resident. A long-established resident population is found in the Shannon Estuary, with a semi-resident group in Cork Harbour (Wall & Murray, 2010).

Common dolphins have been noted regularly in the southern Irish Sea, though their Irish Sea population (366; CV=0.73; CI 95%=98 – 1,368. SCANS II, 2006) is of low significance compared to numbers in the Celtic Sea, where their population has been estimated at 75,450 (CV = 0·67; 95% CI = 23 000–149 000) (Hammond *et al.*, 2002).

The Risso’s dolphin is believed to have a regular population in the Irish Sea, being most highly concentrated between Anglesey and the Isle of Man and in the southern entrance to the Irish Sea (Evans, 1998, Wall & Murray, 2010). Nineteen Risso’s dolphin were sighted during an Irish Sea survey conducted in 2000/2001 (Coveney & Phalan, 2001) and 11 were sighted during a separate survey (Coveney Wildlife Consulting, 2002) in the same period. A pod of five Risso’s dolphins was recorded in the course of the current survey at the southern end of the study area in June 2011. They feed mainly on squid and groups may be faithful to particular areas.

Minke whales have been recorded from the Irish Sea and the population has been estimated to be 1,073 (CV=0.89; CI 95%=237-4,862) (SCANS II, 2006). The sightings that contributed to this estimate were concentrated along the Irish Sea Front and the Celtic Sea Front. One Minke whale was recorded in the course of the current survey, while in transit between Transect 1 the Northern Control during the June 2011 survey.

Northern bottlenose whale, white-beaked dolphin, white-sided dolphin, long-finned pilot whale and killer whales are occasionally recorded in the Irish Sea in very small numbers (Baines, 1997, Hayden & Harrington, 2000, Northridge, 1990, Pollock *et al.*, 1997). The numbers of all of these cetacean species in the Irish Sea is understood to be of minor significance when compared to other waters around Ireland and the UK, such as the Celtic Sea. There is no suggestion that the area of the Kish and Bray banks are of any particular importance to any of the other cetaceans that have been recorded in the Irish Sea.

10.2.5.3 Pinnipeds (seals)

2 species of seal occur along the coasts of the Irish Sea; the grey seal and the common or harbour seal. Seals were observed in both aerial surveys that were undertaken by Ecology Consulting in 2002. 14 seals were noted in March, with 4 located within the main study area while 11 were noted in April, with none located within the main study area. The boat-based surveys carried out by EcoServe in 2010-11 recorded grey seals on three occasions, one within the study area (September), and twice on the western control transect (June & September).

The numbers of each of these species found in the Irish Sea is low. The Irish Sea grey seal population is between 5,000 and 7,000 animals, of which at least 90% is in Wales (Kiely *et al*., 2000). In comparison, the coastline and islands of northeastern Scotland and eastern England support a population of over 110,000 animals.

The most important sites in eastern Ireland for grey seals are the islands of north Dublin, in particular Lambay Island with 53 (±4 S.E.) grey seals (Kiely *et al.*, 2000). Outside of north Dublin, areas in Wexford (The Saltees, Raven Point, Blackrock and Carnsore Point) support the greatest numbers of grey seals along the east coast with approximately 192 animals (Kiely *et al*., 2000).

The Irish population of harbour seals has been estimated to be at least 2,905 and the bulk of these are found along the northwest, west and southwest coasts (Cronin *et al*., 2004). The most significant concentration of common seals along the east coast of Ireland is at Strangford Lough in Co. Down (Baines, 1997). Small numbers have been recorded in Dublin area, concentrated mainly on the north Dublin islands and coast, with Dalkey Island on the south side of Dublin Bay also acting as a haul-out site for small numbers of harbour seals (Cronin *et al*., 2004).

Both seal species are protected under the Wildlife Acts 1976 to 2010 and are listed on Annex II of the EU Habitats Directive. In the Irish Sea, Lambay Island has been designated an SAC for grey seals. The next closest designated site is the Saltee Islands SAC, while the remaining sites are on the southwest, west and northwest coasts.

It is clear that the number of seals that occur along the east coast of Ireland is small when compared to the numbers along other stretches of the Irish coast. Those that do occur close to the study area are in the north Dublin area. There is no indication that the Kish and Bray banks are of particular importance for foraging seals.

10.2.5.4 Turtles

As stated in section 10.2.4, five species of marine turtle have been recorded in Irish waters. The leatherback turtle is the only species to occur in the Irish Sea with any regularity, and therefore is the only species to be considered here in more detail.
The leatherback turtle is the largest of the marine turtles, with the largest recorded specimen a 3 m individual washed up on the coast of Wales in 1988 (BBC, 2011). It feeds predominantly on jellyfish and other soft-bodies planktonic species.

The leatherback turtle population in the Atlantic Ocean breeds around the Caribbean and the west coast of Africa (Dutton, *et al.,* 1999, Witt, *et al.,* 2011), but forages widely throughout the Atlantic, including around the coast of Ireland. Global estimates puts the population of the leatherback turtle at 34,529 breeding females (Confidence Limits 26,177 – 42,878), with the Atlantic population 27,608 (C.L. 20,082 – 35,133) (Spotila *et al*., 1996).

No leatherback turtles were recorded in the course of the survey of the study area. The most recent record for a sighting of a leatherback turtle in the vicinity of the Kish and Bray banks is 2005 (NBN, 2011).

10.3 Potential Impacts of wind farms on marine mammals and turtles

The potential impacts of the proposed development on marine mammals and turtles are assessed in terms of short-term and long-term impacts. In the case of the construction and operation of a wind farm, the short-term impacts are largely temporary impacts that arise during construction, while long-term impacts are those permanent impacts that would be experienced during the operation of the wind farm. The cumulative impacts of offshore wind farms are also discussed.

10.3.1 Construction Phase Impacts

The use of heavy jack-up barges, piling equipment, cranes, trenching and cable laying vessels, and the deposition of rock armour during the construction stage of the project are likely to generate noise and vibrations and disturbance to seabed sediments in the vicinity of the site. Potential impacts on marine mammal and turtle species associated with these operations during the construction stage of the project include:

10.3.1.1 Noise and Vibration

Noise and vibrations from shipping vessels and equipment and from operations such as pile driving during the construction phase of the development may disturb marine mammals, fish and benthic organisms around the site. Pile driving in particular can generate very high sound pressure levels and given the likely use of monopile foundations to support the turbines for the Dublin Array it is anticipated that the underwater noise generated by the installation of the piles during the construction stage of the project is likely to have the greatest potential effect on marine wildlife.

Detailed research into the effects of offshore wind farm noise on marine mammals and fish was undertaken on behalf of COWRIE Ltd (Collaborative Offshore Wind Research into the Environment) the results of which are presented in the following report:

- biola, Hamburg, Germany - Effects of offshore wind farm noise on marine mammals and fish (Thomsen, F., Ludemann, K., Kafemann, R., Piper, W.), (2006).

A detailed joint study investigating underwater effects from pile driving operations and reviewing marine mammal and fish mitigation and monitoring measures for the proposed London Array, Greater Gabbard and Thanet Round 2 offshore wind farm projects in the Thames Estuary in the UK was completed by RPS Energy and Subacoustech Ltd for CORE Limited on behalf of the Developers of those projects. The results of the study are presented in the following reports:

- RPS Energy - Underwater Noise Impact Assessment on Marine Mammals and Fish during Pile Driving of Proposed Round 2 Offshore Wind Farms in the Thames Estuary for CORE Limited on behalf of London Array Limited, Greater Gabbard Offshore Winds Limited and Thanet Offshore Wind Limited – Report No. EOR0523 Final Version 5.1, Authors: Dr Barry Shepherd, Caroline Weir, Dr Chris Golighty, Dr Terry Holt, Nathan Gricks, Approved: Chris Jenner, Date: 24/07/2006.

- Subacoustech – Underwater noise impact modeling in support of the London Array, Greater Gabbard and Thanet offshore wind farm developments – S J Parvin, J R Nedwell and R Workman, 29th June 2006, Subacoustech Report No. 710R0517.

Given the likely use of similar monopile foundations to support the turbines on the Dublin Array as those proposed for the wind farm developments in the Thames estuary, the above documents form the basis of the assessment of the potential impact of noise from the construction and operational phases of the proposed Dublin Array Offshore Wind Farm on marine mammals and turtles included in this Chapter of the Environmental Impact Statement.

Since water is a relatively dense, incompressible medium compared to air, the pressures associated with underwater sounds tend to be much higher. Sound also travels much faster in water (c. 1500 m/s) than in air (340 m/s). The Subacoustech report refers to research by Nedwell *et al* (2003) identifying common background levels in the order of 130 dB re. 1 μPa for coastal waters and notes that such a level equates to about 100 dB re. 20 μPa in the units that would be used in air. It further notes that while such high noise levels in air would be considered to be hazardous to human beings and terrestrial animals, marine animals have evolved to live in this environment and are thus comparatively insensitive to sound compared with terrestrial mammals.

The steel mono-pile supports onto which each wind turbine will be secured is typically 40 to 50 m in length, and for the Dublin Array Offshore Wind Farm development, may vary in diameter from 4.0 to 6.5 m depending on the wind turbine selected, water depth, detailed geotechnical investigations and final design. The impact piling operation to secure the pile into the seabed involves the use of a large pile hammer mounted on a 'jack-up' barge. A typical impact piling operation to secure a single pile may take from 3 to 5 hours, and involve 3000 to 4000 individual blows, each with an impact energy of some 300 to 500 kJ.

During the piling operations noise is generated both in air, and in the water, as a result of the impact of the pile hammer with the steel pile. Some of this airborne noise is transmitted into the water, but of more significance is the noise radiated into the surrounding water medium as a consequence of the compressional, flexural and other complex structural waves that travel down the pile. As the density of steel is similar to that of the surrounding water, sound waves in the submerged section of the pile couple efficiently into the surrounding water. These waterborne waves will radiate outwards usually providing the greatest contribution to underwater noise.

The report prepared by Subacoustech Ltd for the Thames Estuary projects identified the following potentially harmful physical and behavioural effects of high-level underwater noise, such as that which might be generated by impacts from the pile driving, on species of fish and marine mammals:

Lethal Effect: At very close range from the source the peak pressure levels have the potential to cause death, or severe injury leading to death, in human divers, marine mammals and fish.

Physical Injury: At greater range from the source, the construction noise may cause physical injury to organs surrounding gas containing structures of the body.

Hearing Impairment: At high enough sound levels and particularly where there are repeated high level exposures from activities such as impact piling the underwater sound has the potential to cause hearing impairment in marine species. This can take the form of a temporary loss in hearing sensitivity, known as Temporary Threshold Shift (TTS), or a permanent loss of hearing sensitivity known as Permanent Threshold Shift (PTS). For transient noise such as piling this may occur where species are exposed to a number of repeated pile strikes. The potential for injury is related to the level of underwater sound, and the duration, duty cycle and hearing bandwidth of the species.

Behavioural Response: At greater range the underwater sound wave may not directly injure species, but has the potential to cause behavioural disturbance. Subacoustech have developed a weighted metric system, dBht (species) to quantify the risk of this behavioural effect on different marine mammals and fish species. It gives a species-specific noise level referenced to a species hearing ability, and therefore a measure of the potential of the noise level to cause an effect on that species. The measure that is obtained represents the loudness of the sound for that species. This is very important because even apparently loud underwater noise may have no effect on a particular species if it is at frequencies outside that species hearing range.

Audible Range: The audible range, the range over which marine species can hear the construction activity, will extend to the distance that the construction noise either falls below the ambient perceived sea noise level or the auditory threshold of the species.

Compared to fish species, which as detailed in Chapter 7 are more sensitive to low frequency sound below 1000 Hz, marine mammal species such as the bottle nose dolphin, striped dolphin and harbour porpoise are sensitive to a very broad bandwidth of sound. The audiogram data presented in the Subacoustech report indicates that they are responsive at frequencies from 100 Hz to 170 kHz with peak hearing sensitivity occurring over the frequency range from 20 kHz to 150 kHz (Fig. 10.5). Currently there are no accurate audiogram data available for the larger (mysticete) marine mammal species such as the humpback whale and minke whale. Many of these species are known to use low frequency vocalizations for communication and hence are also likely to be sensitive to the low frequency components of underwater sound.

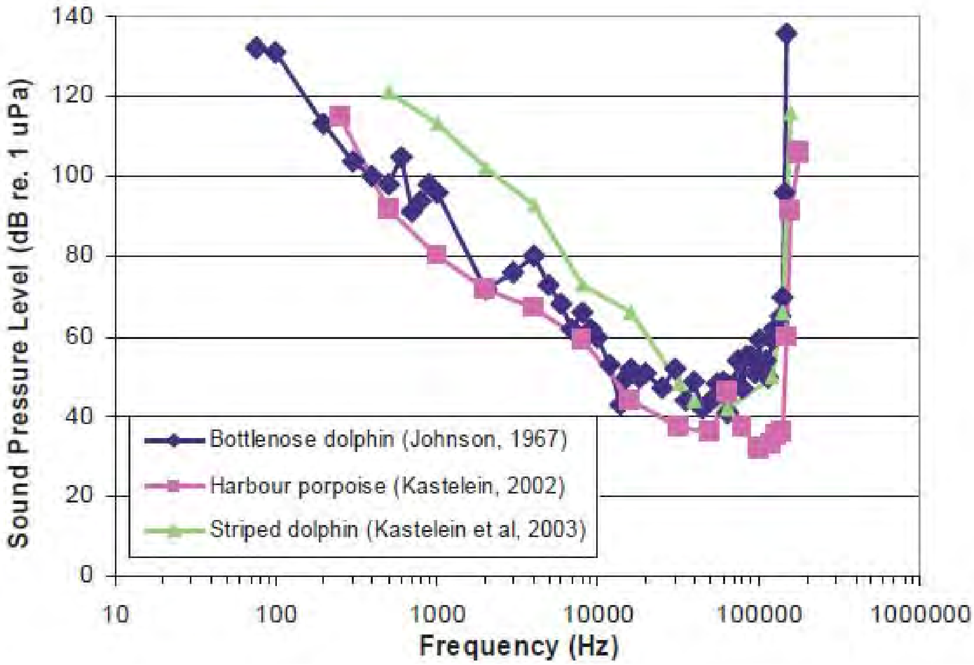


Figure 10.5 Hearing Threshold Data for species of marine mammal

The COWRIE Report concluded that wind farm noise has the potential to affect the physiology and behavior of harbour porpoises and harbour seals at considerable distances with the zone of audibility during pile driving operations likely to extend well beyond 80 km from the source.

The study undertaken by RPS Energy and Subacoustech Ltd for CORE Limited on behalf of the Developers of the Thames estuary offshore wind farm projects included a more comprehensive analysis of the potential physical and behavioural effects on marine mammals and fish associated with the underwater noise generated by the pile driving operations for the steel monopile foundations.

The dB_{ht} (Species) metric developed by Subacoustech Ltd forms the basis of the analysis, as it provides a measurement of sound that accounts for inter-species differences in hearing ability by passing the sound through a filter that mimics the hearing ability of the species. A set of coefficients is used to define the behaviour of the filter so that it corresponds to the way that the acuity of hearing of the candidate species varies with frequency. The level of sound is measured after the filter, the level expressed in this scale is different for each species (which is the reason that the specific name is appended) and corresponds to the likely level of perception of the sound by that species. It is thus closely analogous to the dB(A) scale used for human noise exposure. The Subacoustech report notes that while the scale was still in the process of validation, initial experimental results indicated that at levels of 90 dB_{ht} and above, strong avoidance reaction occurs and that strong avoidance in this context related to a high proportion of fish (c. 90%) being deflected from their swimpath. The scale therefore has the benefit that it is prospectively possible to apply it to both hearing damage and behavioural effects such as avoidance. The dB_{ht} can be applied to both narrow and broadband sources by intergrating the level above threshold over the frequency range of the sound source.

The Subacoustech report notes how the concept of auditory injury from exposure to noise is well established for airborne sound exposure to humans. At a high enough level of sound, traumatic hearing injury may occur even where the time exposure is short and injury of this type is normally associated with immediate and irreversible hearing loss. Injury also occurs at lower levels of noise where the period of exposure is long and in this case the degree of hearing damage depends on the level of the noise and the period of exposure to it. The report describes how the degree of hearing damage for complex and time varying signals can be related to 'Noise Dose' which effectively combines the continuous noise level containing the same sound energy as the time varying sound (the equivalent level of noise, or L_{eq}) and the duration of exposure. The report refers to research by Ward (1997) providing guidance on the exposure period to sound levels above hearing threshold (dB_{ht}) over which hearing injury can occur in humans and by Schlundt *et al* (2000)) as to how this effect translates to marine mammal and fish species exposure to underwater sound. It also quotes a recent review by Marsden *et al* highlighting experiments with marine mammals demonstrating a near linear relationship between sound exposure level and duration of exposure (i.e. an equal 'Energy Dose' relationship) and presents a Table, similar to Table 7.1 below showing how each doubling of the noise energy (3 dB increase in noise level) results in a halving of the acceptable exposure period. The same 'Noise Dose' (and therefore potential for auditory injury) occurs, for instance, following an exposure of 90 dB above threshold level for a species for a duration of 8 hours, 93 dB above threshold levels for 4 hours or 130 dB above threshold for a few seconds. Hearing impairment in the form of Temporary Threshold Shift (TTS) in hearing may occur where a species is exposed to these levels for the durations identified, and Permanent Threshold Shift (PTS) will occur with repetitive exposure. The higher the 'Noise Dose' above this limit, the more rapid will be the damage.

Exposure Level dB(A) or dB_{ht}	**Exposure Duration**
90	8 hours
93	4 hours
99	1 hour
110	Approx. 5 minutes
120	Approx. 30 seconds
130	Approx. 3 seconds

Table 10.2 Comparison of noise exposure level and duration for the same cumulative 90 $L_{EP\ D}$ Noise Dose

On the basis of the above it is concluded that fish or marine mammals may suffer hearing impairment should they be exposed to continuous or repeated underwater sound from a source such as the pile driving for a period of time. The 'Noise Dose' that a species will accumulate will depend on the following:

- The incident level of the underwater sound and hence the distance from the source.
- The hearing threshold and associated dBht of the particular species.
- The behaviour of the species to the noise – if the species moves away from the source following the initial pile strikes the incident levels of subsequent strikes will reduce accordingly.
- The time period and repetition rate of the pile strikes.

In order to predict auditory and behavioural response effects on different fish and marine mammal species, Subacoustech Ltd. estimated the level of noise from the proposed piling operations by making use of an existing database of piling noise measurements undertaken by them of piling noise in similar coastal locations. The measured data from piling operations at Barrow, North Hoyle, Scroby Sands and Kentish Flats offshore wind farm developments indicated a clear dependence on the depth of water with piling operations in very shallow water conditions (a few metres), over a number of kilometres are also very shallow, lead to poor underwater sound propagation and low sound levels. At deeper water sites (10m or more), the sound propagates to greater range and the underwater sound levels are much higher. Allowance was made in the estimates for the different underwater sound propagation conditions that can result from varying bathymetric conditions and also for variations in pile diameter which can affect the source level of the noise.

Estimates of noise were made both in conventional units such as unweighted peak pressure and impulse, and using the frequency weighting technique developed by Subacoustech Ltd. based upon the hearing threshold of the species (dB_{ht}), to predict auditory and behavioural response effects.

The lethal range for impact piling operations was estimated at 5m in shallow water and 10m in deep water sites. The corresponding physical injury ranges were estimated at 50m and 150m respectively.

Auditory injury was assessed by considering the cumulative 'Noise Dose' for a marine species based on the continuous equivalent loudness level. The results indicated that auditory injury can occur from within the 150m physical injury range, based on a single pile strike, to a range of 2 km if a marine mammal (harbour porpoise) were to remain within this range for the full c. 5 hour duration of a typical piling operation. Outside of this range, the predicted perceived loudness is sufficiently low that auditory injury is unlikely to occur. In practice, unless a marine species is within a range of c.300m of the piling operations and receives an unacceptable 'Noise Dose' causing auditory injury within the first few minutes of piling, the loudness of the transient pressure wave is likely to cause an aversive behaviour response resulting in the mammals fleeing the area before auditory injury occurs. On this basis it is concluded that the analysis suggests that the duty cycle of the transient pressure wave noise from the repeated pile strikes is sufficiently low that auditory injury from the accumulation of noise in marine species is considered unlikely.

Behavioural impact of marine species was assessed using a 90 dB_{ht} peak to peak level criteria. The analysis predicted that the piling noise is likely to be aversive to ranges of approximately 7km for species of dolphin, 9 km for the common seal and 13km for the harbour porpoise.

The data in the following table summarises the impact range data for typical marine mammal species from a 6.5m diameter piling operation for a deep water site based on current best information regarding Source Level noise from impact piling operations as presented in the Subacoustech report. Sound transmission loss with range has been predicted from measured data in similar bathymetric conditions. Hearing threshold is based on current peer review data, and in general, more sensitive data were preferred thereby providing a conservative over-estimate of loudness. The behavioural impact is based on a strong avoidance response (deflection) to the sound at a level of 90 dB_{ht}.

