Department of Communications, Energy and Natural Resources
Roinn Cumarsáide, Fuinnimh agus Acmhainní Nádúrtha
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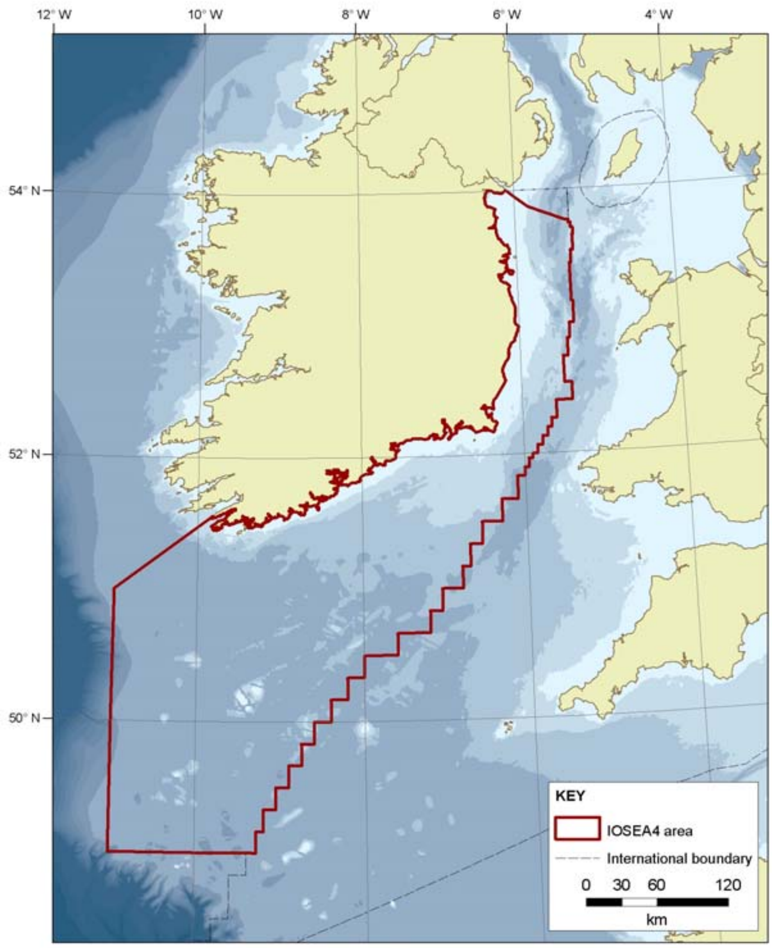
Appropriate Assessment for IOSEA4: Irish and Celtic Seas



IOSEA 4

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Department of Communications, Energy and Natural Resources
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This report was commissioned by:

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Contents

Summary

Summary

Exploration activity levels in the Irish and Celtic Seas have been relatively low over the past decade when compared to, for example, the North Sea. The IOSEA4 area however, does contain proven oil and gas accumulations at different stratigraphic levels and includes all three of Ireland's currently producing gas fields (Kinsale, Ballycotton and Seven Heads). This is the fourth SEA for oil and gas activities in the Irish offshore environment. The IOSEA4 covers the period 2011 to 2020.

Following the requirements of Article 6(3) of the Habitats Directive, implemented into national law under Regulation 31 of the Habitats Regulations SI 94/1997, an Appropriate Assessment (AA) has been conducted to assess whether the Draft Plan will have any adverse effects on the integrity of Nature 2000 sites. This is a plan level AA which has been prepared following the European Commission Methodological Guidance on the provision of Article 6(3) and 6(4) of the 'Habitats' Directive 92/43/EEC and the European Commission Guidance ' Managing Natura 2000 Sites.

The initial screening stage identified all potential impacts resulting from the plan, considering both individual and cumulative impacts, which might have an effect on the integrity of a European Site. At this stage an initial list of all Natura 2000 sites which might be affected by the plan was compiled including coastal site on both the Irish south and east coasts and also on the adjacent coastlines of England and Wales (Section 2.3). The initial 'long list' of European Sites has been analysed through an assessment of significance to consider which site(s) could be excluded from further assessment on the basis that it can be demonstrated that the Draft Plan will have no adverse effects on the integrity of the site(s) as defined by their status and conservation objectives.

A number of Natura 2000 sites were brought forward for further consideration based on the potential for significant impact from specific and identified elements of the Plan. Potential issues associated with acoustic disturbance from seismic survey activity, direct drilling impacts, and risks associated with accidental hydrocarbon spills were given consideration.

Under normal operating circumstances and taking account of the mitigation measures already in place relating to individual exploration activities the Draft Plan will not compromise the integrity of the sites under consideration.

However, it is recommended that site-specific AA studies should be carried out for the following activities:

- Seismic survey activities in, or in close proximity to the Roaringwater Bay and Islands SAC;
- Direct drilling activities proposed within, or in close proximity to the Wicklow Reef SAC and also the Hook Head SAC and the Roaringwater Bay and Islands SAC.

Whilst it is considered that the risk of a major hydrocarbon spill as a result of the Draft Plan activities is very low, given the close proximity of the IOSEA4 area to the sensitive coastlines not only of Ireland but also of Wales, Northern Ireland and other sensitive locations along the UK western coastline between the Isle of Scilly to the south and the Dumfries and Galloway coast to the north, the consequence of a spill is unpredictable at this stage and should be subject to further specific oil spill risk assessment at individual project level.

Taking into account all the matters discussed, and provided that the above measures are implemented, it can be concluded that continued targeted assessment is required at individual project level to ensure that the proposed plan will not adversely affect the integrity of any relevant Natura 2000 sites.

Section 1

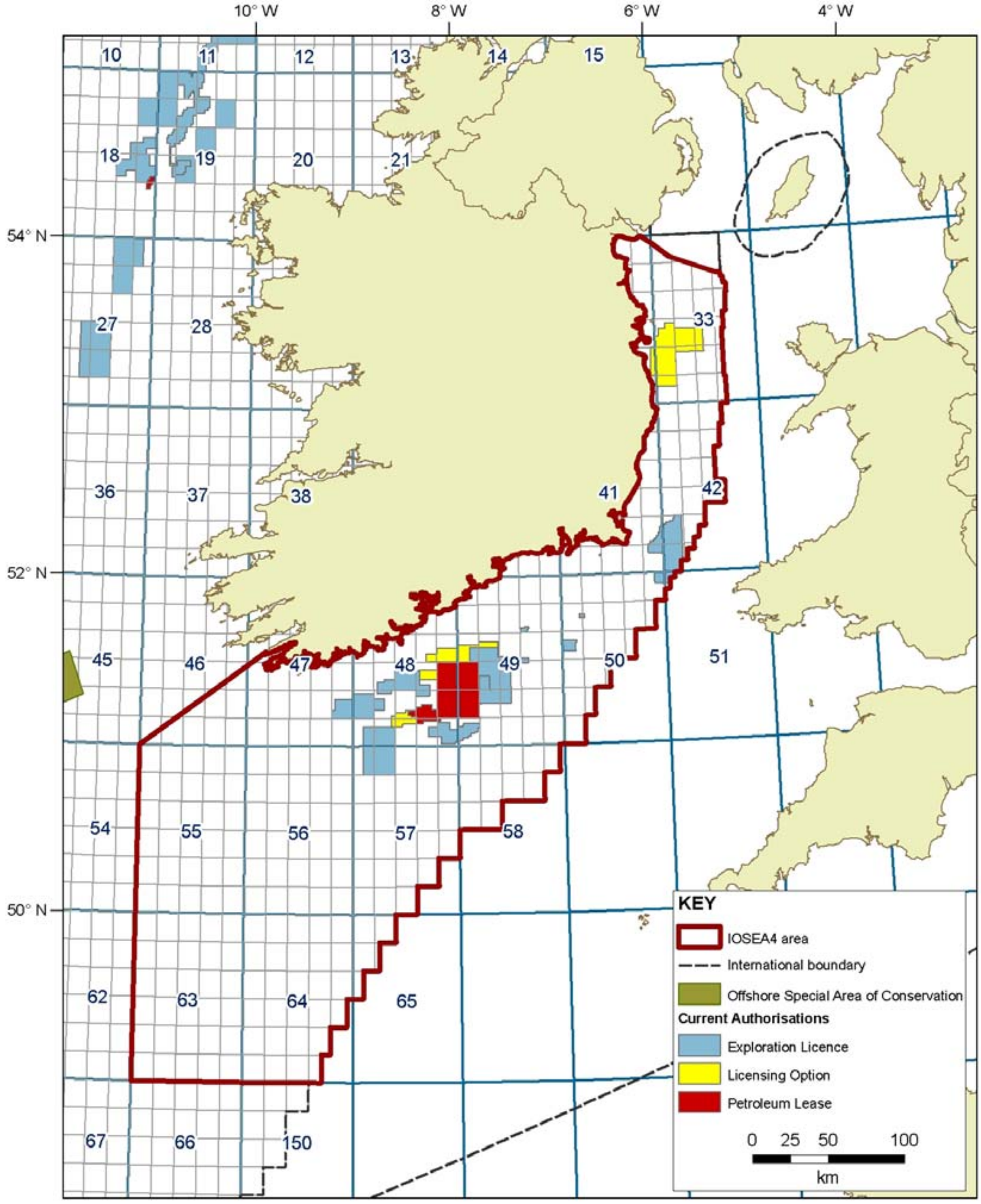
Introduction

1 Introduction

1.1 Background

Over the past decade, exploration activity levels offshore Ireland have been relatively low. The Department of Communications, Energy and Natural Resources (DCENR) initiated a review of the hydrocarbon-bearing potential of the Atlantic Ireland Basins and followed this up with a series of licensing rounds, each preceded by a Strategic Environmental Assessment (SEA), commencing with the acreage covering the Slyne, Erris and Donegal Basins to the west and northwest of Ireland in 2006. This was followed by the Porcupine Basin to the west and southwest in 2007, and the Rockall Basin located further offshore to the west and northwest of Ireland in 2009. The current review is now examining the Irish and Celtic Seas within an area of 78,096 km^2, located to the east and south of Ireland and for which a fourth Irish Offshore Strategic Environmental Assessment (IOSEA4) is being conducted (Figure 1.1).