Species	Peak to peak Perceived Source Level (dB_{ht} @ 1m)	Auditory injury range 92 dB_{ht} L_{eq}	Behavioural Impact 90 dB_{ht}	Range to background sea noise
Bottlenose Dolphin	208	500 m	7 km	40 km
Striped Dolphin	204	500 m	6 km	30 km
Harbour porpoise	204	2 km	13 km	30 km
Common Seal	184	350 m	9 km	100 km

Table 10.3 Summary of impact range for typical marine mammal species from a 6.5 m diameter piling operation for a deep water site

Given the varying bathymetric conditions on the Kish and Bray banks with water depths varying from a few metres towards the crest of the banks up to c. 30m towards the outer edges of the array it is considered that the adoption of the higher predicted noise levels for the deeper water as presented in the above table will represent the most onerous condition that might apply. It is also noted that the predicted source levels in the Subacoustech Report for the Thames estuary projects are based on a 6.5m diameter impact piling operation which is the maximum pile diameter envisaged for the Dublin Array project and that any subsequent reduction in pile diameter is likely to reduce the source level accordingly.

Section 8.6 of the report prepared by RPS Energy on the Underwater Noise Impact Assessment on Marine Mammals and Fish during Pile Driving for the Thames Estuary Wind Farm projects identifies the likely impacts on marine mammals based on the above physical and behavioural effects associated with the noise from the impact piling operations as follows:

Mortality and Physical Injury: The report concludes that the sound pressure waves generated by driving piles of large diameter are potentially damaging to marine mammals in close proximity to the source and would constitute a direct short term effect but be potentially lethal and injurious to the individual and therefore permanent.

Permanent Threshold Shift in Hearing Sensitivities: The report concludes that permanent threshold shift(PTS) is likely to occur if an animal remains within an area for more than 3 seconds of exposure to levels of 130 dB above threshold levels (130dB_{ht}(species)). This coincides with a modelled range of approximately 300 m for the most sensitive species. The noise report therefore concludes that animals occurring within 300m of the piling operating at full power would be likely to sustain PTS/auditory impairment. The value of 300m was based on species thresholds, swim speeds and the build-up of noise dose over time of the sound wave and was adjusted to 400m to include a margin of safety.

The report also concluded that PTS could occur at lower noise levels if the exposure occurs over a longer period. At 92 dB_{ht}(species) PTS could occur if the animals received more than 5 hours of exposure. It was considered unlikely that an animal would receive this dose as they are likely to move away from the source due to physical discomfort.

On the basis that animals would be unlikely to remain in an area in which sound levels exceeded 130dB_{ht}(species) due to discomfort and would more likely move to an area in which noise levels were more comfortable it was considered that PTS would only affect animals within the 130dB_{ht} range were the piling operations to start at full power.

Temporary Threshold Shift in Hearing Sensitivities: The report concludes that temporary threshold shift(TTS) is likely to occur if an animal remains within an area receiving more than 92 dB above threshold levels for more than 5 hours. At $90dB_{ht}$(species), which would represent distances estimated at 1100m and 400m for porpoises and common seals respectively, TTS could occur if the animal received more than 8 hours exposure. However, it is unlikely that a single piling operation would exceed this duration.

Displacement and behavioural responses: The report notes that the potential for temporary displacement and behavioural effects from the noise generated by the pile driving operations could affect a radius of up to 14 km for porpoises and 9 km for seals from each of the turbine locations but concludes that such effects are likely to be short term given the observations recorded at Horns Rev and that animals present towards the outer limits of the displacement zone are likely to exhibit fewer behavioural effects.

Effects from Masking: The report notes that piling noise has the potential to mask cetacean and seal vocalizations because of the overlap in frequencies. The low frequency noises from piling travel further than the higher frequencies and therefore could affect larger cetaceans and seals to a greater distance than harbour porpoises and echolocating bottlenose dolphins. The higher frequencies would potentially have a masking effect at closer range for species that use higher frequencies. However, for masking to occur the duration of the noise must extend beyond the duration of the sounds that would be masked. Cetacean and seal vocalizations are very short in duration and recur repeatedly over the course of several seconds while piling sounds on the other hand are short in duration but only occur every 5 to 10 seconds. On this basis it is concluded that the sounds would only be marginally masked.

Loss of prey species from injury due to noise generated from piling: As detailed in Chapter 8, prey fish and invertebrate species for marine mammals could be potentially affected by impulse sound from the piling to similar ranges as the mammals themselves. The use of mechanical soft starts would reduce this potential effect.

Loss of prey species due to behavioural effects in fish: The piling could potentially affect very large areas around the turbine locations from which fish could be driven. The report concludes that this is unlikely to be a problem as marine mammals are mobile and naturally follow fish and search for new sources. In addition, marine mammals are likely to move in the same direction as the fish, i.e. away from the source of the sound and therefore would naturally move towards areas that contain the displaced fish. The fish and marine mammals are likely to move back towards the area on cessation of the piling.

10.3.1.2 Habitat Disturbance

During construction, the seabed habitats and feeding grounds under the 'footprint' of the turbine foundations and cable trenches would be lost or disturbed and would therefore be unavailable for use as feeding grounds by marine mammals during this period. However, this impact would be minimal as marine mammals and turtles can forage over a wide area for food and, in any case, the area impacted would represent a very small percentage (< 1%) of the entire area of the wind farm site. Once the habitat is reinstated, it is expected that species would readily recolonise the area from the surrounding habitat. The impact of disturbance to habitat during construction on marine mammals and turtles would be expected to be of low significance, and have a temporary impact.

10.3.1.3 Increased Suspended Sediment/Turbidity

The construction of the cable trenches and turbine foundations would result in a short-term increase in the turbidity of the water as increased suspended solids enter the water column. This may affect the foraging behaviour, social and predator prey interactions and associated success of marine mammals and turtles. However, due to the high tidal current regime and sedimentary nature in the vicinity of the Kish and Bray Banks, there is already a high degree of naturally suspended solids in the area and the small amounts of sediment released into the water column during turbine foundation and cable installation will be rapidly dispersed and will therefore have a negligible effect on background suspended sediment and turbidity levels. This temporary impact would not have a significant impact on marine mammals or turtles as they would easily be able to avoid any affected areas.

10.3.2 Long-term impacts

10.3.2.1 Noise and vibration

The effects of anthropogenic noise and vibrations generated by the operation of the wind turbines were investigated as part of a previous COWRIE report into the sub-sea acoustic noise from offshore wind farms and its impacts on marine wildlife (Nedwell *et al.*, 2003). Noise measurements showed that the background noise levels at typical wind farm sites are towards the upper boundary of typical deep water background noise levels. The overall sound pressure level was found to vary significantly more during the daytime than at night time, due to the higher number of local ship movements during the day. The perceived sound level was examined for three marine mammal species (dolphin, seal and harbour porpoise). It was found that all three marine mammals perceive higher sound levels than the fish species examined. Of the mammals, the porpoise perceived the highest sound level at a mean of about 53 dB. In the case of all mammals, the existing background noise was found not to be far above the threshold of hearing of the mammals. It was found that the highest level measured (53 dB for the harbour porpoise) is similar to the level that humans would perceive in an average office environment. It was concluded that, for most marine mammal species, the background noise level resulting from the operation of an offshore wind farm is perceived as being relatively quiet, equivalent to the perception for humans of a typical rural night time background of 20 – 40 dB.

It has been calculated that harbour porpoises are likely to hear an operating wind turbine at a range of 100-300 m, but the zone of responsiveness is likely to be less than the zone of audibility (Tougaard *et al*., 2005). Koschinski *et al.* (2003) showed that the median approach distance of harbour porpoises to a point increased from 120 m to 183 m when the noise of an operating wind turbine was simulated, but porpoises were not excluded from the area and still approached the noise source. It is also suggested by the author that harbour porpoises would habituate to the sound of an offshore wind turbine. It has been suggested by Madsen *et al*. (2006) that the experiment carried out by Koschinski *et al*. (2003) introduced high-frequency sound that was not present in the turbine recording and that it was this high frequency sound that the harbour porpoises were reacting to. It is expected that the impact of operational noise of wind turbines on marine mammals will be insignificant (Madsen *et al*., 2006).

10.3.2.2 Loss of habitat

As outlined above under the short-term impacts, there would be a direct loss of habitat under the footprint of the turbine. The area affected would be minimal, and marine mammals and turtles would easily replace this feeding ground by foraging over a wider area if necessary. In any case, this feeding ground would be reinstated by natural processes over approximately 2 years, with initial recolonisation by marine benthic invertebrates occurring quickly during the first spawning season post-construction. As a negative impact on marine mammals and turtles this is considered to be insignificant.

10.3.2.3 Electromagnetic fields

The effects of electromagnetic radiation emanating from submerged electric cables on marine mammals are not well documented, though some information, much of it theoretical does exist. Some marine mammals, mainly cetaceans, appear to use the Earth's magnetic field for navigation, particularly for long distance migration. Submarine power cables can have a localised effect on the magnetic field in an area to a distance tens of metres from the cable (Normandeau *et al*., 2011). This localised change in the magnetic field could have an effect on the navigation of cetaceans. The type of current flowing in the cable influences the effect of the cable on cetaceans, with Direct Current (DC) having a notable effect, while Alternating Current (AC) rapidly changes polarity, and therefore does not have such a pronounced effect on the sensory systems of the cetacean.

Turtles also use geomagnetic fields for navigation and carry out long distance migrations. Experiments conducted that included attaching magnets to migrating turtles have shown that animals with magnets attached take longer to reach their destination and travel via a more convoluted route (Normandeau *et al*., 2011). The operation of transmission cables could affect the navigation of turtles.

There is no evidence to suggest that seals are sensitive to magnetic fields (Normandeau *et al*., 2011).

10.3.2.4 Decommissioning

The impacts that would arise during decommissioning of the turbines would be similar to the short-term impacts described above.

10.4 Case studies

In recent times, a number of offshore wind farms have been constructed throughout Europe and so the results of monitoring programmes are available that assess the impact that the construction and operation of wind farms have had on the environment, and specifically marine mammals. A number of case studies are presented he detailing the results of these monitoring programmes.

10.4.1 Horns Rev

Horns Rev is 14 km west-south-west of Blavands Huk on the west coast of Denmark. 80 x 1.8 MW turbines are now in operation on a 27.5 km^2 site in water depths of 6.5 to 13m. As part of the construction of this wind farm it has been required that monitoring be undertaken to determine if wind farms cause measurable, temporary or permanent, changes in the local stock of harbour porpoises.

Baseline observations have shown that harbour porpoises were abundant at Horns Rev prior to construction of the wind farm (Tougaard *et al.* 2005). It was predicted that there will be a negligible physical loss of seabed habitat due to the turbine foundations. Studies performed during construction showed a pronounced effect on the distribution and behaviour of harbour porpoises, with the porpoises leaving the area during pile-driving operations. Continuous monitoring studies at the wind farm, during its operation, have resulted in no strong conclusions on the general effects of the wind farm on harbour porpoises.

In order to determine the importance of Horns Rev as a foraging area for harbour seals, 21 seals were equipped with satellite transmitters and data loggers (Tougaard et *al.* 2006). Further aims of this study were to determine whether seals were present in the wind farm after construction and whether their behaviour was affected by the presence of the turbines. Observations taken during the construction phase identified very few seals in the wind farm and surrounding areas. The accuracy of the satellite positions proved to be insufficient to conclude with certainty on the degree to which the wind farm has affected seals. Visual surveys as part of the porpoise monitoring program have identified seals as being present within the wind farm area, in numbers not readily different from the surrounding waters. The only perceived negative effect on seals is the noise produced by the turbines. Based on measurements of background noise in the area the impact from noise produced by the turbines is deemed to be negligible.

10.4.2 Nysted

The Nysted offshore wind farm is made up of 72 turbines, each capable of generating 2.3MW. This results in a total generating capacity of 165.6 MW, making Nysted one of the largest in the world. As part of a comprehensive environmental survey, the effects of the wind farm on seals will be monitored. Aerial surveys to count harbour and common seals in the area were conducted between March 2002 and January 2004, at the nearby Rodsand seal sanctuary. There was no observed difference between the baseline and construction surveys for the proportion of seals present at Rodsand (Teilmann *et al.* 2004). The construction activities appear to have had no effect on the Rodsand seal population differing from natural population fluctuations in the region.

A monitoring program to examine the effects of construction and operation of the Nysted wind farm on harbour porpoise was conducted from 2001 – 2005. The study used acoustic dataloggers, T-PODs, that record and stored the time and length of harbour porpoise echolocation. Prior to construction there was no recorded difference in the time between recorded echolocations, indicating how often a porpoise enters the area, and how intensely the porpoise used echolocation when within range of the T-POD. During construction of the wind farm there was a notable increase in the time between recorded echolocations and a decrease in intensity when within range of the T-POD (Tougaard *et al.* 2006). This effect was also observed in the reference area, which is located 10km from the wind farm area, but to a smaller degree. This may have been indicative of the effect of construction impacting porpoise abundance in the Rodsand area. Data from the post-construction monitoring study indicate that there is a tendency towards baseline conditions, with the reference area activity being back at baseline levels two years post-construction (Tougaard *et al.* 2006). Acoustic behaviour, which appeared to have been affected during construction, had returned to normal in the wind farm area two years after construction. The low return to baseline levels indicates that the harbour porpoise are adapting to the presence of the wind farm, gradually using the area more frequently. The construction and operation of the Nysted wind farm had a negative impact on the abundance and behaviour of harbour porpoise in the area, lasting at least until the second year of operation.

10.4.3 Egmond aan Zee

The Egmond aan Zee wind farm was the first of its type built in the North Sea off the Dutch coast. It is comprised of 36 turbines, each with a capacity of 3MW, for a total generating capacity of 108MW. The occurrence of harbour porpoises in the wind farm and two reference sites was studied using acoustic monitoring at period prior to construction and during the operation of the wind farm. Results of this monitoring study indicate an increase in harbour porpoise activity inside the operating wind farm when compared to pre-construction activity (Scheidtat *et al.* 2011). This effect is linked to the presence of the wind farm and not to a natural population increase as there was no significant increase in activity at the reference sites prior-to and after construction. The reasons for the increase in activity in the wind farm area are not certain but may be attributed to an increase in food or a sheltering effect. There were no monitoring studies undertaken during the construction of the Egmond aan Zee wind farm, resulting in no data on harbour porpoises during this time.

Data collected on harbour seals indicates that there were very few movements through the wind farm area, both prior-to and after construction (Brasseur *et al.* 2008). It is not, therefore, possible to determine if the wind farm has any impact on harbour seals.

10.5 Mitigation Measures

10.5.1 Noise and Vibration

The report prepared by RPS Energy on the Underwater Noise Impact Assessment on Marine Mammals and Fish during Pile Driving for the Thames Estuary Wind Farm projects examined a number of potential mitigation measures to reduce the impact of noise from the piling operations. These included noise reduction and noise transmission mitigation measures (e.g. bubble curtains, cushioning, etc.), soft start, acoustic harassment devices, marine mammal observers (MMOs), acoustic monitoring (passive and active), etc. The conclusions from the review of mitigation measures can be summarized as follows:

- Acoustic and mechanical soft starts would offer a substantial reduction in the effects of lethal and injurious noise on marine mammals within close proximity to the piling operations.

- Other mitigation measures could be used such as exclusion zones, marine mammal observers (MMO’s) and acoustic monitoring. However, these measures were considered unnecessary should the acoustic and mechanical soft starts be shown to be reliable at displacing animals from a predefined area around the piling operations.

- The review of noise reduction measures indicated that emerging technologies associated with marine piling are not yet established.

On the basis of the above it is concluded that adopting a mechanical and acoustic soft start procedure will represent the most effective mitigation measure to reduce the impact of noise from the piling operations for the Dublin Array on marine mammals. It is also proposed that marine mammal observers (MMO’s) would be used during the initial piling operations to confirm the reliability of the acoustic and mechanical soft start procedures at displacing marine mammals from a predefined area around the works.

10.5.2 Electromagnetic Fields

The use of appropriately sheathed/insulated AC cables buried to a minimum depth of 1m below the seabed will minimise the impact of electromagnetic fields on marine mammals and turtles.

10.5.3 Loss or Alteration of Habitats and Feeding Grounds

The following mitigation measures will be adopted to minimise the impact the construction and operation of the wind farm on existing habitats and feeding grounds used by marine mammals:

- In order to minimise the extent of potential habitat loss associated with the construction and operation of the wind farm the extent of seabed disturbed to facilitate the installation of the piles, scour protection and cable trenches will be kept to a minimum.
- Cable trenches will be formed, the cable installed and the trench backfilled in a single operation using a purpose designed plough thereby allowing immediate re-colonisation of the affected substratum from surrounding unaffected areas by the natural hydrodynamic regime over the banks.
- Scour protection will be provided on the seabed around the base of each pile in order to limit the extent of seabed affected by scour associated with the alteration of hydrodynamic flows around the pile.

10.5.4 Increased Suspended Sediment/Turbidity

The following mitigation measures will be adopted to minimise the impacts associated with increased suspended sediment and turbidity during the construction and operational stages of the wind farm on marine mammals and turtles:

- In order to minimise the extent of potential sediment disturbance associated with the construction and operation of the wind farm the extent of seabed disturbed to facilitate the installation of the piles, scour protection and cable trenches will be kept to a minimum.
- Scour protection will be provided on the seabed around the base of each pile in order to limit the extent of seabed affected by scour associated with the alteration of hydrodynamic flows around the pile.

10.5.5 Pollutants and Waste

The following mitigation measures will be adopted to minimise the impact of pollutants and waste generated during the construction and operation of the wind farm on marine mammals and turtles:

- The Construction Management Plan will include strict controls to minimise the risk of pollution or contamination associated with the construction stage of the proposed development including the storage and use of lubricants, placement of grout, and management of waste which will be sorted and returned to shore for recycling/disposal by a Licenced contractor.
- Similar controls will be adopted during the operational stage of the project to prevent pollution and contamination.

10.6 Predicted Impacts

10.6.1 Noise and vibration

An assessment of the significance of the potential effects of noise from the piling operations, as identified in the RPS report and outlined in Section 10.3.1.1., during the construction of the wind farm on marine mammals concluded as follows:

Physical Injury or Death: The use of acoustic and mechanical soft start to clear the immediate area of marine mammals prior to attaining full power would virtually eliminate these potential effects and it was concluded that the overall effect on seals and cetaceans would be low or negligible and of low significance on this basis.

Permanent Threshold Shift (PTS) in Hearing Sensitivities: The use of acoustic and mechanical soft start to clear the immediate area of marine mammals within which PTS associated with potential short term exposure to noise levels of 130 dB above threshold levels could occur, and the likelihood that animals would move away from the source of noise levels which could lead to PTS at lower levels over longer durations lead the report to conclude that the overall significance of effects on seals and cetaceans from potential permanent reduction in hearing threshold would be low adverse and the significance of the effect would be low.

Temporay Threshold Shift (TTS) in Hearing Sensitivities: The use of acoustic and mechanical soft starts would reduce the risks to marine mammals as they would already be a sufficient distance from the piling location before the noise dose would take effect and it was concluded that the overall level of effects on seals and cetaceans from a potential temporary reduction in hearing threshold would be low adverse on this basis.

Displacement and Behavioural Responses: It was considered that displacement and behavioural effects were likely to be short term for each piling operation, given the observations recorded at Horns Rev, and that animals towards the outer limits of displacement were likely to exhibit fewer behavioural effects. It was concluded that the effects due to displacement were therefore unlikely to be significant and the effects on seals and cetaceans from disturbance due to sub-lethal noise sources from the pile driving would be low adverse.

Leatherback turtles in the immediate vicinity of the wind farm during construction are likely to avoid the area during construction, but the frequency of occurrence of this species in the area means there is unlikely to be any significant effect on individuals or the species in general.

The operation of the wind farm is not expected to have any significant effect on marine mammals or leatherback turtles as the sound levels are so low as to not cause avoidance behaviour and that habituation will occur.

10.6.2 Loss of habitat

The loss of habitat available to marine mammals for foraging by the construction of the Dublin Array will be small and will not have a significant negative effect on marine mammals. Turtles forage in the pelagic zone and so will not be significantly affected by the loss of habitat under the footprint of the wind turbines.

10.6.3 Increased suspended sediment/turbidity

Any increase in suspended solids caused by the construction of the Dublin Array would be temporary and occur in an area already subject to turbidity caused by suspended solids, therefore it is not expected that there will be any significant negative impact on marine mammals or turtles as a result.

10.6.4 Electromagnetic fields

It is unlikely that there will be any effect on cetaceans as a result of the operation of the transmission cable. Equally, the localised effect of the cable of magnetic fields is unlikely to impact significantly on turtles in the area, as they are capable of fine-scale navigation using the Earth's magnetic field and the minor effect of the cable would not cause a large deviation in their path.

10.7 Cumulative impacts

When assessing the cumulative impacts it is necessary to also consider the effect of other developments that, together with the current project, would have a cumulative impact on the marine environment.

To date two offshore wind farms have been granted a Foreshore Lease off the east coast. The Arklow Bank and the Codling Bank wind parks off the coast of county Wickow. The Arklow Bank is located approximately 40 km south of the Kish and Bray banks, while the Codling Wind Park would be located just southeast of the Dublin Array.

The range at which a harbour porpoise is expected to hear an operating wind turbine is in the region of 100-300 m, with the zone of responsiveness even less (Tougaard *et al*., 2005). Therefore, there is no cumulative effect expected in terms of operational noise, should both wind farm developments proceed.

In addition to operation of other wind farms in the surrounding environment, other sources of undersea noise need to be considered as cumulative with the proposed wind farm. The Irish Sea is an important shipping corridor, with regular ferries operating out of Dublin Port and Dún Laoghaire Harbour and ships generate considerable noise when in transit. Shipping noise in close proximity to a wind farm would mask the turbine noise (Madsen *et al*., 2006). Given that ships generate transient noise, and harbour porpoises continue to occur in areas with high levels of shipping, it is not expected that a significant negative effect will be caused by any accumulation of these noise sources.