Figure 1.1 The IOSEA4 area within the Irish and Celtic Seas



1.2 Regulatory Context

The Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora, known as "The Habitats Directive", provides legal protection for habitats and species of European importance. Articles 3 to 9 provide the legislative means to protect habitats and species of Community interest through the establishment and conservation of an EU-wide network of sites known as Natura 2000. These are Special Areas of Conservation (SACs) designated under the Habitats Directive and Special Protection Areas (SPAs) designated under the Conservation of Wild Birds Directive (79/409/ECC).

Articles 6(3) and 6(4) of the Habitats Directive set out the decision-making tests for plans and projects likely to affect Natura 2000 sites (Annex 1.1). Article 6(3) establishes the requirement for Appropriate Assessment (AA):

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

The requirement is implemented in Ireland by the European Communities (Natural Habitats) Regulations SI 94/1997, under Regulation 31 (Annex 1.2).

1.3 Stages of the Appropriate Assessment

This AA has been undertaken in accordance with the European Commission Methodological Guidance on the provision of Article 6(3) and 6(4) of the Habitats Directive and the European Commission Guidance Managing Natura 2000 Sites.

In complying with the obligations under Article 6(3) and following the Guidelines, this AA has been structured in a stage-by-stage approach as follows:

1) Screening Stage

- Description of the Draft Plan;
- Review of consultation feedback received for the IOSEA4 Draft Plan including consultees in the UK;
- Identification of Natura 2000 sites potentially affected;
- Identification and description of individual and cumulative impacts likely to result from the Draft Plan; and
- Assessment of the significance of the impacts identified above on site integrity[1]. Exclusion of sites where it can be objectively concluded that there will be no significant effects.

2) Appropriate Assessment stage

- Description of the Natura 2000 sites that will be considered further in the AA;
- Description of significant impacts on the conservation features of these sites likely to occur from the Draft Plan; and
- Recommendations.

The Habitats Directive promotes a hierarchy of avoidance, mitigation and compensatory measures. First, the plan should aim to avoid any negative impacts on Natura 2000 sites by identifying possible impacts early in the plan-making, and writing the plan in order to avoid such impacts. Second, mitigation measure should be applied if necessary during the AA process to the point where no adverse impacts on the site(s) remain. If the plan is still likely to result in adverse effects, and no

[1] *The integrity of the site involves its ecological functions. The decision as to whether it is adversely affected should focus on and be limited to the site's conservation objectives.*

further practicable mitigation is possible, then it is rejected. If no alternative solutions are identified and the plan is required for imperative reasons of overriding public interest (IROPI test) under Article 6(4) of the Habitats Directive, then compensation measures are required for any remaining adverse effect.

Section 2

Screening

2 SEA Screening

2.1 Description of the Draft Plan

The IOSEA4 has been undertaken in response to the Irish Government's plan to retain the 'open door' licensing policy for hydrocarbon exploration in the Celtic Sea and Irish Seas for the period 2011 to 2020 (the Draft Plan), in compliance with EU Directive 2001/42/EU of 27th June 2001 on the assessment of the effects of certain plans and programmes on the environment.

In addition to the assessment of impacts described in the Environmental Report from IOSEA4, this AA will inform the DCENR of specific environmental considerations relating to Natura 2000 sites to assist its future licensing process in the Irish and Celtic Seas.

2.1.1 Scenarios and assumptions for the Draft Plan

The scenarios being considered for the activity levels following the award of an exploration licence from time to time comprise 2D and 3D seismic survey and exploratory drilling in the period 2011 to 2020. Although IOSEA4 is an assessment of exploration activities only, it is recognised that a proportion of the exploration may ultimately result in development taking place. Recommendations regarding environmental protection during the exploration phase of the area are made based on an assessment of the potential impacts of exploration and appraisal activity. Estimates of maximum levels of each activity have been made by the DCENR on the basis of historical experience and are shown in Table 2.1.

Table 2.1 Exploration activities (and potential development activity) forecast in the IOSEA4 area between 2011 and 2020 arising from exploration activity in the Irish and Celtic Seas

Type of activity	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
2D seismic survey (km)	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
3D seismic survey (km^2)	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
Exploration drilling (no of wells)	6	6	6	6	6	6	6	6	6	6
Appraisal drilling (no of wells)	5	5	5	5	5	5	5	5	5	5
Development drilling (no of wells)	7	7	7	7	7	7	7	7	7	7

Seismic acquisition intensities could be up to 10,000 line km of 2D data, plus up to 3,000 km^2 of 3D data per annum. Drilling intensity levels could be up to six exploration, five appraisal and seven development wells per annum.

2.1.2 Seismic Surveys

Offshore seismic surveys are conducted by a vessel towing acoustic sound sources (air guns) that release pulses of compressed air into the water column. The air guns are towed 5 to 10 m below the sea surface and will release a bubble of compressed air at intervals of 10 to 20 seconds, equivalent to a spacing of approximately 12 metres on the sea bed. Air guns produce loud impulsive low frequency sounds which are usually around 226 dB for a single air gun or 242 to 252 dB for an array (e.g. Richardson, 1997).

The generated sound waves travel to the sea floor, both penetrating and reflecting off the sea bed itself and successively deeper rock strata beneath (Figure 2.1). The reflected signals are detected by hydrophones towed in streamers behind the survey vessel. Each streamer is constructed in sections comprising a central core containing the electronics, surrounded by a layer of cable oil (a light kerosene-type oil), and enclosed in a durable outer skin. Increasingly, however, solid streamers are being used in the industry. The streamer is towed at 5 or 6 m depth behind the noise source and has a tail buoy attached which locates the furthest extent of the towed array behind the survey ship (Figure 2.1). The reflected signals picked up by the hydrophones are recorded and processed using computer software to create either a 2D vertical section or a 3D picture of the seabed and underlying geological formations.

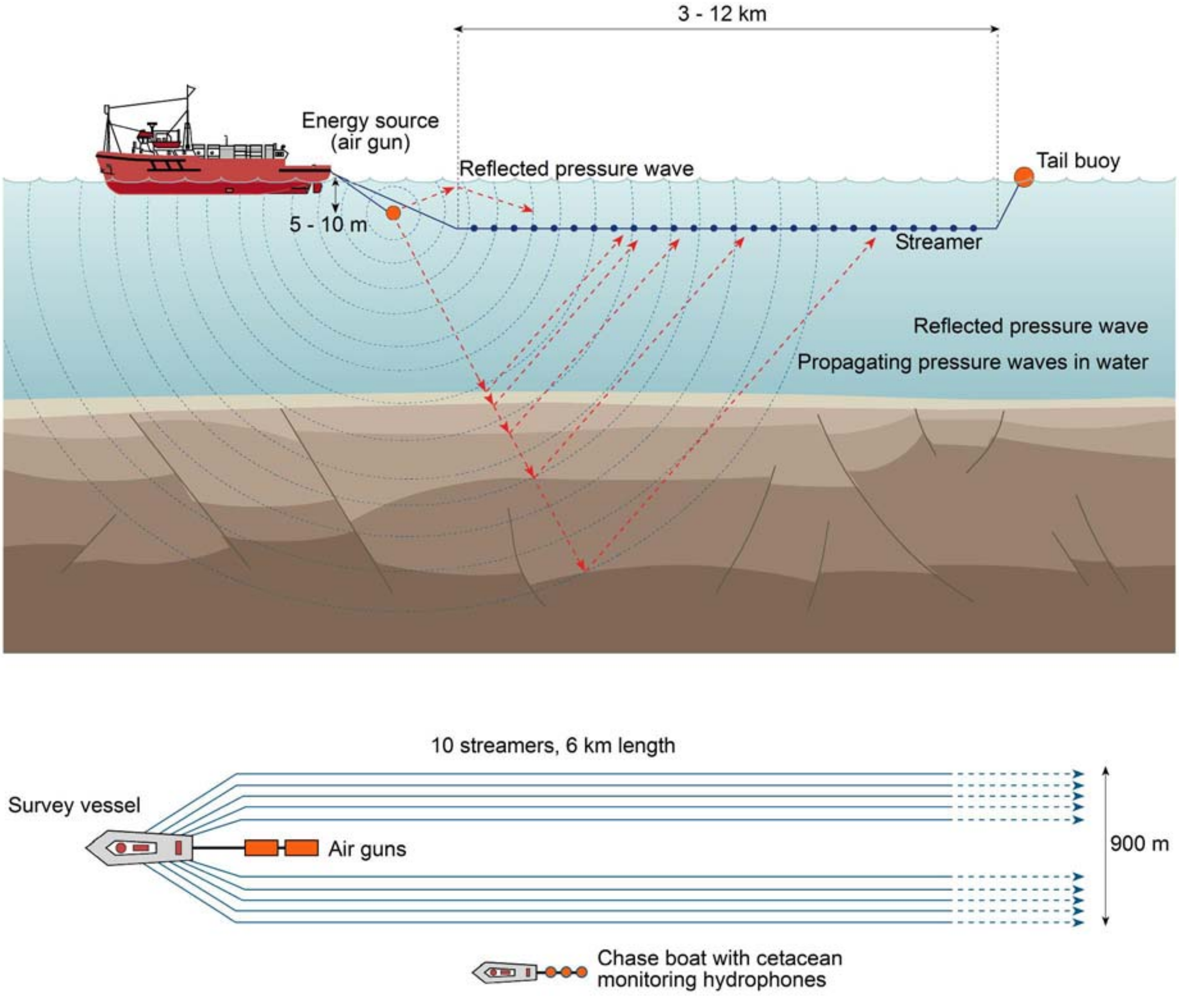
A 3D seismic survey is basically derived from a dense grid of 2D survey lines. However, the way in which it is processed and interpreted is different from that of 2D data. If enough closely-spaced seismic survey lines are acquired, the data can be used to create a 3D image of the subsurface by layering the 2D cross section images side by side. This difference enables practitioners to take the data from linear (2D) to volume (3D) information. In 3D surveys, the subsurface is closely sampled in every direction, leaving no open loops or gaps in the structure or stratigraphy when it is analysed.

The greatest advantage of 3D data is that it provides the ability to map the subsurface more completely, allowing the interpreter to fill in the 'gaps' that are inherent in 2D data. Other advantages of 3D over 2D stem from the greater density of data points, leading to more accurate positioning of drilling targets through improved horizontal and vertical resolution, and a choice of viewing perspective in the software-generated 3D models.

In 2D seismic surveys, one streamer with a length of 3 to 12 km is used (Figure 2.1). In 3D seismic surveys, many parallel traverses must be carried out, and it is therefore more efficient to collect swathes of data by towing six to twelve streamers, each separated by approximately 100 m from its neighbours (Figure 2.1). Ensuring that a large number of streamers remain straight and parallel to each other is difficult and 3D survey vessels rarely tow streamers that are longer than 5-6 km. During survey work, the survey vessel is accompanied by a chase boat whose function is to patrol the towed array and to assist in ensuring other vessels maintain a safe distance.

Normally, a seismic survey vessel travels at approximately 4.5 to 5.5 knots, or around 10 km/hour (Turnpenny & Nedwell, 1994). However, this describes the velocity of the seismic survey vessel and not the survey rate, which must take account of weather downtime and any technological difficulties. A survey rate of 25 km/day for 2D and 30 km^2 for 3D including weather downtime and other delays has been used to calculate ship time from exploration activity in the Celtic and Irish Sea between 2011 and 2020.

Figure 2.1 Typical seismic survey set-up (not to scale)



Seismic scenario assumptions

The seismic survey effort estimated by the DCENR (Table 2.1) for the IOSEA4 area amounts to a likely maximum of 100,000 km of 2D and 30,000 km^2 of 3D survey. In terms of ship time at sea this amounts to approximately 4,000 days vessel time for 2D seismic over the period 2011 to 2020, and 1,000 days vessel time for 3D seismic over the same period.

Due to operators clubbing together or 'piggybacking' surveys together in order to achieve economies in vessel hire and concerns over noise contamination, it is assumed that seismic activity will be restricted to two or three vessels working over the IOSEA4 area with work being concentrated in the summer months each year.

2.1.3 Exploration Drilling

Although the IOSEA4 area extends from offshore right up to the south and east coasts of Ireland, most of the drilling activity to date in the Irish and Celtic Seas has nevertheless taken place offshore in relatively deep water. The well drilled closest to shore to date is Well 33/21-1, located approximately 15 km east of Dublin in the Kish Bank Basin in 1979 in approximately 15 m of water (DCENR, 2010a). A jack-up rig was used for this, but whilst jack-up drilling rigs could potentially be used in exploration activity in shallow water, the main type of rig used offshore in the IOSEA4 area in practice has been the semi-submersible drilling rig.

Semi-submersible drilling rig

A semi-submersible drilling rig, or semi-sub is a drilling unit which is usually supported on two parallel submersible hulls that are streamlined like a ship. The hulls carry columns extending above the sea surface which support the main deck, superstructure and drilling rig.

The rig is normally floated in from offsite but the lower hulls are then flooded to cause the rig to partially submerge. In this half submerged state, the rig becomes a stable work platform and is far less susceptible to wave motion, particularly rolling and pitching, than when de-ballasted and floating on the sea surface.

It is often the case that a semi-sub will have eight to twelve anchor lines set at various points around the rig to keep it in position (known as a moored semi-sub). In deeper water the anchor spread radius might extend to two kilometres from the drilling location, with half of the anchor chain resting on the sea bed. Additionally, the rig carries several thrusters (or propulsion units) as part of a dynamic positioning (DP) system. Controlled by a computer that determines the exact position of the drilling rig relative to the well, the thrusters are automatically actuated as necessary to maintain the rig precisely on station.

Although this kind of drilling rig is usually capable of self propulsion, they are often towed into position. Once in place, anchor handling vessels (usually the same vessels as the tugs) place the anchors in position in order to secure the rig at the exact drilling location.

Drilling operations

Typically the first step in the sequence of drilling activities is to drill a top hole section into the sea bed into which the conductor pipe is cemented, following which the well is drilled in successively smaller diameter sections until the hydrocarbon-bearing formation is reached. Once each well section is drilled, steel casing of appropriate diameter is inserted and cemented into place, to provide stability and a barrier between the wellbore and surrounding formations. In addition the casing provides a firm anchorage for the blow out preventer (BOP) stack and structural integrity for subsequent drilling, testing and possible future production operations. Once the BOP is in place the marine riser, a large-diameter pipe that connects the BOP stack to the drilling rig, is installed.

The use of drilling fluid, also known as drilling mud, is intrinsic to all drilling operations. Drilling mud assists in a number of functions such as lubrication and cooling of the drilling bit, suspension and transport of rock cuttings to the surface and, most importantly, the provision of hydrostatic pressure to counterbalance formation pressure. Drilling mud consists of a liquid mixture of clay, water or oil, and other chemical additives. The most commonly used drilling fluids contain water as the fluid continuous phase, and are known as water-base muds (WBMs). However, certain borehole conditions might require a mud formulation where the continuous phase is oil or a synthetic fluid and these are known as oil-base muds (OBMs) or synthetic base muds (SBMs).

The mud is pumped down the drill stem to the drill bit, then circulated back to the surface via the annulus (the space between the drill stem and the wall of the bore hole) and through the BOP stack and the marine riser back to the drilling rig or ship. Back onboard, these muds and cuttings pass through a mud recovery system where part of the drilling mud is recovered. Once reconditioned, this mud is used again. However, the cuttings must be disposed of, together with any adhering mud and chemicals not removed by the cleaning system. For this process three main alternatives are on offer:

- Overboard discharge;
- 'Skip-and-ship' i.e. to send the cuttings back to a shore facility for cleaning and landfill; and
- Cuttings re-injection.

When using WBM the rock cuttings, and any mud remaining at the end of drilling, are usually discharged to the sea. Under OSPAR Decision 2000/3 the discharge into the sea of cuttings contaminated with oil-base fluids at a concentration greater than 1% by weight on dry cuttings is prohibited. This option is therefore not available for oil-contaminated cuttings unless they can be cleaned offshore to meet these requirements.

Although pilot projects are currently running in the North Sea, offshore cleaning of oil-contaminated cuttings is not yet considered to be achievable in general industry practice. A more common approach for oil-contaminated cuttings is to ship them to shore where they can be cleaned and re-cycled as, for example, road aggregate, or put into landfill. Cuttings re-injection (CRI) is another disposal option, useful for contaminated cuttings, where drill cuttings are mixed into a slurry with water and pumped at high pressure down a separate injection well. CRI is slowly becoming more widespread in mature oil development areas where there are enough potential injection wells available.

The top hole section of the well has to be drilled without the conductor and BOP in place, and thus with no riser from the seabed to the drilling platform. This means that all drilling fluids, rock cuttings, and cement returns from the top section are discharged directly from the top of the well onto the sea bed. Once the marine riser is in place, the drill fluids and cuttings can be circulated from the well back up to the drilling rig where they will be treated so that the drilling mud can be re-used and the cuttings disposed of appropriately as described above.