11 TERRESTRIAL ECOLOGY

11.1 Introduction

The proposed Dublin Array offshore wind farm development on the Kish and Bray banks will involve the installation of up to 145 wind turbines and associated infrastructure including an offshore substation and inter-turbine array cables as well as the export cable from the offshore substation to the proposed connection point to the National Grid at Carrickmines substation. The initial part of the export cable will be laid beneath the seabed along a route between the offshore substation and the proposed landfall site at Shanganagh, south of Shankill, Co. Dublin and north of Bray, Co. Wicklow. The potential impacts of that section of the export cable are addressed elsewhere in this EIS. This chapter of the EIS addresses the potential impacts of the proposed onshore section of the export cable installation on terrestrial ecology along the route between the landfall site at Shanganagh and the connection point to the National Grid at Carrickmines substation. Potential impacts of the proposed development during construction, operation and decommissioning are discussed and mitigation measures proposed by the Developers are addressed.

The initial section of the onshore cable route from the proposed landfall site at Shanganagh will extend from the seashore under the existing railway line and across Shanganagh Park to the R119 regional road on the western side of the Park. From there it will be routed along public roadways to the proposed connection point at Carrickmines substation (Fig.11.1).

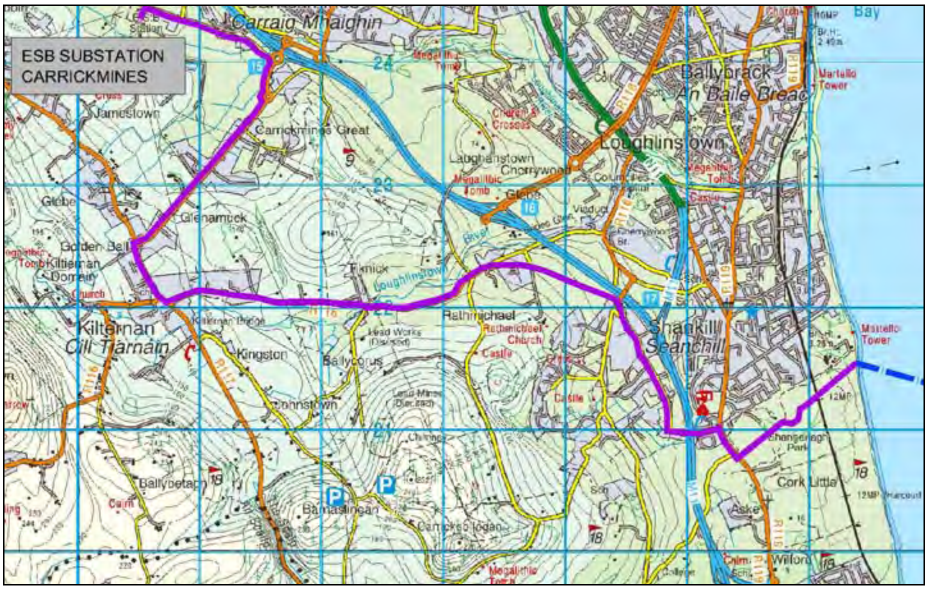


Figure 11.1 Proposed Indicative Cable Route

Ecological Consultancy Services Ltd. (Ecoserve) were appointed by the Developers to undertake a terrestrial ecology impact assessment on the proposed onshore cable route identified above. The principal aim of their survey was to identify and map the habitats present along the proposed cable route, to note the occurrence of mammal species and to identify associated ecological constraints and any potential impacts of the proposed onshore cable route. The Ecoserve report notes that the initial proposed cable route across Shanganagh Park passed through a long section of linear woodland (WL) (Figure 11.2). The results of the archeological survey and the Ecoserve survey which identified the presence of a badger sett, and the potential impact on the linear woodland, resulted in an alternative proposed cable route across the park being selected (Figure 11.3).

The area surveyed by Ecoserve for the purposes of their assessment encompassed the seashore, Shanganagh Park and a section of the public roadway to the M11 motorway, along the proposed route for the transmission cable. This section of the cable route has a length of approximately 2km from the point of landfall to where it crosses the M11. On the basis that the remaining section of the onshore cable is routed along existing public roadway and would therefore not have an impact on terrestrial ecology it was not surveyed for the purposes of the Ecoserve assessment.
It is proposed that the electrical cables will be installed by directional drilling under the beach from the existing field behind the beach area to approximately 200m out to sea. The cable ducts will be installed in excavated trenches through the park, with directional drilling under the existing railway line. After the cable ducts have been installed the trench will be backfilled and the ground re-seeded.

A copy of Ecoserve's report is included in Appendix L in Volume 3 of this Environmental Impact Statement.

11.2 Description of Existing Environment

11.2.1 Conservation

The proposed development site itself is not under any designation as per the European Communities (Natural Habitats) Regulations, 1997 (S.I. No. 94 of 1997) as amended or the Wildlife Acts 1976 to 2010.

11.2.1.1 Conservation Designations

A number of conservation designations exist in Ireland providing protection to habitats and species. A summary of these designations is presented here.

Special Protection Areas (SPAs) are created under the European Union's Birds Directive (2009/147/EC) and are designated for the protection of species of wild birds. No formal criteria are set out in the Directive for selecting SPAs, so Ireland has set the following criteria:

- Site regularly used by 1% or more of the all-Ireland population of an Annex 1 species
- Site regularly used by 1% or more of the biogeographical population of a migratory species
- Site regularly used by more than 20,000 waterfowl. In addition, sites important for dispersed species require protection under the Directive.

There are currently 150 sites designated as SPAs in Ireland, with a small number still being considered for designation. As well as providing for the designation of SPAs, the Birds Directive provides general protection to all wild bird species in Ireland.

Special Areas of Conservation (SACs) are designated under the European Union's Habitats Directive (92/43/EEC), which was transposed into Irish law by the European Communities (Natural Habitats) Regulations 1997 (S.I. 94/1997) as amended. SACs are designated for the protection of habitats, plants or animals listed under Annex I and II of the Directive. A total of approximately 13,500 km^2 has been designated as SAC in Ireland and its surrounding waters.

Natural Heritage Areas (NHAs) are designated under the Wildlife Acts 1976 to 2010 for the protection of Ireland's natural heritage, including habitats, species or geological features. To date, 148 NHAs have been designated throughout Ireland, though these are limited to areas supporting two habitat types: Raised Bog and Blanket Bog. In addition to the 148 designated NHAs, there are 630 non-statutorily proposed NHAs (pNHAs), which have no statutory protection and will not have any until they are statutorily proposed.

Ramsar sites are internationally important sites designated under the Convention on Wetlands of International Importance (Ramsar, Iran, 1971), to which Ireland is a Contracting Party. Ramsar sites may be designated for a number of reasons. The criteria for selection are based on wetland types, species and ecological communities, waterbirds, fish, and other taxa. Ireland has 45 Ramsar sites, covering an area of 66,994 ha.

11.2.1.2 Conservation Designations in the vicinity of the cable route

There are no nature conservation designations within the immediate area of this study; however there are designated sites within 10 kilometres of the site. North of the study site, Dalkey Island SPA (site code 004172) is designated as a Special Protection Area. Dalkey Coastal Zone and Killiney (site code 001206) and South Dublin Bay are designated as a Proposed Natural Heritage Areas, with South Dublin Bay also designated as a Special Area of Conservation. Sandymount Strand/Tolka Estuary (site code 004024) is a designated Special Protected Area. Also to the north of the study site, Loughlinstown Wood (site code 001211) is a Proposed Natural Heritage Area. West and southwest of the study site, Dingle Glen (site code 001207) and Ballybetagh Bog (site code 001202) are also Proposed Natural Heritage Areas.

11.2.2 Field survey

11.2.2.1 Methodology

Habitat and plant survey: The habitats and plants along and adjacent to the proposed cable route were surveyed by conducting a walk-over survey on the 15th October 2011 during good weather conditions. The purpose of the habitat survey was to identify all of the existing habitats along the cable route, with the collation of a species list for each. Habitats in the locality of the proposed cable route were identified using the Fossitt (2000) classification system, with all impacted and adjacent habitats identified to Level III of this system. Relevant habitat information was noted onto wire maps of the study area. For each habitat classified, a list of species and their estimated abundance was recorded. Plant abundance was determined based on the DAFOR scale (D = Dominant, A = Abundant, F = Frequent, O = Occasional, R = Rare).

Mammal survey: All signs, either direct or indirect, of mammals were recorded, and their position noted on a map of the study area. The mammal survey was conducted by walking line transects along the proposed cable route and the adjoining habitats.

11.2.2.2 Habitat and plant survey

The proposed cable route lies within a suburban/urban fringe setting and runs from the upper shore at the proposed landfall site on Shanganagh beach through Shanganagh Park, which includes a mixture of amenity parks and fields, to the R119 Dublin Road. The habitat survey identified a total of eleven different habitat classes based on the Fossitt classification system (Table 11.1) along the proposed cable route (See Figure 11.3). A full description of the habitat classes based on Fossitt Classification scheme can be seen in Appendix II of the Ecoserve report.

Fossitt Classification			
Level I	**Level II**	**Level III**	**Habitat Code**
Grassland and Marsh	Improved grassland	Amenity Grassland	GA2
	Semi-natural grassland	Dry meadows and grassy verges	GS2
Woodland and Scrub	Highly modified/non-native woodland	(Mixed) Broadleaved woodland	WD1
		Mixed broadleaved/conifer woodland	WD2
	Linear woodland/scrub	Hedgerows	WL1
		Treelines	WL2
	Scrub/transitional woodland	Scrub	WS1
		Immature woodland	WS2
Exposed rock and disturbed ground	Disturbed ground	Spoil and bare ground	ED2
Freshwater	Drainage ditches	Drainage ditches	FW4
Coastland	Sea cliffs and islets	Sedimentary sea cliffs	CS3
Cultivated and built land	Built land	Buildings and artificial surfaces	BL3

Table 11.1 Habitat Classes identified during a survey of the study area

On entering the park from the shoreline there is a sedimentary cliff (CS3) leading onto a section of immature woodland (WS2), when following the path of the initial proposed cable route. This immature woodland contains bramble (*Rubus fruticosus* agg), small-leaved Elm (*Ulmus minor*) and sea buckthorn (*Hippophae rhamnoides*). The immature woodland is followed by a section of hedgerow (WL1) composed of bramble, hawthorn (*Crataegus monogyna*), blackthorn (*Prunus spinosa*) and small-leaved elm. The path of the initial proposed cable route encounters a section of (mixed) broadleaved woodland (WD1) upon exiting the hedgerow (WL1). Areas of (mixed) broadleaved woodland contain 75 – 100% broadleaved trees with the remainder composed of conifers (Fossitt, 2000). Tree species may be native or non-native. The species ash (*Fraxinus excelsior*) and sycamore (*Acer pseduoplantanus*) are the most frequently occurring trees in this woodland, with Hedera helix shrubs and the grass creeping bent (*Agrostis stolonifera*) also occurring frequently.

As the initial proposed cable route continues west it moves into an area of mixed broadleaved/conifer woodland (WD2) containing Lawson's Cypress (*Chamaecyparis lawsoniana*). The woodland quickly returns to a (mixed) deciduous composition with sycamore being the more frequently occurring tree species. The shrubs of this woodland are dominated by bramble, with the grass layer being abundant in bindweed (*Calystegia sepium*) and creeping buttercup (*Ranunculus repens*). Within this section of woodland there is evidence of the Eurasian badger (*Meles meles*). The survey identified a badger sett occurring along the path of the initial proposed cable route. This sett contained a single entrance hole and has been classified as an outlier sett based on the classification outlined by Thornton (1988). These setts are used only sporadically, and, when not in use by badgers, may be taken over by foxes or rabbits.

A small section of scrub (WS1), composed of gorse (*Ulex europaeus)* and bramble, can be found running parallel to the railway line, on both sides. Once the initial proposed cable route crosses under the railway line it meets a section of (mixed) deciduous woodland. This woodland consists of newly planted trees and is dominated by ash and sycamore. The cable exits this woodland into an area of amenity grassland.

This section of the cable route, the initial proposed cable route, was subsequently amended, due to the impact it would have on a large section of woodland and the presence of the badger sett. The amended proposed cable route follows a parallel course to the north of the initial proposed cable route (See Figure 11.3).

The alternative proposed cable route enters the park from the shoreline encountering the same section of immature woodland, although at a different point, as the initial proposed cable route. Upon passing under the immature woodland the alternative cable route moves through a section of amenity grassland (GA2), intersecting with two hedgerows before reaching the railway line. Fossitt (2000) describes amenity grassland as being improved, or species-poor, and managed for purposes other than grass production. At the railway line the alternative proposed cable route encounters the scrub line running parallel to the railway line. The composition of the scrub at this point is similar to that encountered along the initial proposed cable route. Once the alternative cable route passes under the railway line and through the section of scrub it once again enters amenity grassland. At this point the cable route continues through amenity grassland to the location where it merges with the initial proposed cable route. From this point the initial and alternative cable routes follow the same path.

The cable route, at this point, continues through the amenity grassland until it reaches a section of (mixed) deciduous woodland. This woodland is an extension of the newly planted ash and sycamore woodland already encountered by the initial proposed cable route. After exiting this woodland the proposed cable route will follow a straight line parallel to a drainage ditch (FW4) and treeline (WL2) until it exits the park. There is sufficient space between the drainage ditch and treelines, made up of a walking trail and amenity grassland that neither should need to be removed to facilitate the cable trench. Within the treeline, whitebeam (*Sorbus hibernica*) and crab apple (*Malus sylvestris*) are the rarest species, with wood false-brome (*Brachypodium sylvaticum*) being the dominant. Once the cable route exits the park it follows the public roadway to the proposed connection point to the national grid at Carrickmines substation.

11.2.2.3 Mammal Survey

A survey for signs of mammal activity was conducted along the two proposed routes for the transmission cable. This survey involved looking for indirect indicators, such as setts and feeding signs, of mammal presence. Line transects were performed along the cable route and through adjoining habitats.

The mammal survey yielded only two indicators of mammal presence. The most significant indicator was a badger sett located in the area of woodland beside the golf course (See Figure 11.2). In the section of hedgerow beside the grassland used as football pitches there was a small rabbit (*Oryctolagus cuniculus*) burrow and signs of possible rabbit hairs caught in a barbed wire fence.

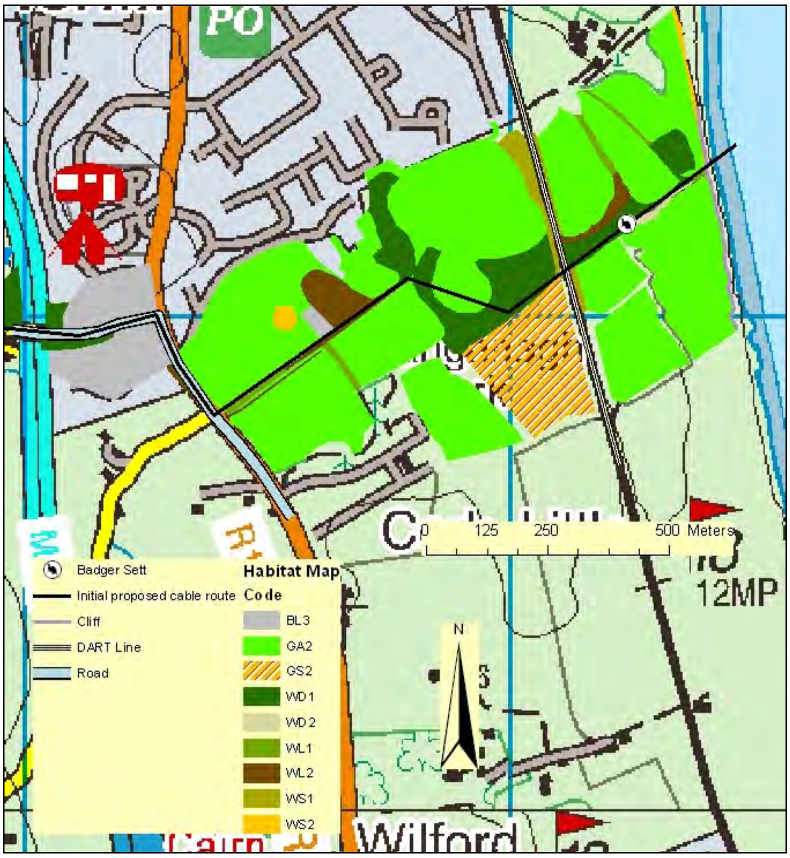


Figure 11.2 Habitat map of the original proposed cable route (Option 1)

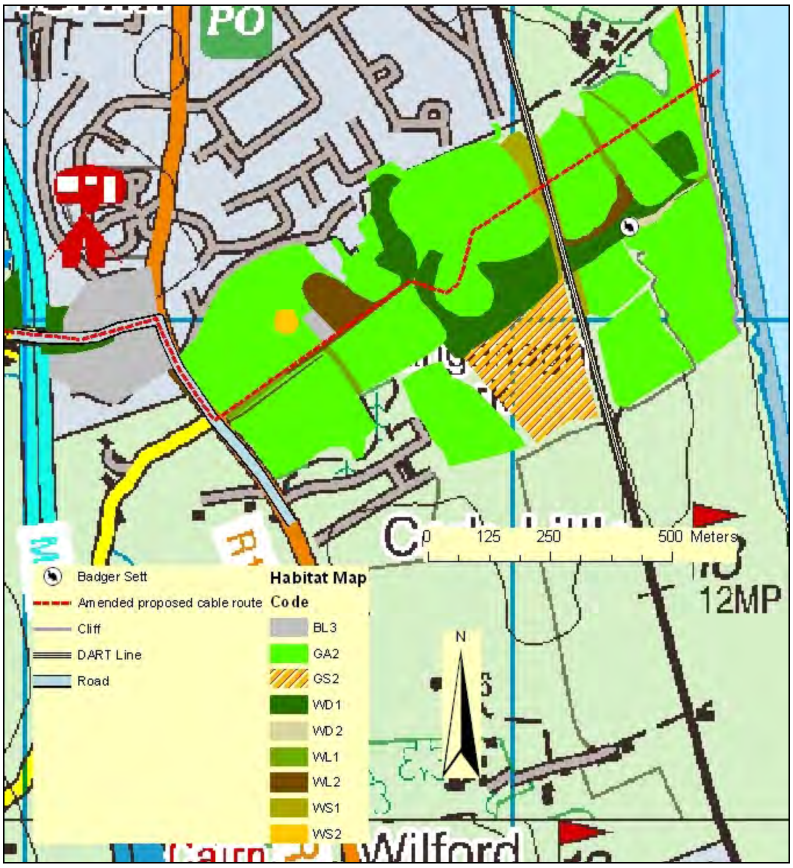


Figure 11.3 Habitat map of the proposed cable route (Option 2)

11.2.2.4 Mapping

All habitats were mapped by Ecoserve to Level III of the Fossitt (2000) classification system and were digitised into colour-coded polygons and lines in a GIS (Geographic Information System) vector layer using ESRI ArcGIS v10. Features of interest, such as rare species, were added and geo-referenced. The vector layers were created using orthophotography of the study area as a guide. Polygons were divided based on the Fossitt (2000) classification assigned to different habitats.

11.3 Potential impacts

The Ecoserve report identified the following potential impacts on terrestrial ecology associated with the onshore section of the export cable from the proposed Dublin Array offshore wind farm development on the Kish and Bray banks.
The duration of impacts, based on the EPA (2002) terminology, are as follows:

- Temporary Impact – Impact lasting for one year or less.
- Short-term Impact – Impact lasting one to seven years.
- Medium-term Impact – Impact lasting seven to fifteen years.
- Long-term Impact – Impact lasting fifteen to sixty years.
- Permanent Impact – Impact lasting over sixty years.

11.3.1 Construction Stage Impacts

11.3.1.1 Loss or alteration of habitats and loss of species

There is a potential for habitat loss as a result of the construction of the cable trench.
The following habitats may be impacted upon during construction:

- Hedgerows
- Mixed broadleaved woodland
- Scrub
- Treelines
- Amenity Grasslands

The loss or removal of wooded habitats will impact upon the available nesting sites for bird and mammal species, as well as, loss of feeding habitat. There is also the potential for bats to use hedgerows in the area, and the loss of this habitat may impact on the movement of bats between roosts and feeding grounds.

Habitat loss, resulting from the construction of the cable will directly impact areas of hedgerow, (mixed) deciduous woodland, and amenity grassland. The method of construction will require the removal of sections of hedgerow that intersect the cable route, resulting in a short-term impact. The proposed cable route will intersect with two sections of hedgerow, occurring in the region between the coast and the railway line.

The railway line is bordered on either side by a screening of scrub, and sections that intersect the cable route may also have to be removed. The removal of sections of scrub will result in a short-term impact.

The majority of the proposed cable route occurs in areas of amenity grassland. Sections of this grassland will be removed during construction, resulting in a temporary impact.

To the west of the railway line, the cable route passes through a section of (mixed) deciduous woodland. A small section of this woodland may need to be cleared. This impact will have medium-term duration.

Before exiting Shanganagh Park, the proposed cable route runs parallel to a section of hedgerow and a treeline. A crab apple tree occurs in this hedgerow, the only one recorded in the park. There is ample space between the treeline and hedgerow that neither should be impacted during construction.

Upon exiting the park the cable route will follow existing public roadways as far as the proposed connection point to the national grid at Carrickmines substation. This section of the cable route will not impact on any habitats or faunal species.

11.3.1.2 Habitat fragmentation

The presence of a trench may inhibit the movements of terrestrial species i.e. habitat fragmentation for terrestrial fauna. The disturbance will be a temporary impact, lasting for the duration of the construction, which will be about four weeks.