Cementing operations

The steel casings that are run into each of the well sections have to be cemented into place. When setting the conductor it is normal practice to use a certain amount of excess cement. To minimise the amount of cement being discharged it is considered good practice to have a remotely operated vehicle (ROV) present at the wellhead to observe the cement returns.

Excess cement from the deeper sections is circulated back to the drilling rig or ship through the marine riser, and treated in the same way as the cuttings (i.e. cleaned and discharged overboard).

Well testing

If hydrocarbons are found, a well test may be required to establish the well performance and well characteristics.

The most conventional well test method involves flowing or producing the reservoir fluids up to the drilling unit, where they are flared off. Whilst producing the well at different flow rates, a comprehensive evaluation of the well and certain reservoir characteristics can be made which will help in evaluating whether the reservoir could be exploited commercially in the future.

Alternatively a closed chamber well test can be carried out under certain circumstances. During a closed chamber well test, the well bore itself is used to store the produced fluids whilst pressure build up in the well bore and flow are measured downhole. After the test, the oil sample of approximately 20 to 30 barrels of oil is circulated to the surface, collected into containers/tote tanks and shipped to shore for analysis. Although not as comprehensive as a conventional well test, the data obtained, combined with log and seismic data can, in some cases, provide sufficient information to decide if any future development of the well would be viable.

Well abandonment / suspension

Depending on operational issues and the hydrocarbon reserves found, an exploration well can either be abandoned or suspended.

In case of abandonment, mechanical and cement plugs are placed along the well, plugging off all points where hydrocarbons can possibly enter the wellbore. The casing will then be mechanically cut and recovered from below the seabed.

If further development of the well in the near future might be an option, then the well may be suspended. If this is the case, the well will be left intact and a series of mechanical and/or cement plugs will be placed inside the well to prevent the escape of hydrocarbons. The conductor and casings will be sealed and left protruding approximately 1.8 m (6 ft) above the seabed.

Drilling scenario assumptions

Under the maximum drilling activity scenario in Table 2.1, a maximum of 180 wells may be drilled over the period 2011 to 2020 (0 to 60 exploration wells, 0 to 50 appraisal wells, 0 to 70 development wells). At the maximum anticipated rate over the period 2011 to 2020, with no pre-existing drilling activity, this would average out at 18 wells per year.

It is not possible to state unequivocally the distribution of hydrocarbon types within the IOSEA4 area, since both oil and gas have been found (at trace to commercial quantities) throughout the region. Of the 18 fields or wells currently under continuing assessment or production in offshore Irish waters, 12 occur within the IOSEA4 area, all of these are located in the Celtic Sea and are a mixture of oil and gas discoveries (DCENR, 2010a). Of the three producing fields in the IOSEA4 area however (Kinsale, Ballycotton and Seven Heads), all are gas.

For the purposes of assessing potential impacts of drilling activities on Natura 2000 sites, certain assumptions have been made such as the length of time taken to drill a well, the fuel used by the drill rig and associated shipping and the likelihood of a well test being needed. These assumptions are made on a conservative basis, and are summarised in Table 2.2.

Table 2.2 Estimated fuel use and time span of drilling/associated activities per well (source: Institute of Petroleum, 2001)

Vessel type	Time span (days)	Fuel consumption	Fuel used (tonnes)
Semi-submersible drilling rig	50	20 tonnes/day	1,000
Large tug	14	25 tonnes/day	350
Anchor handlers	4 (2 vessels)	30 tonnes/day	240
Standby / safety vessel	50	5 tonnes/day	250
Supply vessel	21	8 tonnes/day	168
Helicopter	9 hrs/week for 7 weeks	0.48 tonnes /hr	30
Well test (required for 50% of wells drilled)	2	-	2 million m^3 per well

If hydrocarbons are found (including finds that turn out to be small non-commercial quantities), then a well test may be required to evaluate the potential reserves which will involve producing the hydrocarbon concerned to the surface over a period of 48 hours. In the absence of any production facilities, the produced hydrocarbon will have to be flared off. The quantity flared in this way is typically in the region of 2 million m^3. However, since the scenario for the Draft Plan includes provision for appraisal and some development drilling, an overall well testing rate of 50% will be assumed, leading to nine well tests per year based on 18 wells per year. It will also be assumed that the unsuccessful wells will be suspended rather than abandoned.

Again, if hydrocarbons are found, a vertical seismic profile (VSP) or checkshot survey may be carried out in order to obtain more detailed data on the formation structure. Such surveys use airguns to emit loud acoustic pulses, and hydrophones to detect the reflected sounds. The airguns used are smaller and fewer in number than those used in 2D or 3D seismic surveys, but are otherwise similar. The hydrophones can be placed at various locations (including inside the wellbore or on the seabed) depending on the information that is required. The airguns may be deployed from the drilling unit or from a small survey vessel and are fired periodically. The blast emitted from the gun is designed so that it directs most of its energy in the vertical plane to prevent noise loss into the surrounding waters. The guns fire at very close intervals so that the pulses generated cancel out the reverberation that follows the initial blast. The number of sound blasts required varies from survey to survey, depending on how much information is required, but surveys would typically be complete within 1 day. On the basis of the assumptions above for well testing, up to 9 VSP/checkshot surveys per year may be expected.

2.1.4 Exploration activity in the IOSEA4 area to date

Exploration activity in the IOSEA4 area to date has been concentrated within the six sedimentary basins present: the Kish Bank Basin; the Central Irish Sea Basin; the North Celtic Sea Basin; the Southern Celtic Sea Basin; the Fastnet Basin and the Cockburn Basin (Figure 2.2).

Figure 2.2 Structural elements of the IOSEA4 area (source: PAD, 2001)

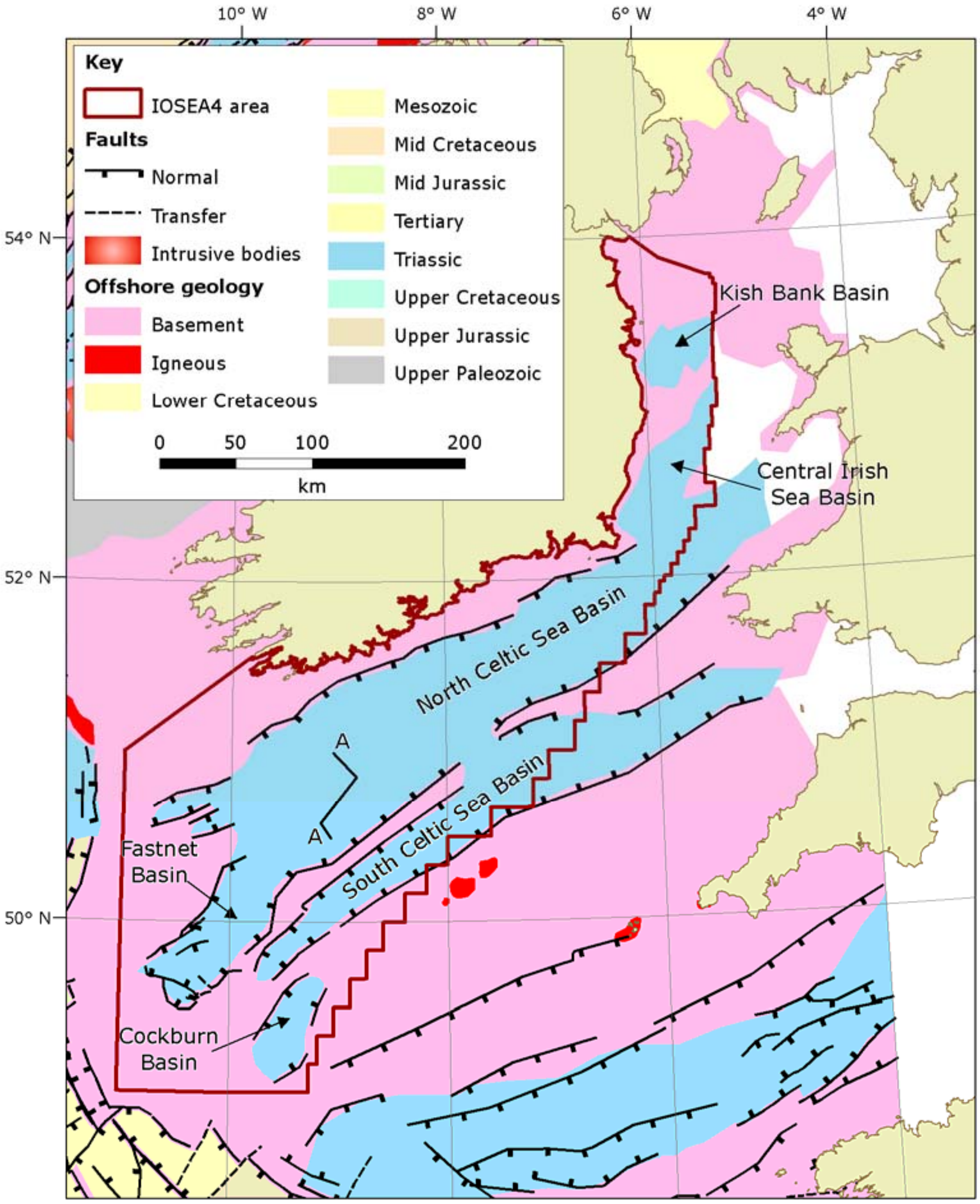
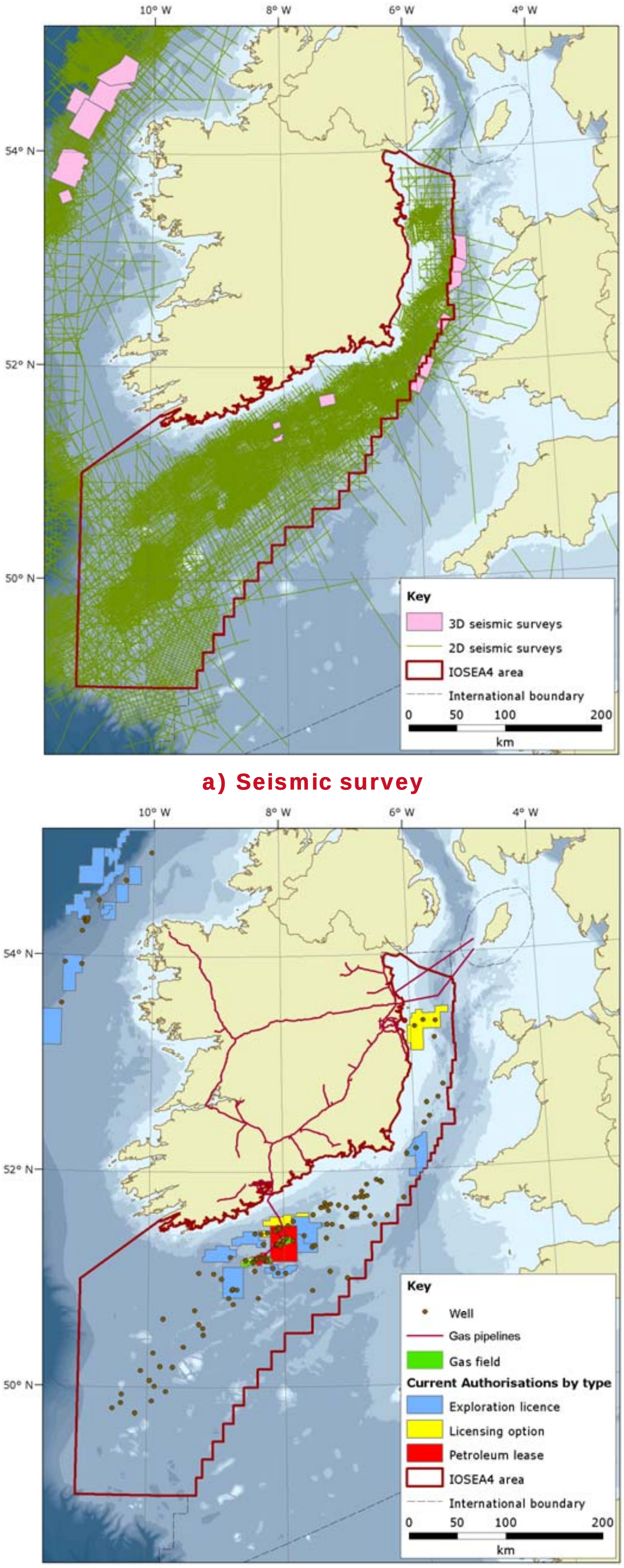


Figure 2.3 shows where the oil and gas industry activity offshore has been concentrated in the IOSEA4 area to date, and by the same token indicate where future exploration activities are likely to take place.

Figure 2.3 Oil and gas activity in the IOSEA 4 area (source: DCENR, 2010)



a) Seismic survey

b) Wells drilled and pipelines

2.2 Consultation Review

Consultation for the AA has been carried out as part of the broader consultation undertaken for IOSEA4. Consultation has been sought from:

- Environment Protection Agency (EPA);
- Department of the Environment, Heritage andLocal Government (DOEHLG); and
- Department of Agriculture, Fisheries and Food (DAFF).

And also with:

- Northern Ireland Environment Agency (NIEA);
- Department of Environment, Food and Agriculture for Isle of Man (DEFA);
- Environment Agency (England and Wales) (EA);
- Countryside Council for Wales (CCW); and
- Natural England (NE).

Table 2.3 summarises the consultation responses received, specifically relating to the scope and requirements for AA.

Table 2.3 Summary of consultation responses received relating to Appropriate Assessment

Organisation	Issue raised	How and where issue addressed
DoEHLG	The environmental report should take note that the scope of the activities encompassed by this strategic environmental assessment may overlap with the range of national and international nature conservation legislation and the requirements and obligations arising from the following:	The Environmental Report, Annex and Appropriate Assessment documents have been produced in close association and overlaps have been systematically identified and correlated.
	Council Directive 92/43/EC (Habitats Directive)	
	European Communities (Natural Habitats) Regulations (SI 94 of 1997)	
	European Communities (Natural Habitats) (Amendment) Regulations (SI 378 of 2005)	
	Council Directive 09/147/EC (the Birds Directive)	
	European Communities (Conservation of Wild Birds) Regulations (SI 291 of 1985)	
	Wildlife Act 1976 and Amendment 2000	
	Bonn Convention 1976 (or Convention on Migratory Species)	
	UNCLOS 1982	
	Convention for the Protection of the Marine Environment in the North-east Atlantic 1998 (OSPAR) (in particular Annex V therein)	
	Convention on Biological Diversity.	

Table2.3 (Continued)

Organisation	Issue raised	How and where issue addressed
EPA	Consideration should be given to preparing a separate free standing Plan / Programme to accompany the SEA Environmental Report, which clearly sets out the aims and objectives of the Plan and stating the requirements to assess the Plan under the SEA and Habitats Directive Regulations.	The Draft Plan for the IOSEA4 area is provided in Appendix 1 of the Environmental Report and summarised in Section 4 of the Environmental Report.
	In addition…, consideration should be given to describing whether the environmental issues are / are not included in the scope of the IOSEA4 environmental assessment. The reasons / justifications for scoping in / out of each environmental issue should also be provided.	Within the context of the Appropriate assessment this is dealt with in Section 2.8 of this report where an initial assessment of significance has been documented.
	An assessment of the likely significant cumulative and in-combination effects in relation to designated conservation sites (marine / coastal / estuarine / terrestrial) both of national and international significance should be considered.	Sections 3 of this AA gives consideration to both in-combination, cumulative and transboundary issues where relevant which specifically considers impacts on designated conservation sites.
	It should also be ensured that the recommendations of the Appropriate Assessment should be integrated as appropriate to ensure protection of Natura 2000 sites, including transboundary Natura 2000 sites.	Throughout Environmental Report and Appropriate Assessment
	The requirement for Appropriate Assessment (AA) to be carried out should be highlighted in the environmental report.	Section 3.3 of the Environmental Report outlines the requirement and where appropriate this has been recommended during impact assessment.
	A clear description of the scoping process, including issues raised by stakeholders consulted and there would be merits in listing stakeholders including transboundary stakeholders consulted.	Section 2.2.1 of the Environmental Report describes the scoping process and Section 2.2 of the Appropriate Assessment (here) describes the relevant issues raised by stakeholders.
Wexford County Council	Wish to make observations on the scope of environmental information to be included in the environmental report:	N/a
	Wexford is dependant on its coastline for commercial, recreational and amenity activities. Its coastline encompasses a number of candidate and designated Natura 2000 and coastal Ramsar sites.	The recreational value is detailed in Section 5.3 of the Annex and summarised in Section 5.4.3 of the Environmental Report. Details of the coastal conservation designations are detailed in Section 2.4 of this Appropriate Assessment.
CCW	It is particularly important that the IOSEA4 process allows for consideration of the environmental effects, either alone or in combination, at an appropriate geographical scale.	The principle of consideration of environmental effects at an appropriate geographic scale has been acknowledged throughout the Environmental Report and the Appropriate Assessment.
	Clarification regarding potential for any activity that might require transboundary infrastructure and potential transboundary effects.	The Draft Plan is for exploration activity and would not include installation of transboundary infrastructure.