11.3.1.3 Disturbance

Noise, disturbance and vibration from the machinery might cause certain species, including badgers to avoid the area during the working hours. Badgers are nocturnal animals that rest during the day in under-ground setts. They are known to utilise many setts, so in theory they should respond by moving away from the disturbance area. Thus, the impact of ground investigation works on badgers is expected to be temporary and localised as the badgers will still be able to utilise the area for feeding during night time. These disturbances are likely to be temporary impacts, lasting for the duration of the construction, which will be about four weeks.

11.3.1.4 Ground deterioration

Activities associated with the excavation of a trench will lead to a localised clearance of the vegetation. Soil heaps stored on site may be subjected to erosion by wind or rain. In addition trampling by people or machinery will result in ground deterioration in the vicinity of the excavation areas. In addition there will be disturbance to fauna, due to noise and activity of machinery. These disturbances will be temporary impacts, lasting for the duration of the construction.

11.3.1.5 Pollution

Pollution can occur from the drilling plant, service vehicles and storage containers in a number of ways. Site machinery and vehicles create a risk of contamination through neglected spillages, the improper storage, handling and transfer of oil and chemicals and refuelling of engines. Incorrectly maintained sanitation facilities and/or using 'outdoor toilet' introduce toxins and excess nutrients into the environment. Rubbish items, such as chewing gums, cigarette butts beverage containers and food wrappings may create hazard to fauna that may accidentally ingest it or get entangled into it.

Accidental leakage or discharge of chemicals and pollutants could cause changes in the pH of the soil and could have a direct toxic impact on the fauna and flora on site.

11.3.2 Operational Stage Impacts

Once the trench has been backfilled and the area re-seeded, no long term impacts are predicted on terrestrial ecology from the operation of the wind farm and associated onshore underground cable.

11.4 Mitigation Measures

The following mitigation measures were identified by Ecoserve to minimise the impact of the works on terrestrial ecology:

11.4.1 Loss or alteration of habitats and loss of species

To minimise habitat and species loss and disturbance, efforts will be made to keep the area of ground disturbed by the cable trench to a minimum and removing vegetation during sensitive periods such as nesting will be avoided. Following construction of the cable trenches, efforts will be made to restore habitats to their current condition, if impacted upon. Cable trenches will be filled to their pre-construction level and with material of a similar nature to allow re-colonisation of the earth by similar species.

Section 40 of the Wildlife Act 1976 to 2010, restricts the cutting, grubbing, burning or destruction by other means of vegetation growing on uncultivated land or in hedges or ditches during the nesting and breeding season for birds and wildlife, from 1 March to 31 August. Unless agreed in advance with the National Parks & Wildlife Service, removal of hedgerows and trees will be done outside of the restricted period to prevent the destruction of active bird's nests.

11.4.2 Habitat fragmentation

To reduce the potential impact of habitat fragmentation it is suggested to erect a fence around any uncovered area of trench during construction or as the ducting is laid they backfill the trench so as not to leave an open trench.

11.4.3 Disturbance

Noise, disturbance and vibration from the machinery will be kept to minimum in terms of intensity, duration and spatial extent. Where possible, working hours shall be restricted to the daytime in order to minimise the disturbance.

11.4.4 Pollution

All materials will be properly stored in designated areas and away from the shore. All fuels or chemicals kept on the site will be stored in bunded containers. All machinery will be well-maintained and refuelling carried out within bunded enclosures or away from the beach. Where machinery is working within the immediate vicinity of the beach, oil interceptors will be installed. Spoil and fluids need to be contained and handled according to their contaminants. All other waste material, including rubbish will be contained in appropriate receptacles and properly disposed of. Emergency response procedures will be in place to deal with accidental spillages should such occur. This will include appropriate training of the crew members and a contact list of relevant statutory organisations (to include EPA and NPWS). If accidental spillages were to occur these will be contained and cleaned up immediately. Remediation measures will be consulted with the relevant organisations (EPA and NPWS) and carried out without delay in the event of pollution of the adjacent watercourse. Documentary evidence of appropriate disposal of waste materials and appropriate crew training will be requested to ensure that fuel, oil and chemical spills do not pose a threat to the aquatic or terrestrial ecology.

11.5 Residual impacts

With the implementation of the recommended mitigation measures, the residual impacts will be significantly reduced or removed entirely. Therefore all impacts would be considered insignificant.

Once the trench has been backfilled and the area re-seeded, no long term impacts are predicted on terrestrial ecology from the operation of the wind farm and associated onshore underground cable.

11.6 Cumulative impacts

When assessing the cumulative impacts it is necessary to also consider the effect of other developments that, together with the current project, would have a cumulative impact on the terrestrial environment. As there are no current or planned projects for the area in the immediate vicinity of Shanganagh Park no cumulative impacts are anticipated.

11.7 Do nothing scenario

Should this development not proceed and in the absence of any other change either anthropogenic or natural then there will be no change to the existing environment.

11.8 Reinstatement

Terrestrial areas temporarily disturbed during construction will be re-vegetated with shrubs, ground cover or grass, in keeping with the original environment, in order to restore the green ambiance which existed before the commencement of the project.

11.9 Monitoring,

No monitoring is required following the completion of construction.

12 LANDSCAPE AND VISUAL IMPACT

12.1 Introduction

The proposed Dublin Array offshore wind farm development on the Kish and Bray banks will involve the installation of up to 145 wind turbines and associated infrastructure including an offshore substation and inter-turbine array cables as well as the export cable from the offshore substation to shore. The objective of this Chapter of the EIS is to describe the existing landscape and seascape in the region surrounding the proposed Kish and Bray Banks wind farm and to evaluate the likely impact of the wind farm on this landscape and seascape. The assessment of the existing landscape and seascape produced a characterisation of the area that allowed the sensitivity of the area to change to be assessed. In this way the capacity of the landscape to accept change was identified. An appraisal of the likely visual impact of the proposed development was carried out. As part of this assessment the Developers commissioned a detailed study by Macro Works Ltd to document the visual impact of The Dublin Array. This study produced photomontages from twenty-two viewpoints, including one offshore vantage point, to simulate the impact of the wind farm at a number of different locations. The cumulative impact of all phases of the proposed Codling Bank wind farm and of the Arklow Bank wind farm were considered as part of the impact assessment.

12.2 Landscape / Seascape Assessment Methodology

The methodology that was used to document the existing landscape and seascape character of the study area and to assess the impact of the proposed development is outlined below:

12.2.1 Definition of Study Area

The landscape assessment of a wind farm development generally involves the identification of a study area around the proposed development. The study area is identified through the production of Zone of Theoretical Visibility (ZTV) maps (previously known as Zone of Visual Influence (ZVI)). The purpose of these maps is to illustrate the extent to which the wind turbines would be theoretically visible in the area around the wind farm. ZTV maps illustrate the worst-case scenario for wind farm visibility since they consider only landform to determine whether or not the wind farm would be visible from a given point. In reality the visibility would be much reduced due to intervening screening provided by vegetation and man-made structures. Macro Works Ltd produced three ZTV maps for this project, one of which included the cumulative impact of the proposed Codling Bank wind farm and of the Arklow Bank wind farm. The ZTV maps are illustrated in Volume 4 of the EIS. Large-scale printed copies of these ZTV maps will accompany the printed copies of the EIS that will be made available for public consultation as part of the application for a foreshore lease. The location and times for the public consultation of the EIS will be advertised in local and national newspapers.

12.2.2 Description of Existing Landscape and Seascape Character

The existing character of the landscape and seascape of the study area of the wind farm was assessed. The existing character of the area was considered under the marine component (Irish Sea and the Kish and Bray Banks), the coastal component and the landform component.

12.2.3 Appraisal of Landscape Sensitivity

The sensitivity of the landscape and seascape was assessed. This allowed the degree of change that the landscape can accommodate to be appraised, as well as helping to identify viewpoints from which the impact of the development should be documented.

12.2.4 Selection of Viewshed Reference Points

Viewpoints, known as Viewshed Reference Points (VRPs), were selected from which to produce photomontages. The sensitivity of the landscape to change was considered in the selection of the VRPs. In general the VRPs were located in the most sensitive areas from which the wind farm would be most visible. This ensured that the photomontages illustrated the worst-case scenario for visual impact on the landscape.

12.2.5 Production of Photomontages

Macro Works Ltd produced photomontages from twenty-two VRPs including one offshore VRP. These VRPs are illustrated in Volume 5 of the EIS. Large-scale printed copies of these photomontages will also accompany the printed copies of the EIS that will be made available for the public consultation as part of the application for a foreshore lease.

12.2.6 Assessment of Photomontages

Each photomontage was assessed in detail, taking into account the cumulative impact of the proposed Codling Bank wind farm and the Arklow Bank wind farm. The existing view from each photomontage was described and the impact of the wind farm as documented on the photomontage was discussed. An impact was assigned to each photomontage.

12.2.7 Summary Estimation of Landscape Impact

A summary of the findings of the impact assessments was provided in order of decreasing impact, to allow the locations with the highest impact to be clearly identified.

12.2.8 Mitigation Measures

As with the impact assessment that is conducted on other environments in this EIS, mitigation measures were recommended to reduce the visual impact of the development on the landscape and seascape.

12.3 Definition of the Study Area

Macro Works Ltd. were engaged by the Developers to prepare Zone of Theoretical Visibility (ZTV) maps for the proposed development to allow the extent of the study area for the landscape assessment to be identified. As discussed above, these maps document the worst-case scenario for visual impact since they take account of topography alone in determining whether or not the wind turbines would be visible from a given point. In reality, local screening effects reduce the actual visual impact as seen from each point. While the ZTV map does not provide an accurate picture of the actual visual impact of the proposed structure, it does allow the *potential* worst-case impact of the wind farm to be identified, and so it is a very useful tool in allowing the study area for the visual impact to be defined.

The Wind Energy Development Guidelines for Planning Authorities published by the Department of the Environment, Heritage and Local Government (DoEHLG), in 2006 recommend that the radius of ZTV maps, measured from the centre of the proposed wind farm, should increase with increasing turbine height. For blade tips in excess of 100m, a Zone of Theoretical Visibility radius of 20km is recommended, and in areas where landscapes of national or international importance are located within 25 km of a proposed wind energy development it is further recommended that the Zone of Theoretical Visibility be extended as far (and in the direction of) that landscape. Given the scale of this project a ZTV radius of 30km from the centre of The Dublin Array was used.

The Wind Energy Development Guidelines also recommend that the ZTV 'should assess the degree of visibility based on the number of turbines visible to half blade length in addition to hub-height'. Two ZTVs were produced to depict the visibility of The Dublin Array turbines in accordance with these recommendations. The first ZTV depicts the number of turbines visible to hub height (100 m and above) while the second depicts the number of turbines visible to at least half the blade length in addition to hub height (130 m and above). The guidelines also recommend that the cumulative effect of different (neighbouring) wind farms should be clearly represented on the ZTV map. An additional ZTV was produced to demonstrate the cumulative impact of the proposed Codling Bank wind farm and the Arklow Bank wind farm in addition to The Dublin Array. Each ZTV was overlaid on the 1:50,000 series OS map and colour coded according to the number of turbines visible at any one location, as required by the draft guidelines. The methodology that was employed by Macro Works Ltd to produce the ZTVs for this assessment is described in Volume 3, Appendix J. The ZTV maps are illustrated in Volume 4 of the EIS

At this point the reader should refer to Volume 4 of the EIS to view the ZTV maps that were produced for the proposed development. For those who are viewing the EIS as part of the public consultation process, large format printed copies of the ZTV maps have been produced and bound in a separate volume. This volume should be consulted at this point.

The ZTV allows the study area for the visual impact assessment to be identified. The following points can be noted from interpretation of the ZTV maps:

- The study area extends along the coast from north County Dublin, near Portrane, south to Wicklow town;
- There is substantial screening provided by Howth Head to the north and Wicklow Head to the south;
- All turbines may be potentially visible along the coast outside of these areas of screening for a number of kilometres inland;
- Turbines would be visible from a number of elevated locations up to 15 km inland;
- The study area also includes all the waters of the Irish Sea in the region around the Kish and Bray Banks; and
- The ZTV presents the worst-case for visual impact as it does not take account of local screening effects. In reality, the visibility of turbines would be reduced due to the screening provided by structures and vegetation. In particular the ZTV indicates that all turbines would be visible from a substantial area within the north side of Dublin city. Substantial screening would be provided by buildings in this area.

12.4 Description of Existing Landscape and Seascape

This section provides a general description of the landscape in the coastal vicinity of the proposed wind farm under the categories of landscape and seascape, vegetation and structures. The landscape description is further broken down into the marine component, coastal component and landward component. In addition, there are detailed descriptions of the landscape as viewed from each VRP that follow under the detailed impact assessment of photomontages. These also provide an insight into the existing character of the landscape.

12.4.1 Landscape and Seascape

12.4.1.1 The Marine Component

The Kish and Bray Banks are two coast-parallel sandbanks that are located approximately 10 km off the east coast of Dublin and Wicklow in the Irish Sea. In contrast to the Atlantic Ocean on the west coast of Ireland, the Irish Sea is calm and does not experience significant waves. The Kish and Bray Banks themselves are not visible since, while water depths can be as low as 2 m in places, the banks are completely submerged. The shallow nature of the banks results in local breaking waves, which give the banks some definition. The Kish Lighthouse, which is located on the northern extremity of the Kish Bank, identifies the banks to marine traffic. The Irish Sea within the bounds of the study area contains a number of shipping routes and is a busy area for marine traffic en route to and from Dublin Port, Dun Laoghaire Harbour and other ports on the east coast of Ireland.

12.4.1.2 The Coastal Component

The coast from north County Dublin south to Wicklow town runs generally north-northwest to south-southeast. It is predominantly linear with few indentations, and only a number of small islands located close to the coast, such as Ireland's Eye and Dalkey Island. The bays tend to be long and slowly curving. The most significant bay is Dublin Bay, which is marked to the south by Sorrento Point and Dalkey Island, and to the north by Howth Head. There are a number of marked headlands along the coast, some of which are elevated, including Howth Head, Bray Head and Wicklow Head. The coastal region within the study area is dominated in the north by the urban shadow of Dublin, which extends to the northern limits of the study area. Moving south of Dublin City there are a number of large towns, such as Bray and Greystones. As one progresses southwards, the extent of the towns tends to decrease. Much of the coastal region is classified as an Area of Outstanding Beauty. Progressing inland from this coastal region, the land is predominantly low-lying, although there are a number of hills from which very panoramic views of the coast can be seen. The views from a number of these viewpoints are described in detail later since some of these viewpoints are used for photomontage locations.

The coastal zone from Portrane to Wicklow is divided into 6 'local units' in accordance with recent guidelines for seascape assessment. These coastal zones are as follows:

- Portrane to Howth Head
- Howth Head to Sorrento Point
- Sorrento Point to Bray Head
- Bray Head to Greystones
- Greystones to Six Mile Point
- Six Mile Point to Wicklow Head

A number of the VRPs that are used in the landscape impact assessment are located within each of the coastal zone's local units listed above.

12.4.1.3 The Landward Component

Inland from the coast the land generally rises in elevation, comprising of a series of hills and ridges, what might be regarded as the foothills of the Wicklow Mountains. Examples of these hills include the Great Sugar Loaf and Carrickgollogan Hill, whose views are described in detail later. The western edge of the study area is defined by higher ridges and mountain slopes including Kippure (757m), Duff Hill (720m), Djouce Mountain (725m), Carrigvore (682m), Tonduff (642m), Corrig Mountain (618m) and Prince William Seat (555m).

The largest rivers in this area include the Liffey, the Glencullen, the Dargle and the Vartry. The River Liffey rises south of Kippure Mountain, thirteen miles from Dublin and pursues a circuitous route through Co. Kildare, Co. Dublin and Dublin City before entering the sea. The Dargle river rises in the Wicklow mountains and flows east to enter the sea at Bray; the Glencullen river is a tributary of the Dargle; the Vartry river rises at the base of Djouce Mountain, is retained at Roundwood as the reservoir of the Dublin Water Supply, and eventually joins the sea north of Wicklow town. There are a number of lakes and reservoirs in the study area, most of which are located in County Wicklow, particularly in the Wicklow Mountains. These include Lough Bray, Lough Dan, Lough Tay, and the Vartry Reservoir.

12.4.2 Vegetation and Land Use

The narrow coastal region is characterised by pebble and sandy beaches as well as exposed rock in places. Sand dunes also occur and are typically covered with grasses. Other vegetation in this area includes trees, hedgerows and gorse, which is visually impressive from April. West of the coastal strip the land is dominated by pasture farmland, defined by hedgerows. Rising to the higher ground, the vegetation is a mixture of bogland and forestry, with extensive planting of commercial forestry having taken place in recent years. Between the north of Wicklow town and Kilcoole, floodwaters are trapped in low-lying marsh, channels and saltmarsh.

12.4.3 Structures

The northern half of the study area is highly urban in character, being dominated by Dublin City and its urban shadow. The area contains a very high density of structures, such as residential and commercial buildings, road and rail networks, ports and associated infrastructure, communication routes and electrical utilities. The southern part of the study area is less urban in character, though the area has experienced significant development recently to serve the increasing size of Dublin City. There are a number of significantly sized towns in this area as well as many private houses located outside the major towns, some of which serve as summer holiday residences. Most of the large towns are located along the coast. The coastal area can be summarised as having a high density of man-made structures similar to, though less dense than, Dublin City. Further inland, the presence of the foothills of the Wicklow Mountains, and the Wicklow Mountains themselves, have few man-made structures. Much of this area is considered an Area of Outstanding Beauty. Structures are limited to isolated farmsteads, and walking routes, such as The Wicklow Way.

12.4.4 Designations

The county development plans of the local authorities in the study area were consulted to review the landscape designations that have been assigned within the area. While the local authorities are not responsible for the grant of planning for The Dublin Array, and while they do not have policies that address large-scale offshore wind farm developments in general, the landscape designations of the local authorities help to identify locations as visual reference points for the visual impact assessment.

12.4.4.1 Fingal County Council

The Fingal Development Plan 2011-2017 includes the following objectives in relation to Wind Energy:

> **<u>Objective EN06:</u>**
> *Support Ireland's renewable energy commitments outlined in national policy by facilitating the exploitation of wind power where such development does not have a negative impact on the surrounding environment, landscape or local amenities.*
>
> **<u>Objective EN07:</u>**
> *Require that all new wind energy developments in the County comply with the guidelines contained within Fingal County Council Wind Energy Strategy.*

The Fingal County Council *Wind Energy Strategy,* referred to in Objective EN07 above, was published by the Council in October 2009 and provides a strategy to direct the location of wind energy developments within the landscape of Fingal County.

The southern coastal section of Fingal County falls within the 30 km visual extent from the proposed wind farm at the Kish and Bray Banks. This area includes, importantly, Howth Head and North Bull Island. There is a Special Amenity Area Order on Howth Head in the County Development Plan. The visual impact from Howth Head and North Bull Island, as well as a number of other coastal viewpoints located within the boundary of Fingal County Council, is assessed in detail in this visual impact assessment. Fingal County Council was consulted with regard to the choice of VRPs for this visual impact study.

12.4.4.2 Dublin City Council

Given the substantial screening provided by topography, structures and vegetation, the Developers are satisfied that the development will have little or no impact on this district. The local County Development Plan is therefore not discussed further. Dublin City Council was consulted with regard to the choice of VRPs for this visual impact study.

12.4.4.3 Dun Laoghaire Rathdown County Council

The Dun Laoghaire-Rathdown County Council County Development Plan identifies that it is Council policy to support and promote, in conjunction with other relevant agencies, wind energy initiatives – both on-shore and offshore – when these are undertaken in an environmentally acceptable manner.

The Development Plan further notes that while the Council has concluded there is no realistic or practical potential for economic on-shore wind farm development in the County without significant and overriding adverse visual and environmental impacts, "*the Council remains supportive of offshore wind energy initiatives and will cooperate with the Department of Communications, Energy and Natural Resources in any practical fashion in relation to the implementation of additional wind and wave projects in the Irish Sea".*

Considerable areas within the county boundaries fall within the 30 km visual extent of the wind farm. A number of scenic routes and views fall within the zone of theoretical visibility, and some of these locations were selected as VRPs for the visual impact assessment. Dun Laoghaire Rathdown County Council was consulted with regard to the choice of VRPs for this study.

12.4.4.4 Wicklow County Council

Wicklow County Council's County Development Plan for the period of 2010 to 2016, includes objectives to encourage the development of wind energy in accordance with the County Wicklow Wind Strategy and in particular to allow wind energy exploitation in most locations in the County subject to considerations set out in the Wind Strategy, which forms part of the Plan and also to facilitate the development of off-shore wind energy projects insofar as onshore facilities may be provided.

Much of the area included in the ZTV from which the wind farm would appear to be visible is deemed to be sensitive to development by Wicklow County Council. Examples include The Great Sugar Loaf and Bray Head. Wicklow County Council was consulted with regard to the choice of VRPs for this study. A number of ZTVs were chosen at sensitive locations along the coastal zone and on elevated ground. The results of the visual impact assessment from these points are presented later.

12.5 Appraisal of Landscape Sensitivity

The review of the existing landscape and seascape of the Study Area allows the capacity of the landscape to accommodate change to be evaluated prior to the detailed assessment of the visual impact of the proposed development being carried out.

The general character of the Study Area is dominated by Dublin city to the north, which contains approximately one third of the population of Ireland. Dublin has undergone extensive growth and development over the last twenty years. To the south of Dublin, County Wicklow contains many areas of outstanding natural beauty, as indicated by the 'Garden of Ireland', for which it is renowned. As Dublin grew, Wicklow also underwent extensive development. The coastal zone in particular has been developed, with towns such as Bray, Greystones and Wicklow growing in population, often to support people working in Dublin that commute from these towns. The Study Area is well marked with signs of man-made developments. The N11 national road route passes through the Study Area linking Dublin with the east and southeast of Ireland. This route, which is undergoing major upgrades, passes close to the Great Sugar Loaf mountain and through the Glen of the Downs. The rail route serving the east coast of Ireland from Dublin passes along the coast. This line has been electrified as far as Greystones to allow the DART service to serve towns such as Bray and Greystones. The character of the landscape in the Study Area can be described as being marked by man-made developments. It is highly urbanised to the north and along most of the coastal zone. The sense of urbanisation decreases as one moves south and with increasing distance inland. The landscape is quite tolerant to a development of the type described in this EIS.

The seascape off the east coast of counties Dublin and Wicklow is less developed than the landscape, with no major offshore developments. The Kish Lighthouse, which marks the northern extremity of the Kish Banks, is the only man-made development of note to be located in the Study Area. The Irish Sea within the Study Area has a number of busy shipping routes that serve the ports of Dublin, Dun Laoghaire and Wicklow. There is also much recreational sailing activity, predominantly in the area close to the shore around Dublin Bay. In contrast to the landscape, the seascape in the Study Area is sensitive to change and, as with the landscape, the sensitivity increases with increasing distance from Dublin.

12.6 Selection of Viewshed Reference Points

Viewshed reference points (VRPs) were selected from which to document the visual impact of the proposed development through photomontages.

The Wind Energy Development Guidelines for Planning Authorities published by the Department of the Environment, Heritage and Local Government (DoEHLG), in 2006 provides the following guidance in relation to the selection of viewshed reference points:

1. *They should reflect local designations as might be relevant from the County Development Plan or Local Area Plan, including Views and Prospects and other scenic amenity designations.*

2. *They should be located at varying distances from the wind farm and where relevant, afford views from all directions so that a good sense of what is proposed can be observed. This might include locations outside the jurisdiction of the planning authority to which the application is being lodged.*

3. *They should always present the worst case (most open) available view from any given location.*

4. *It is advisable to consult with the relevant planning authority(s) in identifying and choosing viewshed reference points so that delays owing to omissions can be avoided.*

These criteria, along with a combination of visits to the study area, desk studies and assessment of the ZTV maps allowed the twenty-two VRPs to be chosen as a basis for this study. Macro Works Ltd, who also produced the photomontages for the Arklow Bank wind farm, provided suggestions for these VRP locations. The VRPs that were chosen included centres of population, elevated viewpoints, communication routes and amenity areas such as beaches and hilltops.

The relevant planning authorities in the Study Area were consulted before the final selection of VRPs was made. Fingal County Council, Dublin City Council, Dun Laoghaire-Rathdown County Council and Wicklow County Council were notified of the suggested VRPs, including the depiction of the VRPs on a map, in order to confirm that they were considered to be suitably representative and appropriate.

The location of the VRPs that were finally selected is illustrated below in Figure 12.1 and described in Table 12.1. Further details of the VRP, such as the angle of view of the panorama, the weather conditions and the distance to the nearest turbine are provided on each of the photomontage prints, which are presented in Volume 5 of this EIS.

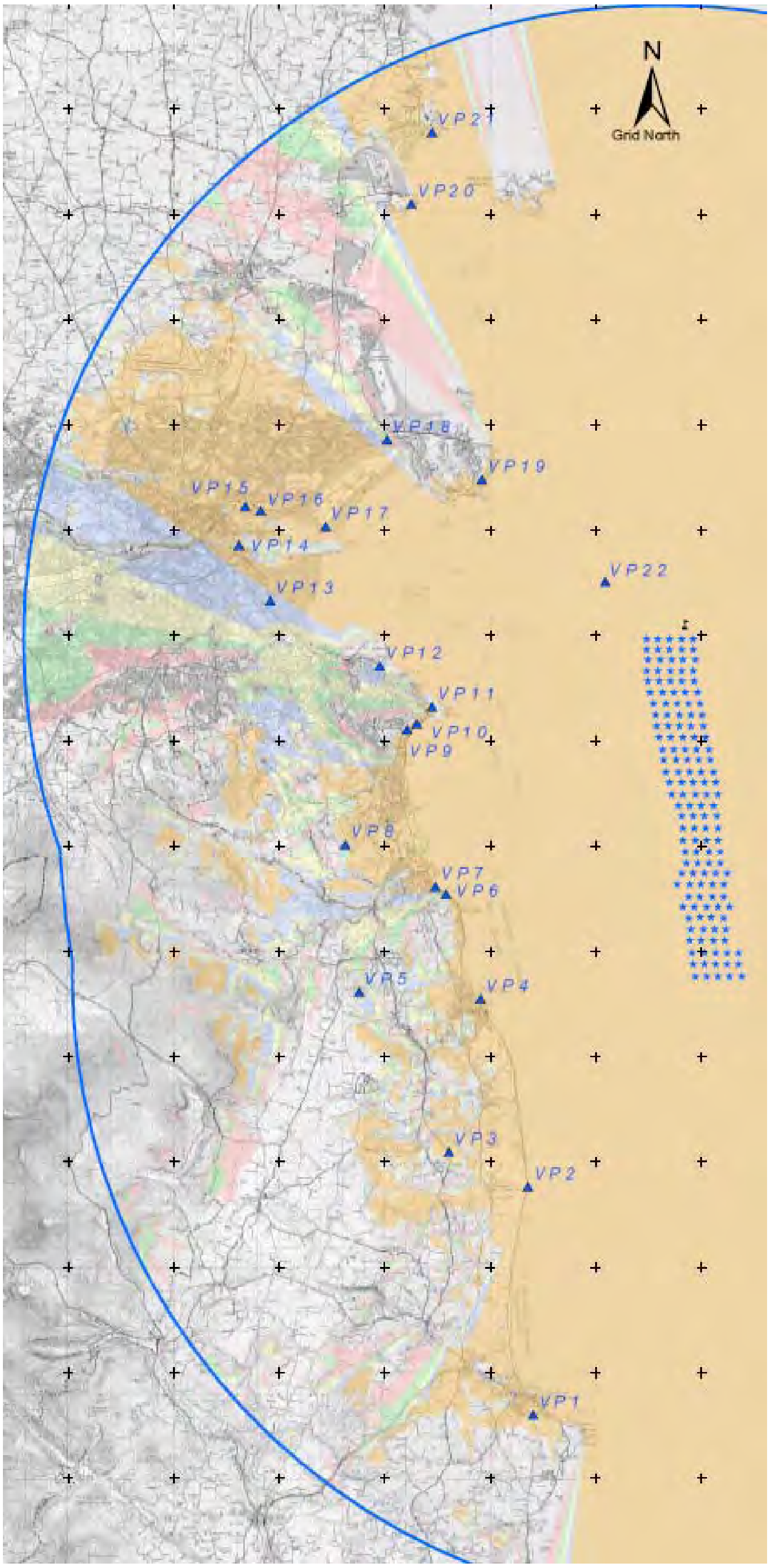


Figure 12.1 Location of Viewshed Reference Points (VRP's)

Viewpoint	Easting	Northing	Description
VRP1	332005	193076	View from scenic car park overlooking Wicklow Town at Corporation Lands, Co. Wicklow
VRP2	331762	203869	View from beach entrance at Six Mile Point, Newcastle, Co. Wicklow
VRP3	328029	205518	View from high bend in the N11 road at Kilmullin, Co. Wicklow
VRP4	329528	212767	View from Greystones Harbour, Co. Wicklow
VRP5	323780	213091	View from the summit of the Sugar Loaf Mountain, Co. Wicklow
VRP6	327893	217729	View from elevated position on walkway around Bray Head, Co. Wicklow
VRP7	327391	218084	View from the southern end of the Bray promenade, Co. Wicklow
VRP8	323134	220070	View from the top of the hill at Carrickgollogan, Co. Dublin
VRP9	326058	225529	View from the obelisk at the top of Killiney Hill, Co. Dublin
VRP10	326513	225809	View from Vico Road adjacent to Killiney Hill, Co. Dublin
VRP11	327226	226611	View from seating area at Coliemore harbour, Dalkey, Co. Dublin
VRP12	324757	228537	View close to the entrance to the East Pier, Dun Laoghaire, Co. Dublin
VRP13	319584	231613	View from the road R131 adjacent to public parking area and amenity close to Sandymount, Co. Dublin
VRP14	318104	234250	View from the East-Link toll bridge, Ringsend, Co. Dublin
VRP15	318402	236089	View from link road between R131 at Dublin Port and the coast road near Clontarf, Co. Dublin
VRP16	319124	235885	View from pedestrian walkway along the sea wall close to Clontarf Village, Co. Dublin
VRP17	322205	235136	View from a point approximately 300 m from the end of the Bull Wall, North Bull Island, Co. Dublin
VRP18	325102	239248	View from the coast road R105 facing Dublin Bay at Sutton, Co. Dublin
VRP19	329595	237364	View from scenic viewpoint adjacent to car park at The Summit, Howth Head, Co. Dublin
VRP20	326256	250417	View from car park at scenic viewpoint close to the Martello Tower at Portrane, Co. Dublin
VRP21	327233	253805	View facing south / south-east from entrance to new housing estate in Rush, Co. Dublin
VRP22	335426	232535	Offshore view facing southeast from small boat 7 km southeast of Howth Head

Table 12.1 Description of Viewshed Reference Points (VRP's)

12.7 Sensitivity of Viewshed Reference Points

The visual impact of the proposed development from each VRP depends on the sensitivity of the location in question, as well as the magnitude of the change as seen from that location. The sensitivity of each VRP was estimated as very low, low, medium, high or very high. The criteria that were used to estimate the sensitivity were based on those used by MosArt in the EIS for the Codling Bank and Arklow Bank wind farms. The criteria consisted of the following:

- Sense of awe;
- Number of viewers;
- Likely mental disposition of viewers;
- Recreational facility;
- Provision of elevated panoramic views;
- Presence of water (river, lake, sea);
- Strong presence of mountains;
- Degree of perceived naturalness and sense of remoteness;
- Ruggedness of landform / exposure of rock outcrops;
- Presence of striking or noteworthy features;
- Integrity of character;
- Distinctiveness / memorability;
- Fragility;
- Tourist or other income value;
- Historical, cultural and / or spiritual significance sensed; and
- Rarity or uniqueness.

The overall sensitivity of each VRP was assessed. The sensitivity of the VRPs is indicated in Table 12.2.

Assessment Criterion	**Viewshed Reference Point Number**																					
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Sense of awe	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	N	Y
Number of viewers	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Likely mental disposition of viewers	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	N	Y
Recreational facility	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	Y
Provision of highly elevated panoramic views	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	N	N	N	N	N	N	N	Y	N	N	N
Presence of water (river, lake, sea)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Strong presence of mountains											N	N	N	N	N	N	Y	Y	Y	N	N	N
Degree of perceived naturalness and sense of remoteness	N	Y	N	N	Y	Y	N	N	Y	Y	N	N	N	N	N	N	Y	N	Y	N	N	Y
Ruggedness of landform / exposure of rock outcrops	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	N	N	N
Presence of striking or noteworthy features	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y
Integrity of character	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Distinctiveness / memorability	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	N	Y
Fragility	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N	Y
Tourist or other income value	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	N	Y
Historical, cultural and / or spiritual significance sensed	Y	Y	N	Y	N	N	Y	N	Y	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	N	Y
Rarity or uniqueness	N	Y	N	N	Y	Y	N	N	Y	N	N	N	N	N	N	N	N	N	Y	N	N	N
Summary Sensitivity Assessment	H	**VH**	**M**	**H**	**VH**	**VH**	**H**	**M**	**VH**	**VH**	**H**	**H**	**H**	**L**	**L**	**M**	**H**	**M**	**VH**	**H**	**L**	**H**

Table 12.2 Assessment of Landscape Sensitivity of Viewshed Reference Points

Key: *'N' indicates that the VRP is generally not sensitive with respect to the assessment criterion, while 'Y' implies that it is sensitive*
The overall sensitivities are indicated as follows:VL = very low sensitivity; L = low sensitivity; M = medium sensitivity; H = high sensitivity; and VH = very high sensitivity

12.8 Overview of Typical Landscape Impact of Wind Farms

12.8.1 Introduction

Modern wind farms, by their nature, consist of large-scale developments of tall vertical structures that are visible on the landscape and to which attention can be drawn due to the rotation of the turbine blades. Because of constraints on the design of wind turbines it is not possible to substantially reduce their size. Similarly, the fact that wind speeds are significantly higher at several tens of metres above the ground, and that a doubling of wind speed would result in an eight-fold increase in electrical output, means that reduction in height is not a commercially viable option. In addition to these size issues, the movement of the blades is an integral part of wind turbine operation and is not a factor that can be changed. These characteristics mean that the visibility of wind energy projects cannot be changed substantially by modification of the structures themselves. Stanton (1996) points out that "*This characteristic exposure, in addition to the height of wind turbines, results in wind farms being highly visible, although this also relates to a number of other variable landscape characteristics, for example weather conditions, the mode and speed of viewing and the nature of the surrounding landscape*". Wind farm size therefore means that forms of screening would not be practical. The only way to substantially reduce the visibility of wind turbines is to site them sensitively. However, neither can they be placed in secluded settings, as it is in exposed sites that the wind energy resource is best. Therefore wind farms are generally highly visible and few mitigating factors are possible at any particular site.

It should also be noted that visibility is different to other environmental considerations (such as atmospheric emissions and noise) associated with industrial projects since it is not effective at all times. Whereas pollution and noise from industrial projects can be constant, visibility is not a factor at night (apart from navigational lights) or in cloudy weather conditions.

There are a number of positive impacts that are associated with the appearance of wind turbines. Wind turbines are associated with green energy and with reducing emissions of harmful pollutants. Wind turbines also possess an aesthetic quality and do arouse a sense of curiosity in people, though this association is subjective.

12.8.2 Research on Public Perceptions to Wind Farms

12.8.2.1 Public Attitudes to Wind Energy in Ireland

As outlined previously, Ireland's first independent study of the Irish public's attitude towards the development of wind energy and the integration of wind farms on the Irish landscape was commissioned by Sustainable Energy Ireland in 2003 ('Attitudes Towards The Development of Wind Farms in Ireland'). Two studies were conducted – the first, a national survey aimed at identifying public attitudes to renewable energy and to wind energy in Ireland, and the second, a catchment area survey focused specifically on people living with a wind farm in their locality or in areas where wind farms are planned. The survey was designed by an independent cross-sector steering group and carried out by Landsdowne Market Research and MosArt. It sought to establish the attitudes and opinions of the public to specific aspects of wind energy, including visual aspects in differing landscapes. The national survey sampled 1,200 people in face-to-face interviews, while the catchment survey sampled 200 people in the areas where wind farms already exist and 150 people in areas where full planning permission for a wind farm has been granted but construction had not yet taken place.

The study indicated that the overall attitude to wind farms amongst the public is almost entirely positive, with more than eight out of ten people being favourable to the construction of more wind farms in Ireland. Over two-thirds of Irish adults (67%) are either very or fairly favourable to having a windfarm built in their locality and, interestingly, this percentage increases (79%) when the people questioned are restricted to those that have actually seen a wind farm.

The survey found that people with direct experience of a wind farm in their locality are generally impressed with it as an additional feature in the landscape and that they do not consider it to have adversely affected their area – *"those with direct experience of wind farms in their locality do not in general consider that they have had any adverse impact on the scenic beauty of the area, on wildlife in the area, or on tourism"*. Indeed the survey found it encouraging that *"over 60% of those living in close proximity to existing wind farms would favour either an additional wind farm in the area or an extension to the existing one"*.

12.8.2.2 Attitudes to Wind Energy Across Europe

The European Wind Energy Association recently published a summary of surveys on European attitudes to wind power (EWEA, 2003). In Europe, the most comprehensive analysis that was conducted recently was the Eurobarometer survey "Energy: Issues, Options and Technologies" (Eurobarometer, 2003) which was commissioned by DG-Research and conducted across the EU-15. In this survey over 16,000 people were interviewed during February-April 2002. The aim of the study was "to obtain a clearer picture of public opinion on energy related issues, including their scientific, technological aspects and prospects for the future". A consistently high level of support for renewable energy emerges from this survey across a range of parameters and issues. In the Eurobarometer survey, almost 90% of respondents consider "global warming and climate change to be serious issues that need immediate action". The EWEA summary of surveys across Europe found that there is overwhelming support for wind power as a renewable energy source. Concerns about aesthetics and noise pollution amongst people who have not witnessed wind farms was an issue. However, in regions where wind farms were installed, those surveyed saw little or no negative effects, and were in favour of further wind park development.

12.9 Classification of Landscape Impact

In order to estimate the visual impact of the proposed development on the landscape from each VRP, the *sensitivity of the viewpoint* and the *magnitude of the change* on the landscape are considered. The sensitivity of the viewpoints were discussed and classified above. The magnitude of the change on the landscape / seascape is determined by the distance to the nearest turbine and the number of turbines that are visible.

The overall impact can be **Positive**, **Adverse** or **Neutral**. It is also possible that there is **No Impact**, in cases where the turbines are not visible from the viewpoint. For clarity, the overall impact is assessed as neutral in cases where the wind farm can be seen from the viewpoint but is judged not to have an impact on the landscape / seascape at this location. This may occur at a viewpoint that is located at a very large distance from the wind farm where, for instance, the view is dominated by the sea and the wind farm is barely visible.

Each impact, whether positive or negative, is quantified as being Minor, **Moderate** or **Major**. Therefore there are eight possible categories of impact:

- Positive Major
- Positive Moderate
- Positive Minor
- Adverse Minor

- Adverse Moderate
- Adverse Major
- Neutral
- No Impact

It should be noted that in the visual impact assessment a 'worst case scenario' approach has been adopted in scoring the overall impact from each viewpoint. Also when choosing the VRPs, locations were deliberately sited in some areas of high sensitivity. This ensures that the worst-case scenario for visual impact would be represented in this assessment.

12.10 Visual Characteristics Common to All Viewpoints

There are a number of landscape impacts that are common to all VRPs. These are discussed below, in advance of the detailed discussion of the visual impact at each VRP, and these are not considered further in the individual assessments at each viewpoint.

12.10.1 Layout of Turbines

In spite of the obvious visibility of a wind farm, wind farms should appear neat and ordered on the landscape. Stanton (1996) states that *"a wind farm possesses visual relationships between each turbine, in addition to the landscape as a collective group. This relationship must appear clear and simple in order for a development to seem rational"*. This principle of clustering has been incorporated as far as possible into the design of the wind farm on the Kish and Bray Banks as a way of mitigating its visibility. The layout comprises a series of straight lines of turbines aligned on the central axis of the banks, approximately parallel to the coastline. Additional regularity is assured through the regular spacing of turbines both within and between rows, which are to be separated by 500 m. The broadly linear layout is more in keeping with the parallel straight coastline than an east-west linear array of turbines would be. The Dublin Array would appear to occupy a wider extent of the seascape when viewed from most points along the coast than the proposed Codling Bank wind farm. Correspondingly, the distribution of turbines along the Kish and Bray Banks would appear to be less dense than that of the Codling Bank wind farm.

With the development of turbine technology, larger capacity turbines may be available at the time of purchasing the turbines (these could have a capacity of upwards of 5 or 6 Mega Watts (MW)). Should such a turbine be used in the development, this would mean that fewer turbines, with a wider spacing, would be installed on the banks. For instance, a capacity of close to 520 MW could be achieved using 145 no. 3.6 MW turbines or 104 no. 5 MW turbines. The turbine dimensions would not exceed the maximum dimensions specified in Chapter 2 of this volume of the EIS in either case. For the purposes of assessing the visual impact of the proposed development in this chapter, the largest number of turbines is assumed i.e. 145 turbines.

12.10.2 Turbine Height and Blade Diameter

The maximum hub height of all turbines proposed for Dublin Array is 100 m, with a maximum blade diameter of 130 m. For the purposes of the visual impact assessment, the maximum hub height and blade diameter has been assumed for all turbines.

12.10.3 Turbine Colour

In the past many different colour schemes have been examined for wind turbines and it is now the industry consensus that plain matte white or mid grey is the option with the least visual effect. White / mid grey is by far the most common colour used in Irish and UK wind farms. Painting turbines dark grey, green or metallic colours can give a menacing aspect to them and convey an impression of being technologically primitive. White is a colour associated in our society with cleanliness and purity and is more in keeping with the public's perception of renewable energy. It is envisaged that the turbines would be painted matte white / mid grey unless a different scheme is specified in planning. It is expected that the lower section of the turbine towers would be painted with bright yellow bands to make the turbines highly visible for marine navigation purposes. This requirement would be as specified by the Commissioners of Irish Lights prior to construction.

12.10.4 Turbine Tower Shape

Visually, lattice towers can appear untidy and with a complex form. Tubular, gently tapering towers appear simpler and more sculptural and so have a lower visual impact. Only tapering tubular towers would be used in this project.

12.10.5 Marine and Aviation Safety Lighting

Each turbine would be marked in such a way that it conforms to the Irish Aviation Authority (IAA) and the Commissioners of Irish Lights standards. Wind turbine towers chosen for representing the periphery of wind farms are termed Significant Peripheral Structures. It is expected that such structures would be spaced at intervals of no more than 3 nautical miles, where practicable. The lighting of these turbine towers would be of a distinctive flashing characteristic fitted above the Highest Astronomical Tide (HAT) but below the lowest point of the arc of the turbine blades. The lights would be visible through 360° in azimuth and would have a range of 10 nautical miles. This would allow the project to be 'ring fenced' with as little as eight navigation Lights for maritime navigation and eight for aviation, The Commissioners of Irish Lights and the Irish Aviation Authority will specify the exact number and type of lights required. It is possible that some of these lights may be visible from the shore.