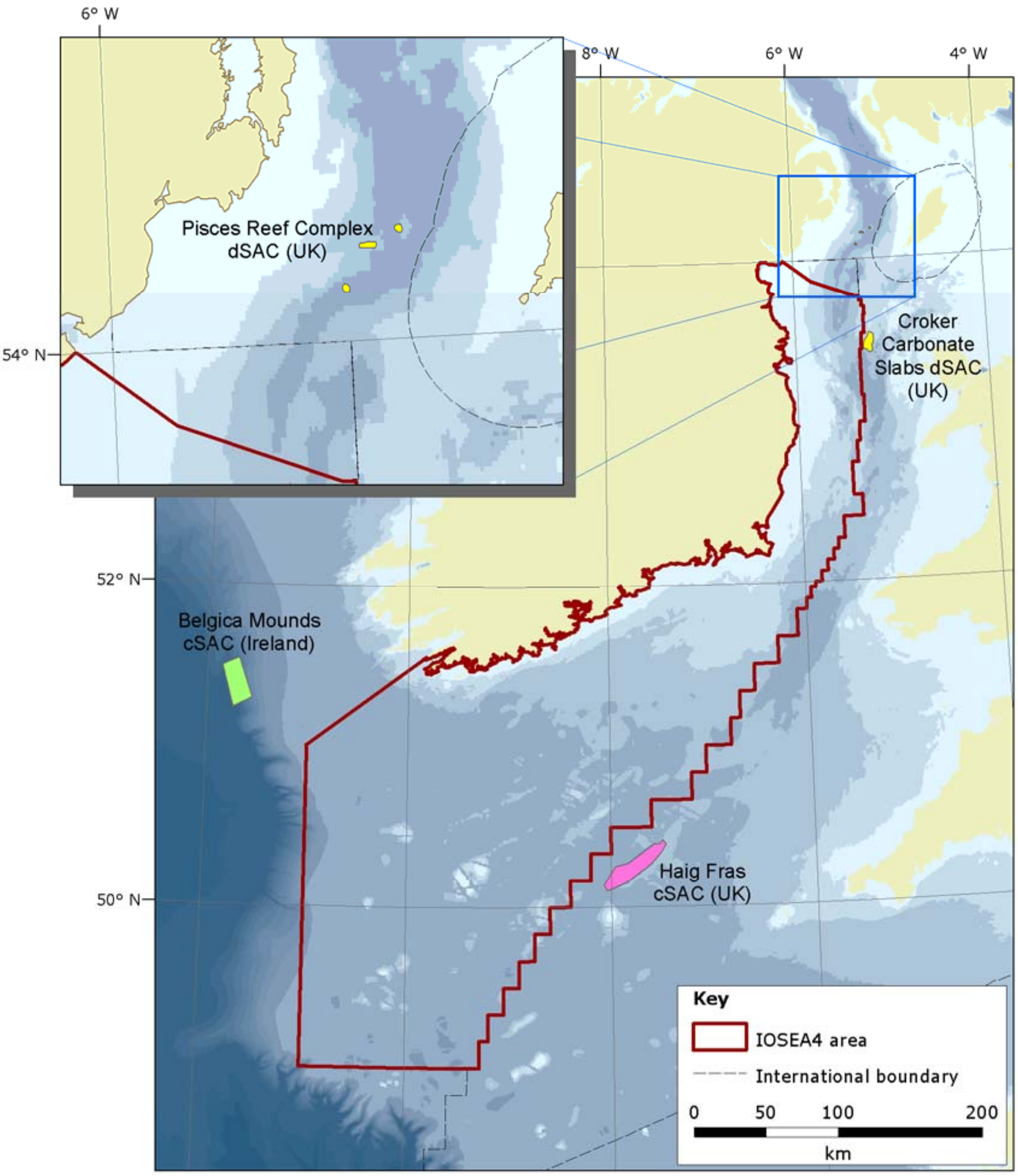
Table2.3 (Continued)

Organisation	Issue raised	How and where issue addressed
	The SEA should consider potential transboundary effects to interest features in Welsh territory related to work or activities taking place within Irish territory. Consideration should be given to the potential effects to mobile species and links through physical and ecological processes.	This point is acknowledged and impacts to transboundary interest features (primarily marine mammals) have been considered where appropriate in Sections 3 of this Appropriate Assessment.
	Particularly in the northern Irish Sea, the scale of development leading up to 2020 is likely to be considerable. There is, therefore, a risk that the effects of individual development projects resulting from Irish and UK offshore activities will act in combination.	Cumulative impacts on Natura 2000 sites are addressed in Section 3 of the Appropriate Assessment.
	The combined effects of noisy activities may result in transboundary effects on marine mammals that are highly mobile and wide ranging. Of particular note are the effects on seals: as a source of baseline information we refer to recent seal tagging studies such as those used in the UK's SEA6 Environmental Report, the Atlas of the Marine Mammals of Wales, and ongoing telemetry work conducted by SMRU.	This point is acknowledged. This baseline information available relating to relevant marine mammals is detailed in Section 2.4 of this Appropriate Assessment.
	An assessment of the likely significant effects should include consideration of any issue or effects of particular uncertainty that should be the focus of new or better environmental information. Would like to see a comprehensive consideration of cumulative and in-combination effects and effective mitigation measures.	The existence of uncertainty, data gaps and effectiveness of mitigation is acknowledged within relevant parts of Section 3 of the Appropriate Assessment.
	CCW draws your attention to the UK Offshore Energy SEA Environment Report 2009 that recommends cross-industry coordination of noise activities. CCW recommends suitable mitigation for noise effects on seals and other marine mammals may require a more strategic approach to managing construction noise taking into consideration the combined effects of noise from seismic surveys in the oil and gas industry throughout the UK and Ireland and from other marine sectors such as offshore wind development.	The need for a strategic approach to cross-industry and transboundary coordination of noisy activities has been recognised through the impact assessment, and in recommendations made in Section 11 of the Environmental Report.

2.3 Sites identification

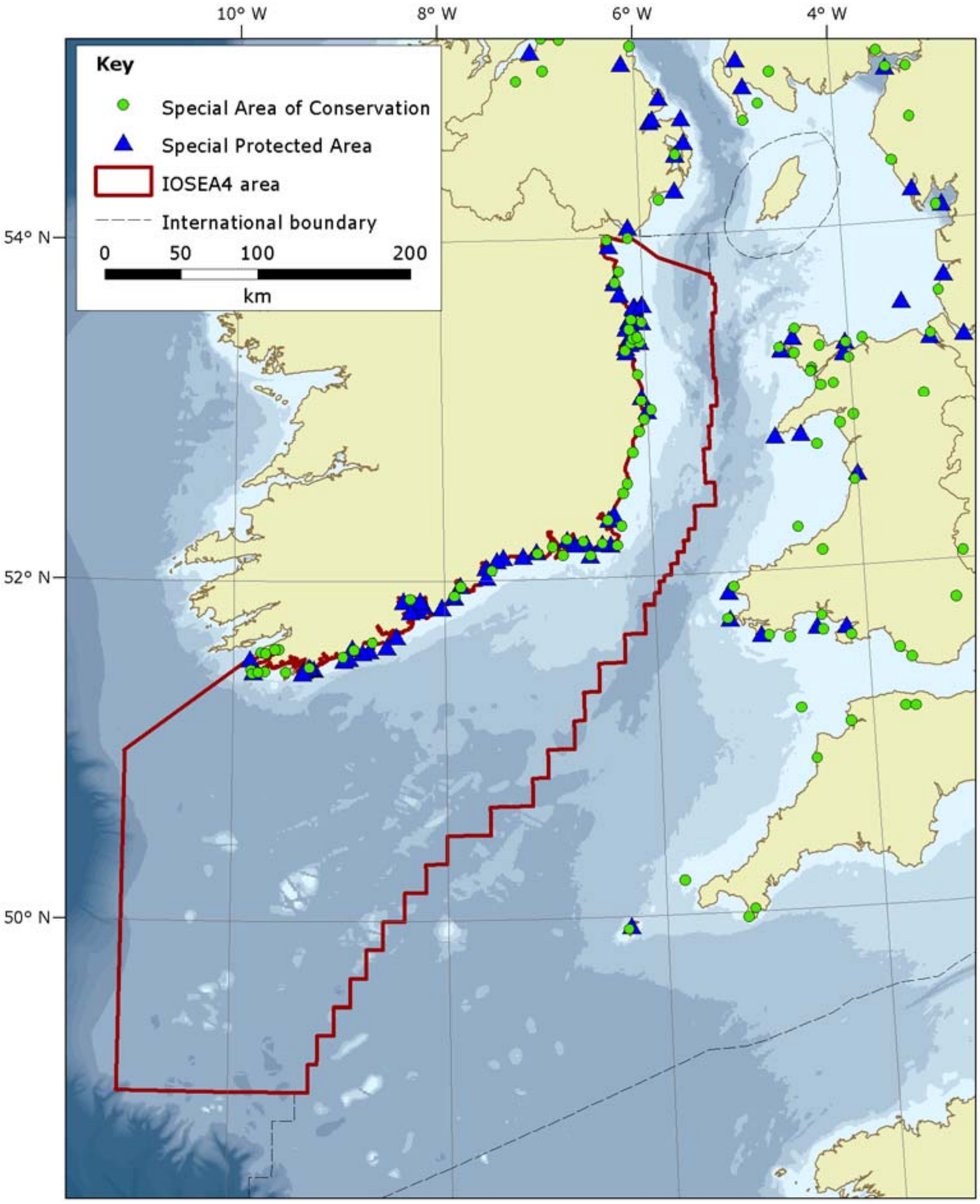
In accordance with the European Commission Methodological Guidance (EC, 2000) a list of Natura 2000 sites that potentially could be affected by the Draft Plan has been compiled. Adopting the precautionary principle in identifying these sites, all Natura 2000 sites with marine interests within the IOSEA4 area have been considered, together with those in close proximity including those in adjacent UK waters or on the UK coastline. These are shown in Figures 2.4 and 2.5 (representative central points only shown for coastal sites). Information about these sites is tabulated in Table 2.4 for offshore SACs close to the IOSEA4 area,, Table 2.5 for coastal cSACs within the IOSEA4 area,, Table 2.6 for SPAs within the IOSEA4 area, and Table 2.7 for SAC and SPA sites on UK coast adjacent to IOSEA4 area).