12.10.6 Transformer Substation

A single offshore substation is proposed within the wind farm to house electrical transformers and associated equipment. This structure will have a height of approximately 40 m. The visual impact of such a structure in the context of 145 turbines with a maximum blade height above sea level of 160 m will be insignificant.

12.11 Detailed Landscape Impact Assessment

12.11.1 Introduction

Having considered the character of the existing landscape and the capacity of this landscape to accommodate change, the impact of the proposed development on the landscape is now assessed. In order to document this impact, the Developers engaged Macro Works Ltd to produce photomontages from each of the VRPs that were identified earlier. A photomontage was produced for each viewpoint. In each photomontage the cumulative impacts of all phases of the proposed Codling Bank wind farm and the Arklow Bank wind farm were taken into account by illustrating turbines from these developments (if they were visible from the viewpoint). In addition, in cases where turbines from The Dublin Array overlapped with turbines from the Codling Bank or Arklow Bank developments, additional photomontages were produced to illustrate the impact of The Dublin Array turbines in isolation (i.e. without the Codling / Arklow Bank developments in the background). This allowed The Dublin Array turbines to be distinguished clearly from neighbouring developments. The methodology that was used to produce the photomontages is described in Volume 3, Appendix J, while the photomontages themselves are presented in a separate volume of the EIS - Volume 5.

At this point the reader should refer to Volume 5 of the EIS to view the photomontages that were produced for the proposed development. The following section "Detailed Impact Assessment" should be read in conjunction with these photomontages. For those who are viewing the EIS as part of the public consultation process, large format printed copies of the photomontages have been produced and bound in a separate volume.

The following section presents the detailed impact assessment from each of the VRPs. The existing view from the VRP location is first described and the impact of the development on the landscape assessed. The overall impact of the development from the VRP is determined by considering the sensitivity of the viewpoint, the magnitude of the effects and the cumulative impact of neighbouring developments at that point.

Prior to considering the detailed impact assessment, there are some points, which have an influence on the impact that is ascribed to each viewpoint, that are worth bearing in mind.

12.11.2 Limits of Human Visibility and Weather

In the Guide to Best Practice in Seascape Assessment (2001) there are comments made on the limits of visibility that the human eye can resolve. It is stated that:

"At a distance of 1 km, in conditions of good visibility, a pole of 100 mm diameter will become difficult to see; and at a distance of 2 km, a pole of 200 mm will be equally difficult to see. In other words, there will be a point where an object, whilst still theoretically visible, will become too small for the human eye to resolve"

The diameter of the wind turbine towers to be used in this project would measure up to 6 m at the base and 4 m at hub height. Using this principle, it is considered that at distances of 20 km many parts of the wind turbines would be close to the natural limits of human visibility in nearly all weather conditions. Beyond 30 km, while the entire wind farm structure would still be theoretically visible from those elevated viewpoints with a clear line of sight to it, the wind farm would not be discerned by the human eye even in clear conditions. Inclement weather conditions would, of course, serve to reduce visibility of the wind farm, even at distances of less than 20 km.

12.11.3 Detailed Impact Assessment

The visual impacts from all VRPs are assessed in detail on the following pages.

12.11.3.1 Landscape Impact Assessment from VRP 1

VRP Location: Scenic Car Park Overlooking Wicklow Town at Corporation Lands, Co. Wicklow

VRP sensitivity	High
Distance to nearest turbine	22.2 km
Number of turbines visible	All visible

Existing View: This viewpoint is from a scenic car park located to the south of Wicklow town. The car park is situated in an elevated position and has panoramic views encompassing Wicklow harbour and bay. The view to the north of the location encompasses the Great Sugar Loaf, the Little Sugar Loaf, Bray Head and distant views of the Wicklow mountains. This viewpoint is set in an urban context with the town centre, harbour and housing estates visible below the car park.

Landscape Impact: The proposed wind farm would be visible from this location with no screening being provided. However there is considerable distance between the turbines and the coast at this point, the closest turbine being located 22.2 km away. While all turbines are visible from this location, the wide panoramic view of the sea from this point reduces the extent of the panorama that is occupied by the wind farm. The layout of the wind farm as viewed from this point consists of a number of groups of turbines that taper to single turbines at the northern and southern edges of the wind farm. This viewpoint is set close to a busy town and working port with a lot of existing human activity, and as such the wind farm may be more accommodated at this location than at other viewpoints.

Cumulative Impact: All turbines in the proposed Codling Bank wind farm would also be visible from this viewpoint. The Codling Bank wind farm is closer to the viewpoint that The Dublin Array (the closest turbine would be located at a distance of approximately 17.9 km). It also occupies a larger extent of the seascape and is more densely clustered than The Dublin Array. The overall cumulative effect of this proposed development at this viewpoint is high. The Arklow Bank wind farm is not visible from this location and so there are no cumulative impacts arising from it.

Summary Impact Assessment: While the entire wind farm would be visible from this popular elevated point, it would be located a long distance from the viewpoint and would not occupy a large extent of the seascape. In addition, since this location is set in the context of a busy working town and port, the overall classification is considered **Adverse Moderate**.

12.11.3.2 Landscape Impact Assessment from VRP 2

VRP Location: View from Beach Entrance at Six Mile Point, Newcastle, Co. Wicklow

VRP sensitivity	Very High
Distance to nearest turbine	12.7 km
Number of turbines visible	All visible

Existing View: This viewpoint is located on a long shingle beach located on the coast close to Newcastle, Co. Wicklow. It is a popular area for walking, swimming and shore angling. The Dublin – Rosslare railway line runs alongside the beach. The panorama from this viewpoint is dominated by the sea to the east, with inland views being dominated by the Great Sugar Loaf and the Wicklow Mountains to the northwest.

Landscape Impact: All turbines in the proposed wind farm would be visible from this viewpoint, and no screening would be provided (except by neighbouring turbines). The nearest turbine is located 12.7 km from the viewpoint, with all turbines being set against the horizon. Due to the wide extent of seascape that is visible from the viewpoint, the wind farm occupies a relatively small extent of the sea view. There is no visual connection between the wind farm and coast, and so views of the wind farm are not fenced-in. The railway line that runs parallel to the shore along the shingle beach environment sets the wind farm in the context of human development that has already taken place in the area. The layout of the wind farm as viewed from this point consists of a regular line of turbines from the left (northern side of the development), with some avenues of turbines appearing the closer one gets to the right (southern side of the development). The panorama tapers to views of single turbines on the far right of the development.

Cumulative Impact: All turbines in the proposed Codling Bank wind farm would also be visible from this viewpoint. The Codling Bank wind farm occupies a similar extent of the seascape though it appears to be more densely clustered than The Dublin Array. The Arklow Bank wind farm would also be partially visible from this location. 80 turbines in all can be seen, with the remainder being screened by the coastline. There is no overlap between turbines from any of the developments from this viewpoint. The overall cumulative effect at this viewpoint is significant.

Summary Impact Assessment: While this location is one of high amenity value, the regular layout of the wind farm viewed against the horizon line and the relatively small extent of the seascape occupied by the development compared to at other locations result in an overall impact of the proposed development of **Adverse Moderate**.

12.11.3.3 Landscape Impact Assessment from VRP 3

VRP Location: View from High Bend in the N11 Road at Kilmullin, Co. Wicklow

VRP sensitivity	Medium
Distance to nearest turbine	14.3 km
Number of turbines visible	All visible

Existing View: This viewpoint is located on an elevated position on the busy national N11 route at Kilmullin, Co. Wicklow. The view towards the sea is dominated by open farmland with the sea in the background. Bray Head is visible to the north along the coast and, inland towards the north are the Great Sugar Loaf and the rolling Wicklow Mountains. Sparse residential housing can be seen along the coast.

Landscape Impact: The entire wind farm would be visible along a large portion of the natural sea views that are visible from this point. The closest turbine is located at a distance of 14.3 km. While some screening is provided by vegetation in the vicinity, no screening is provided from this particular viewpoint location. Turbines to the left of the wind farm appear closely packed, with avenues of turbines visible in the centre and turbines more sparsely laid out to the right. The presence of the N11 road, habitations and other forms of human activity in the area such as telegraph poles set the wind farm in the context of an area that has already seen significant human development.

Cumulative Impact: The full extent of the proposed Codling Bank wind farm would also be visible from this viewpoint, though there is some local screening of turbines provided by vegetation in the area. The Codling Bank wind farm appears as a distinct development, with no overlap between its turbines and the turbines from The Dublin Array. The Codling Bank wind farm occupies a smaller extent of the seascape though it appears to be more densely clustered than The Dublin Array. The Arklow Bank wind farm would not be visible from this location due to screening in the area and so there would be no cumulative impacts arising from it. The overall cumulative effect at this viewpoint is significant.

Summary Impact Assessment: The wind farm is highly visible from this location though local screening effects reduce its visual impact from some points in the vicinity. The wind farm does not dominate the panoramic sea views from this medium sensitivity location. When combined with the sense of the area, which has been developed significantly, the overall classification is considered to be **Adverse Minor.**

12.11.3.4 Landscape Impact Assessment from VRP 4

VRP Location: View from Greystones Harbour, Co. Wicklow

VRP sensitivity	High
Distance to nearest turbine	10.2 km
Number of turbines visible	All visible

Existing View: This viewpoint is located on the shoreline at the seaside town of Greystones. The view from this location is dominated by the wide panorama of the sea. To the north, along the coast, Bray Head can be seen.

Landscape Impact: All turbines in the proposed development would be visible against the horizon from the viewpoint at Greystones Harbour with no local screening being provided. Given that the wind farm occupies a significant portion of the extent of the seascape and that the nearest turbine is located at a distance of approximately 10.2 km, the visual impact from this point would be one of the most significant of all VRPs. The closest turbines, which are located to the right (southern side) of the development, are regularly spaced. As one moves to the left, a number of avenues of turbines appear and towards the far left (northern side) of the development the turbines gradually taper easing the transition to open sea.

Cumulative Impact: All turbines in the proposed Codling Bank wind farm would also be visible from this viewpoint with the closest turbine being located at a distance of approximately 15 km. Each wind farm appears as a distinct development with no overlap between turbines. The Dublin Array occupies a wider extent of the seascape, while the density of turbines in the Codling Bank is greater than that on the Kish and Bray Banks. The overall cumulative effect at this viewpoint would be significant. While the Arklow Bank wind farm could potentially be seen from this viewpoint, it is over 30 km from The Dublin Array. The EIS for the Codling Bank wind farm concluded that the cumulative impact of the Arklow Bank development was negligible. The cumulative impact is also considered insignificant in this EIS.

Summary Impact Assessment: While the development would be clearly visible along the horizon from this viewpoint, and the closest turbines would be amongst the closest of all viewpoints, the wind farm would be viewed from an area that has a largely urban context. The visual impact from this point is therefore judged to be **Adverse Moderate.**

12.11.3.5 Landscape Impact Assessment from VRP 5

VRP Location: View from Summit of the Sugar Loaf Mountain, Co. Wicklow

VRP sensitivity	Very High
Distance to nearest turbine	15.8 km
Number of turbines visible	All visible

Existing View: The Great Sugar Loaf mountain, shaped much like a volcano, is located in north Wicklow. The mountain is very popular with walkers due to its close proximity to Dublin, its ease of access and the panoramic views that can be seen from its summit. Extensive views are afforded of the Irish Sea to the east (indeed the mountains of Wales can be seen on a very clear day). Looking northwards, the expanse of Dublin city can be seen in the distance. The Little Sugar Loaf and the Glen of the Downs are situated between the summit and the Irish Sea, though the national N11 route is also clearly visible. Views to the west are dominated by the Wicklow Mountains.

Landscape Impact: This is the first viewpoint from which the turbines appear below the horizon and from which the viewer can appreciate the full depth of the wind farm. The viewer has a more three dimensional view of the wind farm than that afforded from previous VRPs. The turbines are located just below the distant horizon, with the nearest turbine being located at a distance of 15.8 km from this location. There are several avenues of turbines located on the right (southern) end of the development that allow the viewer to appreciate the grid-like geometry of the wind farm. As one moves to the left, the pattern of turbines becomes less regular and increases in density. The presence of the wind farm would introduce a large human development to the area of open sea that is to date only characterised by the presence of the Kish Lighthouse. However, this development would be set against a backdrop that has a lot of other human development; for instance, Bray town and the N11 are clearly visible from the same viewpoint. In addition, the waters around the development provide busy shipping lanes to marine traffic travelling in and out of Dublin Port and Dun Laoghaire Harbour.

Cumulative Impact: All turbines in the proposed Codling Bank wind farm would also be visible from this viewpoint with the closest turbine being located at a distance of approximately 20.7 km. Each wind farm can be distinguished with no overlap between the turbines of each development. The Codling Bank wind farm has a much higher density of turbines, thus occupying a smaller extent of the seascape. Similar to The Dublin Array, there are several regularly ordered avenues of turbines located towards the right of the development. The overall cumulative effect at this viewpoint would be significant. While the Arklow Bank wind farm could theoretically be seen from this viewpoint, it is located at a distance of over 30 km. The EIS for the Codling Bank wind farm concluded that the cumulative impact of the Arklow Bank development was negligible. The cumulative impact is also considered insignificant in this EIS.

Summary Impact Assessment: While the wind farm would be clearly visible from this viewpoint, the ordered appearance of the wind farm and the developed nature of the surrounding landscape result in an impact classification of **Adverse Minor.**

12.11.3.6 Landscape Impact Assessment from VRP 6

VRP Location: View from Walkway Around Bray Head, Co. Wicklow

VRP sensitivity	Very High
Distance to nearest turbine	10.9 km
Number of turbines visible	All visible

Existing View: A cliff walk runs from Bray town along the coast to Greystones. Good views of the sea and sea cliffs below can be experienced along this route, which is very popular with walkers. Views along the coast extend to Bray in the north and Greystones in the south. A railway line runs parallel to the coast between the route and the sea and trains can be seen at several points along the path. Bray Head has been designated an area of Outstanding Natural Beauty and an Area of Special Amenity by Wicklow County Council.

Landscape Impact: All turbines would be visible from this viewpoint. The turbines appear to be at a closer proximity than at most other viewpoints (the closest turbine would be located approximately 10.9 km from this viewpoint). At distances like this the turbines would be close enough to distinguish clearly the rotation of the blades. The turbines appear regularly spaced in a line along the horizon that occupies a large extent of the panoramic sea view. Towards the right (south) of the development, a number of turbine avenues are visible. The turbines would introduce a change to the predominantly natural character of the views that are to be experienced from this viewpoint.

Cumulative Impact: All turbines from the proposed Codling Bank wind farm would also be visible from this viewpoint with the closest turbine being located at a distance of approximately 17 km. There would be some overlap between the southernmost turbines on the Bray Bank and the northernmost turbines of the Codling Bank, when viewed from this location. This overlap results in a continuous line of turbines running along most of the horizon when viewed from this point. The cumulative impact of The Dublin Array with the Codling development is therefore considered to be very high. The Arklow Bank wind farm would not be visible from this location and so there would be no cumulative impacts resulting from it.

Summary Impact Assessment: Given the highly sensitive nature of this location and the significant visual impact (including cumulative impact) that would result from the development, the overall impact is assessed as **Adverse Major**.

12.11.3.7 Landscape Impact Assessment from VRP 7

VRP Location: View from the Southern End of Bray Promenade, Co. Wicklow

VRP sensitivity	High
Distance to nearest turbine	11.4 km
Number of turbines visible	All visible

Existing View: This viewpoint is located on the sea front promenade at Bray town, Co. Wicklow. The promenade is located between the sea and Bray town, and there are many hotels, houses and commercial outlets facing it. The promenade is a popular place of amenity for residents of the town, especially since it adjoins the walk along Bray Head to the south. It is also popular with day-trippers from Dublin who have convenient access to the town by DART. The location is urban in character with extensive sea views.

Landscape Impact: All turbines would be visible from this viewpoint, the closest being located at a distance of 11.4 km. At this distance the rotation of the turbine blades would be clearly visible. The turbines are set against the horizon, and occupy a large extent of the panoramic sea view. The distribution of turbines is mostly evenly spaced, though some avenues of turbines appear close to the right (southern end) of the development, and to the left the turbine density reduces, easing the transition from the wind farm to the open sea. The wind farm could be regarded as being in keeping with the character of Bray Promenade where the white turbine towers would reflect the flagpoles and railing posts that are characteristic of the seaside resort.

Cumulative Impact: The northernmost turbines of the proposed Codling Bank wind farm would be visible from the promenade, with the remaining turbines being screened by the landform around Bray Head. Approximately 110 turbines from the Codling Bank would be visible from this viewpoint, should all phases of that wind farm be developed. While there would be overlap of the two developments, it would be possible to distinguish the Codling Bank turbines since the closest of these turbines would be located at a distance of approximately 18 km. The cumulative impact of the Codling Bank would serve to extend the portion of the horizon that is lined with turbines. Since the number of turbines from the Codling Bank development that would be visible would be low in comparison to The Dublin Array, the cumulative impact is considered to be relatively low. The Arklow Bank wind farm would not be visible from this location and so there would be no cumulative impacts resulting from it.

Summary Impact Assessment: The visual presence of the wind farm on the promenade would be significant, though it would add in some respects to the character of the seaside town. The overall impact is assessed as **Positive Minor**.

12.11.3.8 Landscape Impact Assessment from VRP 8

VRP Location: View from the top of the hill at Carrickgollogan, Co. Dublin

VRP sensitivity	Medium
Distance to nearest turbine	15.5 km
Number of turbines visible	All visible

Existing View: With an elevation of 276 m, the summit of Carrickgollogan hill has a 360 degree panoramic view, taking in the Irish Sea to the east, Dublin to the north, and the Wicklow mountains to the south west. There is extensive deciduous and pine forest on the slopes of the hill which, when coupled with the panoramic view, make this a popular amenity for walkers. To the north can be seen the expanse of Dublin city and Dublin Bay with Ireland's Eye and Killiney Hill in the distance. To the southeast there are good views of Bray town, with Bray Head in the background. While there is open farmland and forestry in the immediate foreground, the location is set in the context of a highly urbanised area overlooking Shankill, Killiney, Bray and Dublin in the distance.

Landscape Impact: The view of the wind farm from this viewpoint is similar to that seen from the summit of the Sugar Loaf mountain in Co. Wicklow in that the depth and width of the wind farm can be appreciated. All turbines are visible just below the horizon line though distant, the closest being at a distance of 15.5 km. The turbines occupy a wide extent of the sea view and are regularly spaced when viewed from this location. A number of turbine avenues are visible just to the right of centre of the development, which reduces the massing effect of the turbines. Moving towards the left (northern) and right (southern) extents of the wind farm the turbine rows taper to individual turbines, thus easing the transition from the wind farm to open sea. The wind farm does not visually connect with the coast and so the wind farm does not seem to fence in the views. The wind farm would not be out of keeping with the landscape viewed from this elevation, which is largely urbanised. Indeed the wind turbines could be regarded as being in keeping with some of the symbolic man-made features that are visible from the viewpoint, such as the obelisk on Killiney Hill and the chimneystacks of the ESB generating station at Ringsend.

Cumulative Impact: The proposed Codling Bank wind farm would be visible in the distance beyond Bray Head. While there would be some slight overlap between the two developments, the Codling Bank turbines would appear small due to their distance from this viewpoint (the closest would be located at a distance of approximately 23 km) and so it would be possible to distinguish between the two wind farms. While the Codling Bank wind farm appears distant, its impact would serve to increase the visual connection between the turbines and the coast, and so the cumulative impact is considered to be moderate. The Arklow Bank wind farm would not be visible from this location and so there would be no cumulative impacts arising from it.

Summary Impact Assessment: The Dublin Array would be highly visible from this viewpoint. However, given the orderly appearance of the wind farm from this location and the context of the foreground in which it is set, which is highly urbanised, the impact of the wind farm at this viewpoint is assessed as **Adverse Minor.**

12.11.3.9 Landscape Impact Assessment from VRP 9

VRP Location: View from the Obelisk at the Top of Killiney Hill, Co. Dublin

VRP sensitivity	Very High
Distance to nearest turbine	11.6 km
Number of turbines visible	All visible

Existing View: The obelisk on the top of Killiney Hill provides a very popular viewing point for Killiney Bay. A panoramic 360 degree view can be obtained from this location, with views inland of the expanse of Dublin city and views offshore of the Irish Sea. The panoramic sea views are framed at both ends, with Dalkey Island and its Martello tower to the north, and Bray Head to the south. Below the viewpoint, the main Rosslare to Dublin railway line runs parallel to the coast. The Sugar Loaf and other mountains in Wicklow can be seen in the distance to the south and south-east. The immediate area around this viewpoint location is steep and covered by woodland and scrub.

Landscape Impact: All turbines would be visible from the summit of Killiney Hill, and they would be close enough to the viewpoint that the rotation of the turbine blades could be seen (the closest turbine would be located approximately 11.6 km from the obelisk). From the elevated viewpoint the wind farm appears in a well-ordered grid layout with a constant density of turbines and the depth of the wind farm can be appreciated, though not to the same extent as at more elevated viewpoints such as the Sugar Loaf mountain. A number of avenues of turbines appear towards the left (north) of the development. Though the viewpoint is located amid a well-developed area, the elevation of the site results in the view towards the wind farm being dominated by woodland, sea and mountain views. The sensitivity of this location is therefore considered very high. The wind farm would contrast with these surroundings, though a number of man-made features, such as the Martello Tower on Dalkey Island and the obelisk at the viewpoint set a precedent for symbolic developments visible from the viewpoint. The turbines are not visually connected to the mainland, though marine traffic passing to the left of the wind farm would provide a visual link to the coast. As is the case at most other viewpoints, it should be noted that at many lower lying points in the vicinity of Killiney Hill, significant screening would reduce the visual impact of the wind farm.

Cumulative Impact: All turbines from the proposed Codling Bank wind farm would also be visible from this point, though they would appear smaller due to their distance from the viewpoint (the closest would be located at a distance of approximately 23 km). There would be some overlap between the southern part of The Dublin Array and the Codling Bank wind farm. The view of the Codling Bank development would increase the extent of the horizon occupied by turbines, and so the cumulative impact is deemed to be significant. The Arklow Bank wind farm is over 40 km from this viewpoint and so cumulative impacts resulting from it would be negligible.

Summary Impact Assessment: The extent of turbines visible from this site combined with the close proximity of the wind farm to the coast at this point result in a significant visual impact at this highly sensitive location. The cumulative impacts of the proposed Codling Bank wind farm would also be significant. The impact is assessed as being **Adverse Major.**

12.11.3.10 Landscape Impact Assessment from VRP 10

VRP Location: View from Vico Road adjacent to Killiney Hill, Co. Dublin

VRP sensitivity	Very High
Distance to nearest turbine	11.1 km
Number of turbines visible	All visible

Existing View: The viewpoint on Vico Road is situated to the northeast of Killiney Hill. The road runs along the coast and offers many panoramic viewpoints of Killiney Bay, although there is screening in places due to the presence of houses between the coast and the road. The panorama from this viewpoint is dominated by the sea views over the bay. Dalkey Island with its Martello tower, and Sorrento Terrace can be seen to the north, and to the south Bray Head, the Little Sugar Loaf and the Great Sugar Loaf can be seen in the distance. The Rosslare – Dublin railway line is located between the coast and the road and this can be seen below the road. The area is a popular one for walking, and walkers frequently take the route along the road on their way to Killiney Hill.

Landscape Impact: All turbines would be visible against the horizon from the viewpoint on Vico Road, with the closest turbine being located at a distance of 11.1 km. The turbines appear as regularly spaced except for a number of avenues of turbines which gives a good sense of the grid layout of the wind farm. As viewed from this point, the wind farm appears as a substantial man-made development in the open expanse of sea. The density of turbines tapers towards the left (north) and right (south) of the wind farm thus providing a gradual transition from wind farm to the surrounding open sea.

Cumulative Impact: All turbines of the proposed Codling Bank wind farm would be visible from this vantage point. While the Codling Bank development appears further away than The Dublin Array, the density of turbines on the Codling Bank is much higher. There is some overlap between the turbines of both developments. When both developments are considered, the extent of the seascape covered by turbines is much wider. The visual impact is therefore significant. The Arklow Bank wind farm is located over 40 km from this viewpoint. While it could theoretically be viewed from this distance, it is unlikely to be visible in any weather conditions. If it could be seen, its scale would be so small that cumulative impacts resulting from it would be negligible. The EIS for the Codling Bank wind farm also assessed the cumulative impact of the Arklow Bank wind farm to be negligible at a viewpoint located close to Vico Road.

Summary Impact Assessment: The extent of turbines on the seascape as viewed from this viewpoint and the close proximity of the development to the viewpoint result in a significant visual impact at this highly sensitive location. The impact is assessed as **Adverse Major.**

12.11.3.11 Landscape Impact Assessment from VRP 11

VRP Location: View from Seating Area at Coliemore Harbour, Dalkey, Co. Dublin

VRP sensitivity	High
Distance to nearest turbine	10.3 km
Number of turbines visible	Approx. 100 Visible

Existing View: The view from the seating area at Coliemore Harbour looks out over the Dalkey Sound with Dalkey Island and its prominent Martello tower in the foreground. To the north there are views across Dublin Bay to Howth Head. Despite the sea views, the character of the surrounding area is urban residential. The harbour area is popular for fishing and boat trips.

Landscape Impact: This viewpoint is the closest of all onshore viewpoints that have been assessed in this EIS, with the closest turbine being located at a distance of 10.3 km. At this proximity the motion of the turbine blades would be clearly visible. Approximately 100 turbines are visible from this location as Dalkey Island provides screening of the centre of the wind farm. Several avenues of turbines are visible to the left of Dalkey Island. This results in additional screening by neighbouring turbines. The extent of the panorama that is occupied by the wind farm from this viewpoint is not as significant as at other viewpoints, due to these screening effects. Towards the left (north) and right (south) of the development the density of turbines tapers, providing a gradual transition from wind farm to open sea.

Cumulative Impact: Approximately 100 turbines from the proposed Codling Bank wind farm would be visible from this location, though the turbines would be far more distant than those of the Kish and Bray Banks (the closest would be located at a distance of approximately 22.5 km). There would be some overlap of the southernmost Kish and Bray turbines with the Codling Bank turbines. The extent of the horizon occupied by turbines is increased due to the Codling Bank development and so the visual impact would be quite significant. The Arklow Bank wind farm is over 40 km from this viewpoint and so cumulative impacts resulting from it are considered to be negligible.

Summary Impact Assessment: This viewpoint is one of the closest onshore viewpoints of the wind farm. While the close proximity to the turbines would increase the visual impact, the significant screening provided by Dalkey Island would reduce the number of turbines that would be visible. The cumulative impact of the Codling Bank wind farm is significant. The impact is considered to be **Adverse Moderate.**

12.11.3.12 Landscape Impact Assessment from VRP 12

VRP Location: View Close to the Entrance to the East Pier, Dun Laoghaire, Co. Dublin

VRP sensitivity	High
Distance to nearest turbine	12.6 km
Number of turbines visible	65 Visible

Existing View: Dun Laoghaire harbour is a very busy harbour that sees a number of cross-channel ferry sailings each day. It is also a very popular amenity area for walkers and its large marina is very popular for sailing. The views from Dun Laoghaire are dominated by sea views over Dublin Bay. Howth Head can be seen to the north and the coast to the south runs to Sandycove. There are also distant views of the Wicklow mountains to be seen to the south. The character of the landscape is dominated by manmade developments such as the pier, the marina and the buildings that overlook the harbour.

Landscape Impact: The wind farm would be partially screened by both landform and housing in the area surrounding the 'Forty Foot' in Sandycove. 65 turbines are fully or partially visible from this viewpoint. The turbines are regularly spaced in a line against the horizon. The closest turbine is located at a distance of 12.6 km. As one moves outwards from the coast (to the left) several avenues of turbines come into view. There is thus a progression in the density of visible turbines from constant (close to the coast) to sparse (further out to sea).

Cumulative Impact: The Codling Bank and Arklow Bank wind farms are not visible from this viewpoint and so there are no cumulative impacts resulting from these developments. The Codling Bank wind farm would be visible from other viewpoints located close to this viewpoint on the Dun Laoghaire pier. The closest turbine would be located at a distance of approximately 29 km.

Summary Impact Assessment: There is significant screening provided by the landform around Sandycove, which results in 65 turbines being fully or partially visible. There are no cumulative impacts arising from other developments at this viewpoint, though the Codling Bank wind farm would be visible at points further along the Dun Laoghaire pier. As part of the consultations for the Codling Bank EIS, people commented that the proposed wind farm would resemble a flotilla of sailing boats from a viewpoint on the Pier. The visual impact of the development was deemed to be Positive Minor due to the strong association of the turbines with the sailing atmosphere of the area. The visual impact of The Dublin Array from this viewpoint is also considered to be **Positive Minor**.

12.11.3.13 Landscape Impact Assessment from VRP 13

VRP Location: View from the Road R131 Adjacent to Public Parking Area and Amenity Close to Sandymount, Co. Dublin

VRP sensitivity	High
Distance to nearest turbine	17.9 km
Number of turbines visible	Almost All Visible

Existing View: Sandymount beach is situated on the south side of the city close to the East Link Bridge and Ballsbridge. It has a promenade and car park. The beach itself is long and very wide and it virtually disappears when the tide is in. Stretching for approximately 1 km along the Strand Road, the Promenade is a popular walking place and provides outstanding views over Sandymount Strand. The area is popular with walkers, and swimming and shore angling are also enjoyed. The view from this location is dominated by Dublin Bay, with Howth Head to the north and Dun Laoghaire and Killiney Hill to the south. The location has a strong urban character and the tall twin chimneystacks of the power station at Ringsend are clearly visible across the bay to the north.

Landscape Impact: Most of the wind farm's turbines would be visible from this location in a line against the horizon, although there would be slight screening provided by Dun Laoghaire West Pier and buildings around Dun Laoghaire and Sandycove. Since this viewpoint location is situated further inland than previous viewpoints (the closest turbine is located at a distance of 17.9 km), the size of the turbines from this location appear smaller. The layout of the turbines appears as being regularly spaced for the most part. As one moves to the left a number of avenues of turbines come into view that reduces the massing effect of turbines and eases the transition from wind farm to open sea.

Cumulative Impact: The Codling Bank and Arklow Bank wind farms are not visible from this viewpoint and so there are no cumulative impacts resulting from these developments.

Summary Impact Assessment: While there is some screening provided by the landform around Sandycove, there is still significant visual impact from the development. There are no cumulative impacts resulting from other developments. While a large number of turbines would be visible, they would be located quite far in the distance. In addition, the development would be set in an urban context alongside other man-made developments. The impact is considered to be **Adverse Minor**.

12.11.3.14 Landscape Impact Assessment from VRP 14

VRP Location: View from the East-Link Toll Bridge, Ringsend, Co. Dublin

VRP sensitivity	Low
Distance to nearest turbine	19.8 km
Number of turbines visible	None Visible

Existing View: The East-Link Bridge is the final bridge that spans the River Liffey before it enters the sea. The toll bridge is a very busy traffic route that links the Ringsend area with the north quays. This area is of a highly urbanised and slightly industrial nature that sees cargo ships loading and unloading along the quays. The area is dominated by the quays, and views can be seen of merchant ships, cranes and containers. Towards the mouth of the river, the tall twin chimneystacks of the power station at Ringsend dominate the skyline.

Landscape Impact: The wind farm would be completely screened by Dublin Port buildings and by infrastructure on the southern side of the River Liffey. No turbines would be visible from this location.

Cumulative Impact: The Codling Bank and Arklow Bank wind farms are not visible from this viewpoint and so there are no cumulative impacts arising from these developments.

Summary Impact Assessment: Since there would be no turbines visible from this location, the development is assessed as having No Impact.

12.11.3.15 Landscape Impact Assessment from VRP 15

VRP Location: View from the Link Road Between the R131 at Dublin Port and the Coast Road Near Clontarf, Co. Dublin

VRP sensitivity	Low
Distance to nearest turbine	20.0 km
Number of turbines visible	Approx. 55 Visible

Existing View: This viewpoint is situated adjacent to a link road between the R131 road from Dublin Port and the Coast Road near Clontarf. The link road is a very busy traffic route, particularly for trucks passing through Dublin Port. The view from this location takes in the waters of Dublin Harbour with the twin chimneystacks of the power station at Ringsend in the background. To the south there is a transition from the Dublin Port infrastructure and buildings to the modern East Point Business Park with distant views of the Wicklow mountains in the background. To the east the Coast Road runs along towards Clontarf, with its numerous commercial and residential buildings. The character of the area is highly urbanised in its transition from Dublin Port, through the East Point Business Park to the residential area of Clontarf.

Landscape Impact: The wind farm would be visible in the distance against the horizon extending from the edge of Dublin Port across the views of Dublin Harbour. The closest turbine is located at a distance of approximately 20 km, and so the turbines appear smaller from this location than at some of the previous viewpoints. The southern end of the wind farm is partially screened by buildings and infrastructure around Dublin Port. The northern end of the wind farm, which is completely visible, extends across three-quarters of the sea view from this location. Approximately 55 turbines can be seen in all, although 15 of these are only partially visible due to screening. Close to the Poolbeg Lighthouse a number of avenues of turbines are visible. Further to the left the density of turbines tapers, easing the transition to the sea. The wind farm does not completely fence-in the view from this location as it does not extend across the entire sea view.

Cumulative Impact: The Codling Bank and Arklow Bank wind farms are not visible from this viewpoint and so there are no cumulative impacts resulting from these developments.

Summary Impact Assessment: While the wind farm is visible in the distance from this viewpoint location, the viewpoint is set in a highly urban context with existing views of developments such as the Ringsend chimney stacks and Dublin Port. The impact is considered to be **Adverse Minor**.

12.11.3.16 Landscape Impact Assessment from VRP 16

VRP Location: View from Pedestrian Walkway Along Sea Wall Close to Clontarf Village, Co. Dublin

VRP sensitivity	Medium
Distance to nearest turbine	19.2 km
Number of turbines visible	Approx. 90 Visible

Existing View: This viewpoint is situated along a pedestrian walkway that runs between the Coast Road and the sea, close to Clontarf Village. As with the previous viewpoint, the view from this location takes in the waters of Dublin Harbour and the infrastructure around Dublin Port. The twin chimneystacks of the power station at Ringsend are prominent, while in the background the Wicklow mountains can be seen in the distance. To the east the Coast Road runs towards Clontarf, with numerous commercial and residential buildings alongside it. The pedestrian walkway is a very popular amenity for walkers and cyclists. While the waters of Dublin Bay and the green belt around the walkway provide a natural setting for this viewpoint, the character of the area is highly urbanised with its views of Dublin Port and built-up residential and commercial area around Clontarf.

Landscape Impact: Approximately 90 turbines from the northern end of the wind farm would be fully or partially visible from this viewpoint. The southern end of the wind farm would be screened by the buildings and infrastructure around Dublin Port. Those turbines that are visible are located in a line against the horizon, the closest being located at a distance of approximately 19.2 km. There is a visual connection between the wind farm and land with turbines gradually becoming more visible as one progresses from the breakwater at Ringsend towards Poolbeg Lighthouse and on to the open sea. To put the appearance of the turbines in perspective, the hub height of the turbines is just below the height of the Poolbeg Lighthouse. A number of avenues of turbines appear immediately to the left of the lighthouse, and further to the left the density of turbines tapers to individual turbines, easing the transition from wind farm to sea.

Cumulative Impact: The Codling Bank and Arklow Bank wind farms are not visible from this viewpoint and so there are no cumulative impacts resulting from these developments.

Summary Impact Assessment: Almost 90 turbines from the wind farm are visible in the distance from this viewpoint. However, since this area is already highly urbanised and has a number of tall manmade developments such as the Poolbeg Lighthouse and the chimneystacks at Ringsend visible from it, the wind farm would be in fitting with the character of the area more than if it were located in an area with a more natural environment. The impact of the development from this viewpoint is considered to be **Adverse Moderate**.

12.11.3.17 Landscape Impact Assessment from VRP 17

VRP Location: View from a Point Approximately 300m from the End of the Bull Wall, North Bull Island, Co. Dublin

VRP sensitivity	High
Distance to nearest turbine	22.2 km
Number of turbines visible	All Visible

Existing View: North Bull Island is a 300 hectare island in Dublin Bay formed from the sandbank that accumulated after the construction of the Bull Wall in the 1820's. It is a Nature Reserve and Bird Sanctuary of international importance and is a proposed Special Protection Area. North Bull Island is a favourite haunt for many Dubliners, who come to walk, jog or cycle. There is also a large golf course and bathing areas off the Bull Wall. Facing southeast along the Bull Wall, one can enjoy a panoramic view of Dublin Bay with Howth Head to the northeast and the Dublin and Wicklow Mountains to the south. Marine traffic can be seen entering and leaving the busy Dublin Port from this viewpoint.

Landscape Impact: All turbines would be visible from this viewpoint with only partial screening of a number of turbines being provided by the North Bull and Poolbeg Lighthouses. The turbines are located in a line against the horizon, the closest being located at a distance of approximately 22.2 km. The turbines are distributed regularly across the horizon, and they provide a visual connection to the land through the Poolbeg Lighthouse. Looking in a straight line along the Bull Wall, a number of avenues of turbines can be seen, which reduces the effective massing of these turbines.

Cumulative Impact: All phases of the proposed Codling Bank wind farm can be seen from this location though in the far distance, the closest turbine being located at a distance of approximately 33 km. There is a small element of screening provided by the Poolbeg Lighthouse. There is overlap between the southern end of The Dublin Array and the Codling Bank wind farm, which increases the density of turbines when viewed from this point. The cumulative impact of all phases of the proposed Codling Bank wind farm would theoretically be significant from this viewpoint though, given the large distance to the Codling Bank, the turbines would not be visible except in clear weather conditions, and so the cumulative impact is reduced. The Arklow Bank wind farm is not visible from this viewpoint and so there are no cumulative impacts arising from it.

Summary Impact Assessment: All turbines of The Dublin Array can be potentially seen in the distance from this viewpoint. While this location is an important nature reserve, the far distance to the wind farm reduces the visual impact of the development. The overall impact is considered to be **Adverse Moderate.**

12.11.3.18 Landscape Impact Assessment from VRP 18

VRP Location: View from the Coast Road R105 Facing Dublin Bay at Sutton, Co. Dublin

VRP sensitivity	Medium
Distance to nearest turbine	15.5 km
Number of turbines visible	Approx. 65 Visible

Existing View: This coastal viewpoint is located close to Sutton on the narrow isthmus connecting Howth Peninsula to the mainland. The area is urban in character with numerous commercial and residential buildings situated along the coast road. Looking south over Sutton Strand, one can see the flat expanse of North Bull Island with the Dublin and Wicklow Mountains in the background. To the east is Howth Head at the north end of Dublin Bay. There is a popular walk and cycleway that runs along the shoreline between the coast and the road.

Landscape Impact: The southern end of the wind farm would be visible against the horizon at this point with the northern end of the wind farm being screened by the landform around Howth Head. Approximately 65 turbines would be fully or partially visible in total, the closest being located at a distance of approximately 15.5 km. The turbines extend from the Martello tower on Howth Head across most of the sea view towards North Bull Island. The density of turbines as seen from this viewpoint is more irregular than from other viewpoints, though as with other viewpoints the turbine density reduces towards the right (south) of the development, easing the transition from the wind farm to open sea. Also, views from this location are not completely fenced-in as there is a stretch of open sea visible to the south of the development.

Cumulative Impact: The proposed Codling Bank wind farm is visible from this viewpoint. It overlaps with The Dublin Array, and so increases the density of turbines when viewed from this location. The extent of sea occupied by the wind farms does not increase. The Arklow Bank wind farm is not visible from this viewpoint and so there are no cumulative impacts arising from it.

Summary Impact Assessment: While the northern end of The Dublin Array would be screened by the landform at Howth Head from this location, there would be views of the southern turbines in the distance. The proposed Codling Bank wind farm could, theoretically, be seen further away from this point. The visual impact at this viewpoint is considered to be **Adverse Minor.**

12.11.3.19 Landscape Impact Assessment from VRP 19

VRP Location: View from Scenic Viewpoint Adjacent to Car Park at The Summit, Howth Head, Co. Dublin

VRP sensitivity	Very High
Distance to nearest turbine	10.8 km
Number of turbines visible	All Visible

Existing View: Howth is located on the north side of Dublin Bay and, at its highest point rises to 171 m. There is a cliff walk around Howth Head that extends from Balscadden Bay on the north of the peninsula to the Martello tower in the south. The natural landscape and elevated panoramic views that are to be found along this path make the route a very popular amenity. There is a lighthouse located on the southeastern tip of Howth Head. The viewpoint for this photomontage looks beyond the lighthouse over Dublin Bay. To the east there are extensive views of the Irish Sea with its marine traffic en route to and from Dublin Port and Dun Laoghaire Harbour. To the south, across Dublin Bay, the Wicklow mountains can be seen in the distance. Views of Dublin city to the south cannot be seen from this point, though such views are to be seen around the southern end of Howth Head. The character of this location is natural, though it is set against the highly urbanised backdrop of Dublin city and its suburbs.

Landscape Impact: This is one of the closest of all viewpoints with the closest turbine being located at a distance of 10.8 km. The viewpoint is also located in an elevated position. All turbines would be visible from this viewpoint and they would appear to run in a diagonal line, with hub heights set just below the horizon. The elevated nature of the viewpoint allows the depth of the turbines to be viewed, though not to the same extent as from the Sugar Loaf or Carrickgollogan viewpoints. To the left (north) of the development a number of avenues of turbines can be seen before the density of turbines gradually tapers to a single turbine. The Kish Lighthouse, seen to the left of the northern most turbine, eases the transition of the development to open sea. To the right (south) of the development the turbines appear to be more tightly clustered as they become fainter with distance. The view from this location is still dominated by the open sea and there is no visual connection between the wind farm and the coast.

Cumulative Impact: There would be some overlap of the southernmost Kish and Bray turbines with the Codling Bank turbines. The extent of the horizon occupied by turbines would increase due to the Codling Bank development and so the visual impact would increase as a result. The nearest turbine of the Arklow Bank wind farm is located over 50 km from this viewpoint and so, while these turbines would theoretically be visible, in practice they would not be seen from this viewpoint. The cumulative impact of the Arklow Bank wind farm was also assessed from a viewpoint on Howth Head as part of the EIS for the Codling Bank wind farm. This assessment also concluded that the cumulative impact of the Arklow Bank development from this location was negligible.