Figure 2.4 Offshore Natura 2000 sites close to the IOSEA4 area



Ireland currently has no offshore cSACs within the IOSEA4 area. However, Irish offshore SACs neighbouring the IOSEA4 area have been included here, due to the potential for transboundary impacts.

Figure 2.5 Coastal Natura 2000 sites within or close to the IOSEA4 area



Natura 2000 sites along the adjacent UK coastline from Northern Ireland to the Scilly Isles have been reviewed in order to assess the potential for transboundary effects. Of the 89 SAC designations identified along this stretch of the UK coastline, 43 include coastal and/or marine features or species within their designations. The 31 SPA sites along the same stretch of UK coastline have also been included.

Table 2.4 Offshore cSACs close to the IOSEA4 area

Site name	Area (ha)	Distance to IOSEA4 boundary	Annex 1 Habitat	Annex 2 Species
Belgica Mound	411,000 ha	Off Irish west coast, 50 km northwest of IOSEA4 western boundary.	Reefs (biogenic) of cold-water coral.	
Haig Fras	48,103 ha	20 km southeast, in UK waters	Reefs (rocky) with a variety of fauna ranging from jewel anemones and Devonshire cup corals near the peak of the outcrop to encrusting sponges, crinoids and ross coral towards the base.	N/A
Pisces Reef Complex	698 ha	60 km north of the IOSEA4 area, in UK waters	Reefs (bedrock and boulders).	Harbour porpoise; grey seals; harbour seals. (non-qualifying)
Croker Carbonate Slabs	6,591 ha	Immediately adjacent to IOSEA4 boundary in central Irish Sea.	Submarine structures made by leaking gases.	Harbour porpoise; grey seal. (non qualifying)

Table 2.5 Coastal cSACs within the IOSEA4 area

Site name	County	Annex 1 Habitat	Annex 2 Species
Carlingford Shore (002306)	Louth	Mudflats and sandflats not covered by seawater at low tide; Annual vegetation of drift lines, Perennial vegetation of stony banks, Atlantic salt meadows.	
Dundalk Bay (000455)	Louth	Estuaries; Mudflats and sandflats not covered by seawater at low tide; Perennial vegetation of stony banks; Salicornia and other annuals colonizing mud and sand; Atlantic salt meadows; Mediterranean salt meadows.	
Clogher Head (001459)	Louth	Vegetated sea cliffs.	
Boyne Coast & Estuary (001957)	Louth	Estuaries; Mudflats and sandflats not covered by seawater at low tide; Salicornia and other annuals colonizing mud and sand; Spartina swards; Atlantic salt meadows; Mediterranean salt meadows; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation.	
Baldoyle Bay (000199)	Dublin	Mudflats and sandflats not covered by seawater at low tide; Salicornia and other annuals colonizing mud and sand; Spartina swards; Atlantic salt meadows; Mediterranean salt meadows.	
Howth Head (000202)	Dublin	Vegetated sea cliffs.	
Lambay Island (000204)	Dublin	Vegetated sea cliffs.	Grey seal
Malahide Estuary (000205)	Dublin	Mudflats and sandflats not covered by seawater at low tide; Salicornia and other annuals colonizing mud and sand; Spartina swards; Atlantic salt meadows; Mediterranean salt meadows; Fixed coastal dunes with herbaceous vegetation; Shifting dunes along the shoreline.	
North Dublin Bay (000206)	Dublin	Annual vegetation of drift lines; Salicornia and other annuals colonizing mud and sand; Spartina swards; Atlantic salt meadows; Mediterranean salt meadows; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation.	
Rogerstown Estuary (000208)	Dublin	Estuaries; Mudflats and sandflats not covered by seawater at low tide; Salicornia and other annuals colonizing mud and sand; Spartina swards; Atlantic salt meadows; Mediterranean salt meadows; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation.	

Table 2.5 (Continued)

Site name	County	Annex 1 Habitat	Annex 2 Species
South Dublin Bay (000210)	Dublin	Mudflats and sandflats not covered by seawater at low tide.	
Ireland's Eye (002193)	Dublin	Perennial vegetation of stony banks; Vegetated sea cliffs.	
Bray Head (000714)	Wicklow	Vegetated sea cliffs.	
Buckroney-Brittas Dunes and Fen (000729)	Wicklow	Annual vegetation of drift lines; Perennial vegetation of stony banks; Mediterranean salt meadows; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation; Atlantic decalcified fixed dunes; Dunes with *Salix repens* ssp. *argentea.*	
Magherabeg Dunes (001766)	Wicklow	Annual vegetation of drift lines; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation; Atlantic decalcified fixed dunes.	
The Murrough Wetlands (002249)	Wicklow	Annual vegetation of drift lines; Perennial vegetation of stony banks; Atlantic salt meadows; Mediterranean salt meadows.	
Wicklow Reef (002274)	Wicklow	Reefs.	
Ballyteige Burrow (00696)	Wexford	Estuaries; Mudflats and sandflats not covered by seawater at low tide; Coastal lagoons; Annual vegetation of drift lines; Perennial vegetation of stony banks; Salicornia and other annuals colonizing mud and sand; Spartina swards; Atlantic salt meadows; Mediterranean salt meadows; Mediterranean and thermo-Atlantic halophilous scrubs; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation; Atlantic decalcified fixed dunes.	
Bannow Bay (000697)	Wexford	Estuaries; Mudflats and sandflats not covered by seawater at low tide; Annual vegetation of drift lines; Perennial vegetation of stony banks; Salicornia and other annuals colonizing mud and sand; Spartina swards; Atlantic salt meadows; Mediterranean salt meadows; Mediterranean and thermo-Atlantic halophilous scrubs; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation.	
Cahore Polders and Dunes (000700)	Wexford	Annual vegetation of drift lines; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation.	

Table 2.5 (Continued)

Site name	County	Annex 1 Habitat	Annex 2 Species
Lady's Island Lake (000704)	Wexford	Coastal lagoons; Reefs; Perennial vegetation of stony banks.	
Saltee Islands (000707)	Wexford	Mudflats and sandflats not covered by seawater at low tide; Large shallow inlets and bays; Reefs; Vegetated sea cliffs; Submerged or partly submerged sea caves.	Grey seal
Tacumshin Lake (000709)	Wexford	Coastal lagoons; Annual vegetation of drift lines; Perennial vegetation of stony banks; Embryonic shifting dunes; Shifting dunes along the shoreline.	
Raven Point Nature Reserve (000710)	Wexford	Mudflats and sandflats not covered by seawater at low tide; Annual vegetation of drift lines; Atlantic salt meadows; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation; Dunes with *Salix repens* ssp.*argentea.*	
Hook Head (000764)	Wexford	Large shallow inlets and bays; Reefs; Vegetated sea cliffs.	
Kilmuckridge-Tinnaberna Sandhills (001741)	Wexford	Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation.	
Kilpatrick Sandhills (001742)	Wexford	Annual vegetation of drift lines; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation; Atlantic decalcified fixed dunes.	
Long Bank(002161)	Wexford	Sandbanks.	
Carnsore Point (002269)	Wexford	Mudflats and sandflats not covered by seawater at low tide; Reefs.	
Helvick Head (000665)	Waterford	Vegetated sea cliffs.	
Tramore Dunes and Backstrand (000671)	Waterford	Mudflats and sandflats not covered by seawater at low tide; Annual vegetation of drift lines; Perennial vegetation of stony banks; Salicornia and other annuals colonizing mud and sand; Spartina swards; Atlantic salt meadows; Mediterranean salt meadows; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation.	
Ardmore Head (002123)	Waterford	Vegetated sea cliffs.	
Lower River Suir (002137)	Waterford	Atlantic salt meadows; Mediterranean salt meadows.	Sea lamprey; river lamprey; twaite shad; allis shad; Atlantic salmon; European otter.