Summary Impact Assessment: This viewpoint is situated in a highly sensitive area, and all turbines would be visible at close proximity from this location. While the wind farm does occupy a relatively low proportion of the overall seascape in comparison to other viewpoints, the impact is still considered to be **Adverse Major**.

12.11.3.20 Landscape Impact Assessment from VRP 20

VRP Location: View from Car Park at Scenic Viewpoint Close to Martello Tower at Portrane, Co. Dublin

VRP sensitivity	High
Distance to nearest turbine	23.4 km
Number of turbines visible	All Visible

Existing View: Portrane is situated along the coast in north county Dublin. The viewpoint for this photomontage is situated close to the Martello tower that lies on the coast to the southeast of Portrane. The views from this location are dominated by coastal views of the Irish Sea. Lambay Island can be seen 5 km from the shore in the foreground. To the south there are distant views of Howth Head and Ireland's Eye. Portrane Demesne is located to the west of this viewpoint and there are also a number of golf courses in the area.

Landscape Impact: The Dublin Array would be visible in the distance off Howth Head, the closest turbine being located at a distance of approximately 23.4 km. At this distance the individual turbines appear very small in size against the horizon. Nonetheless the wind farm is visible as a man-made development off the coast. The turbines do not appear to be connected to the mainland, but rather are separated by the sea from Howth Head. Given the broad expanse of sea that commands the view from this location, the relatively low proportion of this view that is occupied by the wind farm results in it having a low visual impact from this location.

Cumulative Impact: Turbines from the proposed Codling Bank wind farm would, theoretically, be visible from this location. The turbines would appear in a cluster behind The Dublin Array. However, in practice, the Codling Bank turbines would be located so far from this viewpoint (the closest turbine would be located at a distance of approximately 43 km) that the cumulative impact arising from them would be negligible. The Arklow Bank wind farm would not be visible from this viewpoint and so there would be no cumulative impacts arising from it.

Summary Impact Assessment: The long distance to the wind farm from this location and the relatively low proportion of the seascape that would be occupied by it would result in a low visual presence overall. The impact is considered to be **Neutral**.

12.11.3.21 Landscape Impact Assessment from VRP 21

VRP Location: View Facing South / Southwest from Entrance to New Housing Estate in Rush, Co. Dublin

VRP sensitivity	Low
Distance to nearest turbine	26.0 km
Number of turbines visible	All Visible

Existing View: Rush is a seaside town and market gardening centre in North Dublin. Fine beaches are located north and south of the town that have attracted generations of Dubliners. Much of the land in the area is cultivated intensively. The location for this photomontage is situated on the coast to the south of Rush town. Views from this point towards the sea are dominated by Lambay Island to the south and Howth in the distance.

Landscape Impact: The entire wind farm would be visible in the distance off Howth Head, with the closest turbine being located at a distance of approximately 26 km. At this distance the individual turbines appear very small in size against the horizon and would not be visible in many weather conditions. Nonetheless the wind farm appears as a man-made development off the coast. The turbines appear to be tightly clustered with the density tapering to individual turbines at the left (north) and right hand side (south) of the development. The turbines do not appear to be connected to the mainland, but rather are separated by the sea from Howth Head. Given the broad expanse of sea that commands the view from this location, the relatively low proportion of this view that is occupied by the wind farm results in it having a low visual impact from this location.

Cumulative Impact: Turbines from the proposed Codling Bank wind farm would, theoretically, be visible from this location. The turbines would appear in a cluster behind The Dublin Array. However, in practice, the Codling Bank turbines would be located so far from this viewpoint (the closest turbine would be located at a distance of approximately 45 km) that the cumulative impact arising from them would be negligible. The Arklow Bank wind farm would be located at such a distance from this viewpoint that visual impacts would also be negligible.

Summary Impact Assessment: The long distance to the wind farm from this location and the relatively low proportion of the seascape that would be occupied by it would result in a low visual presence overall. The impact is considered to be **Neutral**.

12.11.3.22 Landscape Impact Assessment from VRP 22

VRP Location: Offshore View Facing Southeast from Small Boat 7 km Southeast of Howth Head

VRP sensitivity	High
Distance to nearest turbine	3.3 km
Number of turbines visible	All Visible

Existing View: This photomontage is located at an offshore viewpoint to the northwest of the Kish Bank. The existing view from this location is of open sea looking towards the Kish Lighthouse. There is no visual evidence of the submerged Kish and Bray Banks, apart from the Kish Lighthouse that marks the northern extremity of the Kish Bank. Marine traffic bound for Dublin Port and Dun Laoghaire Harbour can be seen passing to the north of the Kish Bank from here. In particular, a number of passenger ferries that operate between the UK and Dublin pass this point a number of times each day. In the distance, to the east of the Kish and Bray Banks, marine traffic bound for other ports on the east coast of Ireland can be seen.

Landscape Impact: The view of the wind farm afforded from this location is typical of the views that would be seen from offshore locations in the vicinity of the Kish and Bray Banks. All wind turbines can be clearly seen from this location, the closest of which is located at a distance of 3.3 km. At this close proximity the regular layout of the turbine rows is clear and the full breadth and depth of the wind farm can be appreciated. To the right (south) of the development there is overlap between the turbine rows. Moving to the left (north) of the wind farm the turbine avenues can be clearly seen as the density of turbine tends to decrease. The Kish Lighthouse, which can be seen beyond the northern extremity of the wind farm, eases the transition from the wind farm to the open sea. To put the turbine dimensions in perspective, the turbine hub height appears to be approximately twice the height of the Kish Lighthouse and equal to the height of the HSS high speed ferry, when viewed from this point.

Cumulative Impact: All turbines from the proposed Codling Bank wind farm would be visible in the distance from this location, the closest turbine being located at a distance of approximately 22 km. The Codling Bank turbines appear in a cluster behind The Dublin Array, their dimensions appearing approximately one third the size of the Kish and Bray turbines. The cumulative impact arising from the Codling Bank turbines is therefore not significant. While the Arklow Bank wind farm is theoretically visible from this location, it is situated at such a long distance from this viewpoint that visual impacts arising from it would be negligible.

Summary Impact Assessment: The wind farm would introduce an interesting feature to the open sea views that are visible from this location at present. The views of the turbines would blend in well with the Kish Lighthouse that is the only man-made feature that is currently visible in this area. The impact of the development is considered to be **Positive Major**.

12.12 Summary Landscape Impact

A summary of the landscape impact assessments as outlined in the previous section is provided in Table 12.3 below for each of the VRPs. The assessments are listed in order of decreasing impact to allow the locations with highest impact to be assessed.

As can be seen from the table, there are four locations that are deemed to have an impact of Adverse Major, equivalent to 18% of the viewpoints assessed. These locations – Bray Head, Killiney Hill, Vico Road near Killiney Hill and Howth Head, are elevated viewpoints that are amongst the closest viewpoints to the proposed wind farm. Six viewpoints are considered to have an Adverse Moderate impact, which is equivalent to 27% of viewpoints assessed. These viewpoints are located from Wicklow town in the south to the North Bull Island in the north. Thus there is a wide range of the coast from which the potential view of the wind farm could have an Adverse Moderate impact. 55% of viewpoints have an impact that is deemed to be Adverse Minor or better. It is generally accepted that an offshore wind farm as viewed from offshore vantage points tends to have a positive impact. For instance, the EIS for both the Codling Bank and Arklow Bank wind farms concluded that the visual impact of the developments as viewed from offshore viewpoints was Positive Major. The impact of the Kish and Bray Banks offshore wind farm as viewed from the offshore vantage point in the Irish Sea is also deemed to be Positive Major. The opinion on whether or not a wind farm can have a positive impact on the landscape from an onshore viewpoint is quite subjective. For instance, as part of the consultations for the Codling Bank EIS, people commented that the proposed wind farm would resemble a flotilla of sailing boats from the viewpoint at Dun Laoghaire Pier, and the impact of the development was deemed to be Positive Minor. The impact from Kilcoole train platform and Bray Promenade were also judged to be Positive Minor and Positive Moderate respectively. In this EIS, the visual impact of the proposed Kish and Bray Banks wind farm from Dun Laoghaire Pier and Bray Promenade is deemed to have a Positive Minor impact. However it should be noted that, at all locations, the visual impact depends to a large degree on the perception of the viewer.

In summary, The Dublin Array would be highly visible from many coastal locations between Howth Head in the north and Wicklow town in the south. The visual impact would be most significant from elevated viewpoints in the vicinity of Bray Head, Killiney Hill and Howth Head. The presence of buildings and infrastructure around Dublin would result in significant screening of the wind farm, and as a result the wind farm would only be visible from locations in the immediate vicinity of the coast or from elevated viewpoints.

VRP No.	Location	Summary Impact
6	View from Walkway Around Bray Head, Co. Wicklow	Adverse Major
9	View from the Obelisk at the Top of Killiney Hill, Co. Dublin	Adverse Major
10	View from Vico Road Adjacent to Killiney Hill, Co. Dublin	Adverse Major
19	View from Scenic Viewpoint Adjacent to Car Park at The Summit, Howth Head, Co. Dublin	Adverse Major
1	Scenic Car Park Overlooking Wicklow Town at Corporation Lands, Co. Wicklow	Adverse Moderate
2	View from Beach Entrance at Six Mile Point, Newcastle, Co. Wicklow	Adverse Moderate
4	View from Greystones Harbour, Co. Wicklow	Adverse Moderate
11	View from Seating Area at Coliemore Harbour, Dalkey, Co. Dublin	Adverse Moderate
16	View from Pedestrian Walkway Along Sea Wall Close to Clontarf Village, Co. Dublin	Adverse Moderate
17	View from a Point Approximately 300 m from the End of the Bull Wall, North Bull Island, Co. Dublin	Adverse Moderate
3	View from High Bend in the N11 Road at Kilmullin, Co. Wicklow	Adverse Minor
5	View from Summit of the Sugar Loaf Mountain, Co. Wicklow	Adverse Minor
8	View from the top of the hill at Carrickgollogan, Co. Dublin	Adverse Minor
13	View from the Road R131 Adjacent to Public Parking Area and Amenity Close to Sandymount, Co. Dublin	Adverse Minor
15	View from the Link Road Between the R131 at Dublin Port and the Coast Road Near Clontarf, Co. Dublin	Adverse Minor
18	View from the Coast Road R105 Facing Dublin Bay at Sutton, Co. Dublin	Adverse Minor
20	View from Car Park at Scenic Viewpoint Close to Martello Tower at Portrane, Co. Dublin	Neutral
21	View Facing South / Southwest from Entrance to New Housing Estate in Rush, Co. Dublin	Neutral
14	View from the East-Link Toll Bridge, Ringsend, Co. Dublin	No Impact
7	View from the Southern End of Bray Promenade, Co. Wicklow	Positive Minor
12	View Close to the Entrance to the East Pier, Dun Laoghaire, Co. Dublin	Positive Minor
22	Offshore View Facing Southeast from Small Boat 7 km Southeast of Howth Head	Positive Major

Table 12.3 Summary of Landscape Impact from each of the VRPs

12.13 Mitigation Measures

As discussed earlier, modern wind farms are, by their nature, large-scale developments of tall vertical structures. In addition to the significant size of turbines, the movement of the blades is an integral part of wind turbine operation and is not a factor that can be changed. These characteristics mean that the visibility of wind energy projects cannot be changed substantially by modification of the structures themselves. Mitigation measures to reduce the visual impact on the landscape are mostly limited to optimising the aesthetic appeal of the wind farm layout at the design stage.

The visual impact of this development was considered in the design stage of the project layout. The layout that was finally chosen maximises the aesthetic appeal of the wind farm within the study area. The layout is regular, with turbines arranged in parallel rows, and not too dense, with turbines separated by 500 m in the lateral and transverse directions. This layout results in several avenues of turbines being visible from most viewpoints that were assessed as part of this study, thus helping to reduce the clutter

The turbines would be painted a matt white / mid-grey colour, unless specified as otherwise in planning conditions. The mid-grey colour is similar to the background colour of the sky in most prevailing conditions in Ireland and experience from onshore wind farms in Ireland has indicated that it is the most effective colour in minimising the visual presence of turbines.

The rotation of all turbine blades would be arranged to be in the same direction; counter rotation of turbine blades would be avoided.

13 WATER QUALITY, AIR AND CLIMATE

13.1 Water Quality

13.1.1 Existing Environment

The quality of the immediate coastal waters around the Irish coastline, (as indicated by bathing water quality), is generally good, with between 102 and 119 bathing beaches, out of a total of 131, being rated as good during the period 2003 to 2009 (EPA 2010). The highest failure rate during this period was for beaches around Dublin and was largely due to excedence of microbial standards which can be attributed to local inputs. The high quality of Irish coastal waters is further demonstrated by analyses of indicator species such as fish and shellfish which show that contamination from metals and halogenated hydrocarbons is not an issue (EPA 2008).

The water quality in the area of the Kish and Bray banks would be expected to be excellent but with a high degree of naturally suspended solids due to the high tidal current regime and sedimentary nature of the seabed.

13.1.2 Potential Impacts of Proposed Development on Water Quality

During the construction and decommissioning stages of the project, appropriate engineering plant and support vessels will operate at the location of each of the turbines for a relatively short period of time in order to prepare the seabed, install the turbine foundations and support structure, scour protection and associated infrastructure including inter turbine and export power cables. Potential impacts on water quality associated with the construction phase of the project include:

- Disturbance and release of sediment into the water column during the preparation of the seabed to facilitate the installation of the turbine foundations. Mono-pile foundations require limited preparation involving localised levelling and removal of large clasts in the immediate vicinity of the pile compared to multi-pile or gravity foundations which would require more intensive site preparation over a larger area with the potential for greater quantities of sediment to be released into the water column.

- Release of sediment into the water column during the installation of piles for turbine foundations. Again the use of driven steel monopiles means that the extent of sediment released will be significantly less than if augered piles were used as might be the case on a harder substrata.

- Release of sediment into the water column during the installation of power cables in the seabed between the turbines, offshore substation and the landfall site on shore.

- Accidental release of contaminants such as grout, fuel, lubricating oil, paints or litter during the construction phase. However in the unlikely event of such an occurrence the appropriate emergency procedure will be implemented immediately to minimise any possible damage.

- Contamination due to accidental spillage of pollutants or waste from vessels maintaining the turbines is also a potential risk during the operational phase of the wind farm.

13.1.3 Mitigation Measures

The use of driven monopiles to support the turbines will minimise the extent of seabed preparation and associated release of sediment into the water column. It will also limit the amount of sediment released during the installation of the piles themselves compared to augered piles which might be required in a harder substrata than exists on the banks. The placing of rock armour scour protection will limit the extent of sediment release associated with scouring action during the operational stage.

Suitable precautions and best practice will be adopted during both the construction and operational phases for the storage, handling and disposal of materials such as fuel, lubricants etc. to reduce the potential impact of contamination associated with a spillage of same to insignificant levels.

Spillage of grout will be prevented using either inflatable or wiper seals, with at least 100% redundancy.

13.1.4 Actual Impacts on Water Quality

The use of driven monopiles to support the turbines and the adoption of suitable precautions and best practice in the storage, handling and disposal of materials such as fuel, lubricants, grout and litter during the construction and operational stages of the project will ensure that there is no significant impacts on water quality in the vicinity of the Kish and Bray banks associated with the construction and operation of the Dublin Array offshore wind farm.

13.2 Air Quality

13.2.1 Existing Environment

Existing ambient air quality in the vicinity of the proposed development on the Kish and Bray banks is expected to be very high with no point sources of industrial atmospheric pollution. Minor intermittent contributions of atmospheric pollutants associated with discharges of combustion gases from passing shipping would be expected to be quickly dispersed.

13.2.2 Potential Impacts on Air Quality

Potential impacts during the construction stage of the project on air quality in the vicinity of the banks will be limited to the emission of combustion gases from shipping and construction plant associated with the delivery and installation of the steel monopiles, rock armour scour protection, transition pieces and turbines, etc. There will be similar emissions, though much lower, associated with maintenance vessels during the operational stage of the project.

13.2.3 Mitigation Measures

Given the exposed nature of the site with expected high levels of wind induced dispersion and the limited duration of the works associated with the installation of the turbines and associated support structures at each turbine location it is highly unlikely that guideline values for SO_2, NO_x and particulates would be exceeded as a result of the operation of construction plant and vessels.

The operation of the wind farm will not involve any activity which would give rise to the emission of gases, particulates or aerosols to the atmosphere.

13.2.4 Actual Impacts on Air Quality

Given the relatively limited duration of the construction works associated with the installation of each turbine and the high levels of wind induced dispersion to be expected in the vicinity of the site it is not expected that air emissions from construction vessels and plant will have an adverse impact on ambient air quality in the vicinity of the proposed development on the Kish and Bay banks. On a larger scale the project will have a significant positive impact on air quality associated with the potential offset in emissions compared with electricity generated from fossil fuel sources.

13.3 Climate

13.3.1 Existing Environment

Mean climatologically data for the 30 year period from 1961 to 1990 for the closest meteorological station which is located at Dublin Airport, approx. 27km north of the proposed development is summarised in Table 13.1 below.

TEMPERATURE (deg.C)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
mean daily max.	7.6	7.5	9.5	11.4	14.2	17.2	18.9	18.6	16.6	13.7	9.8	8.4	12.8
mean daily min.	2.5	2.5	3.1	4.4	6.8	9.6	11.4	11.1	9.6	7.6	4.2	3.4	6.4
mean	5.0	5.0	6.3	7.9	10.5	13.4	15.1	14.9	13.1	10.6	7.0	5.9	9.6
absolute max.	16.6	15.3	21.3	20.5	23.4	25.1	27.6	28.7	23.9	21.2	18.0	16.2	28.7
absolute min.	-9.4	-6.2	-6.7	-3.7	-1.0	1.5	4.8	4.1	1.7	-0.6	-3.4	-10	-10
RELATIVE HUMIDITY(%)													
mean at 0900UTC	86	84	82	79	76	76	78	81	82	85	86	86	82
mean at 1500UTC	79	75	70	68	67	68	68	70	70	75	78	81	72
SUNSHINE (hours)													
mean daily duration	1.8	2.5	3.6	5.2	6.1	6.0	5.4	5.1	4.3	3.1	2.4	1.7	3.9
greatest daily duration	8.0	9.2	11.9	13.8	15.4	15.9	15.4	14.5	12.4	10.4	8.5	6.9	15.9
mean no. of days with no sun	11	8	5	3	2	2	1	2	3	6	8	11	61
RAINFALL (mm)													
mean monthly total	69.5	50.4	53.5	51.1	54.8	55.8	50.0	71.1	66.4	70.1	64.3	75.8	733
greatest daily total	30.3	31.3	35.7	26.2	30.0	46.6	34.8	60.2	40.9	47.5	55.1	41.7	60.2
WIND (knots)													
mean monthly speed	12.2	11.7	11.6	9.7	8.7	8.0	8.1	8.0	8.9	9.9	10.8	11.8	9.9
max. gust	75.0	73.0	61.0	60.0	58.0	55.0	54.0	56.0	64.0	73.0	64.0	71.0	75.0
mean no. of days with gales	2.1	1.1	1.2	0.3	0.3	0.1	0	0.3	0.2	0.5	0.7	1.4	**8.2**
WEATHER (mean no. of days with.....)													
snow or sleet	6.0	5.5	4.3	1.7	0.3	0.0	0.0	0.0	0.0	0.1	0.9	2.9	21.6
snow lying at 0900UTC	2.1	1.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	4.5
hail	0.7	0.9	2.2	2.4	1.4	0.3	0.1	0.1	0	0.2	0.5	0.8	9.5
thunder	0.1	0.1	0.2	0.3	0.6	0.7	0.7	0.6	0.3	0.3	0.1	0.1	4.1
fog	4.8	4.3	3.9	4.5	3.6	3.1	3.6	5.3	4.9	4.7	4.0	3.9	50.5

Table 13.1 Monthly and annual mean and extreme values for Dublin Airport
(1961- 1990) (Source: Met Eireann)

The minimum mean monthly rainfall in the period was 50.0 mm in July and the maximum was 75.8 mm in December. Average annual rainfall in the period was 733 mm and the greatest daily rainfall was 60.2 mm.

Temperature ranges between an absolute minimum of -10°C and an absolute maximum of 28.7°C. Annual mean daily temperatures are 9.6°C with a range between 5.0°C and 15.1°C.

The annual average relative humidity ranges from 82% for the morning recording period to 72% for the afternoon recording period.

Over the 30 year return period, the mean daily sunshine was 3.9 hours, with an annual average of 61 days with no sun.

Annual average wind speeds are 9.9 knots with a mean monthly wind speeds range of 8.0 knots to 12.2 knots. The maximum gust wind speed was 75 knots, with an annual average of 8.2 days with gale force winds recorded.

The annual average number of days with hail is 9.5 days, fog is 50.5 days and with snow or sleet is 21.6 days.

13.3.2 Actual Impacts of Proposed Development on Climate

As there will be no atmospheric emissions from the site, the development will not give rise to adverse impact on the climate.

The development will have a beneficial effect in terms of the reduction of greenhouse gases emissions (GHG) when compared with conventional sources of electricity generation (1.3 million tonnes of carbon emissions per annum.).

Wind energy is a renewable resource and does not give rise to the emission or discharge of greenhouse gases or other waste by products.

The significance of zero emissions in term of regional and global climatic effects is twofold:

Energy generation without GHG emissions contributes positively to national and international policy on reducing potential climate change effects.

As windfarms do not emit SO_2 into the atmosphere, there is a positive impact in terms of reduction in acid rain precursors.

Accordingly, there will be a net beneficial impact on climate through the generation of electricity at the proposed Dublin Array offshore wind farm on the Kish and Bray banks.

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