Table 2.5 (Continued)

Site name	County	Annex 1 Habitat	Annex 2 Species
River Barrow and River Nore (002162)	Waterford	Estuaries; Mudflats and sandflats not covered by seawater at low tide; Salicornia and other annuals colonizing mud and sand; Spartina swards; Atlantic salt meadows; Mediterranean salt meadows.	Sea lamprey; river lamprey; twaite shad; allis shad; Atlantic salmon; European otter.
Blackwater River (002170)	Cork/ Waterford	Estuaries; Mudflats and sandflats not covered by seawater at low tide; Perennial vegetation of stony banks; Salicornia and other annuals colonizing mud and sand; Atlantic salt meadows; Mediterranean salt meadows.	Sea lamprey; river lamprey; twaite shad; allis shad; Atlantic salmon; European otter.
Clonakilty Bay (000091)	Cork	Mudflats and sandflats not covered by seawater at low tide; Annual vegetation of drift lines; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation; Atlantic decalcified fixed dunes.	
Lough Hyne Nature Reserve and Environs (000097)	Cork	Large shallow inlets and bays; Reefs; Submerged or partly submerged sea caves.	
Roaringwater Bay and Islands (000101)	Cork	Large shallow inlets and bays; Reefs; Vegetated sea cliffs; Submerged or partly submerged sea caves.	Grey seal; European otter; harbour porpoise.
Barley Cove to Ballyrisode Point (001040)	Cork	Mudflats and sandflats not covered by seawater at low tide; Perennial vegetation of stony banks; Salicornia and other annuals colonizing mud and sand; Atlantic salt meadows; Mediterranean salt meadows; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation.	
Great Island Channel (001058)	Cork	Estuaries; Spartina swards; Mudflats and sandflats not covered by seawater at low tide; Atlantic salt meadows.	
Kilkeran Lake and Castlefreke Dunes (001061)	Cork	Coastal lagoons; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation.	
Courtmacsherry Estuary (001230)	Cork	Estuaries; Mudflats and sandflats not covered by seawater at low tide; Annual vegetation of drift lines; Perennial vegetation of stony banks; Salicornia and other annuals colonizing mud and sand; Atlantic salt meadows; Mediterranean salt meadows; Embryonic shifting dunes; Shifting dunes along the shoreline; Fixed coastal dunes with herbaceous vegetation.	
Dunbeacon Shingle (002280)	Cork	Perennial vegetation of stony banks; Mediterranean salt meadows.	
Reen Point Shingle (00281)	Cork	Coastal lagoons; Perennial vegetation of stony banks; Mediterranean salt meadows.	

Table 2.6 Coastal SPA sites within the IOSEA4 area

Site name	County	Annex I Birds
Carlingford Lough (004078)	Louth	Bar-tailed godwit.
Dundalk Bay (004026)	Louth	Golden plover; bar-tailed godwit; redthroated diver; great northern diver.
Boyne Estuary (004080)	Louth	Golden plover; bar-tailed godwit; little tern.
Rogerstown Estuary (004015)	Dublin	Golden plover.
Broadmeadow/Swords Estuary (004025)	Dublin	Golden plover; bar-tailed godwit; ruff.
Rockabill (004014)	Dublin	Roseate tern; common tern; arctic tern.
Baldoyle Bay (004016)	Dublin	Golden plover; bar-tailed godwit.
North Bull Island (004006)	Dublin	Golden plover; bar-tailed godwit; ruff; short-eared owl.
South Dublin Bay and River Tolka Estuary (004024)	Dublin	Bartailed godwit; Mediterranean gull; common tern; Arctic tern.
Lambay Island (004069)	Dublin	Peregrine falcon.
Howth Head Coast (004113)	Dublin	Peregrine falcon.
Ireland's Eye (004117)	Dublin	Peregrine falcon.
Skerries Island SPA (004122)	Dublin	Golden plover; short-eared owl.
Wicklow Head (004127)	Wicklow	Peregrine falcon.
Murrough SPA (004186)	Wicklow	Red-throated diver; little egret; whooper swan; Greenland white-fronted goose; golden plover; little tern; sandwich tern; short-eared owl; kingfisher.
Cahore Marshes (004143)	Wicklow	Greenland white-fronted goose; Bewick’s swan; Whooper swan; Golden plover.

Table 2.6 (Continued)

Site name	County	Annex I Birds
Wexford Nature Reserve (004001)	Wexford	Little egret; whooper swan; Bewick's swan; Greenland white-fronted goose; hen harrier; golden plover; bar-tailed godwit; ruff; wood sandpiper; little tern; short-eared owl.
The Raven (004019)	Wexford	Red-throated diver; great northern diver; Slavonian grebe; golden plover; bar-tailed godwit; Greenland white-fronted goose; little tern.
Wexford Harbour and Slobs (004076)	Wexford	Little egret; whooper swan; Bewick's swan; Greenland white-fronted goose; hen harrier; golden plover; bar-tailed godwit; ruff; wood sandpiper; little tern; short-eared owl.
Tacumshin Lake (004092)	Wexford	Whooper swan; Bewick's swan; golden plover; ruff; wood sandpiper; marsh harrier; Greenland white-fronted Goose.
Ballyteige Burrow (004020)	Wexford	Golden plover; bar-tailed godwit; little tern.
Bannow Bay (004033)	Wexford	Golden plover bar-tailed godwit.
Saltee Islands (004002)	Wexford	Peregrine; chough.
Lady's Island Lake (004009)	Wexford	Marsh harrier; ruff; wood sandpiper; whooper swan; golden plover.
Inish and Sgarbheen (004010)	Wexford	Common; roseate; Arctic and sandwich terns; Mediterranean gull.
Keeragh Islands (004118)	Wexford	Arctic tern.
Tramore Back Strand (004027)	Waterford	Little egret; golden plover; bar-tailed godwit.
Dungarven Harbour (004032)	Waterford	Golden plover; bar-tailed godwit.
Blackwater Estuary (004028)	Waterford/ Cork	Little egret; golden plover; bar-tailed godwit.
Helvick Head Coast (004112)	Waterford	Chough; peregrine.
Helvick Head to Ballyquin (004192)	Waterford	Chough; peregrine.
Mid-Waterford Coast (004193)	Waterford	Chough; peregrine.

Table 2.6 (Continued)

Site name	County	Annex I Birds
Ballymacoda (004023)	Cork	Golden plover; bar-tailed godwit.
Ballycotton (004022)	Cork	Golden plover; bar-tailed godwit.
Cork Harbour (004030)	Cork	Whooper swan; golden plover; bar-tailed godwit; ruff; common tern.
Sovereign Islands (004124)	Cork	No Annex I species.
Old Head of Kinsale (004021)	Cork	Chough; peregrine.
Courtmacsherry Bay (004219)	Cork	Great northern diver; golden plover; bar-tailed godwit.
Seven Heads (004191)	Cork	Chough; peregrine.
Galley head to Duneen Point (004190)	Cork	Chough; peregrine.
Clonakilty Bay (004081)	Cork	Golden plover; bar-tailed godwit; little egret; short-eared owl.
Sheep's Head to Toe Head (004156)	Cork	Chough; peregrine.

Table 2.7 Transboundary coastal Natura 2000 Sites

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Pen y Gogarth / Great Orme's Head	SAC	Wales - Conwy	302.63	Vegetated sea cliffs	
Glannau Ynys Gybi/ Holy Island Coast	SAC	Wales - Anglesey	464.27	Vegetated sea cliffs; Submerged, or partially submerged sea caves; Reefs;	Grey seals
Glannau Môn: Cors heli / Anglesey Coast: Saltmarsh	SAC	Wales – Anglesey	1058	Mudflats and sandflats not covered by seawater at low tide; estuaries; *Salicornia* and other annuals colonising mud and sand; Vegetated sea cliffs; Spartina swards; Atlantic salt meadows	
Bse Cemlyn / Cemlyn Bay	SAC	Wales - Anglesey	43.43	Coastal lagoons	
Menai Straits and Conwy Bay	SAC	Wales – Anglesey/Gwynedd/ Conwy	26482.67	Mudflat and sandflats not covered by sweater at low tide; submerged or partially submerged sea caves; Estuaries; Sandbanks which are slightly covered by sea water all the time; Large shallow inlets and bays; Reefs; Atlantic salt meadows.	Grey seal; twaite shad; allis shad; river lamprey; sea lamprey.
Abermenai to Aberffraw dunes	SAC	Wales – Gwynedd/Anglesey	1871.03	Embryonic shifting dunes; Shifting dunes along the shoreline; Dunes with *Salix repens* spp. *argentea*; Fixed dunes with herbaceous vegetation; Atlantic decalcified fixed dunes; Humid dune slacks.	Shore dock
Lleyn Peninsula and the Samau	SAC	Wales – Ceredigion/Gwynedd	146023.48	Estuaries; Spartina swards; Atlantic salt meadows; Reefs; Submerged or partially submerged sea caves; Large shallow inlets and bays; Coastal lagoons; Mudflats and sandflats not covered by sweater at low tide; Sandbanks which are slightly covered by sea water all the time. Salicornia and other annual colonizing mud and sand	River lamprey; sea lamprey; harbour porpoise; grey seal; European otter; bottlenose dolphin; twaite shad; allis shad.
Morfa Harleck a Morfa Dyffryn	SAC	Wales – Gwynedd	1062.57	Humid dune slacks; embryonic shifting dunes; Shifting dunes along the shoreline; Dunes with *Salix repens* ssp. *argentea*	

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Bae Ceredigion / Cardigan Bay	SAC	Wales – Ceredigion / Pembrokeshire	95860.36	Submerged or partially submerged sea caves; Sandbanks which are slightly covered by seawater all the time; Reefs; mudflats and sandflats not covered by seawater at low tide	Grey seal; harbour porpoise, twaite shad; allis shad; sea lamprey; bottlenose dolphin; river lamprey.
Afon Teifi/River Teifi	SAC	Wales – Carmathenshire /Pembrokeshire	715.58	Atlantic salt meadows; Mudflats and sandflats not covered by seawater at low tide; Salicornia and other annuals colonizing mud and sand; Embryonic shifting dunes.	European otter; Atlantic salmon; river lamprey; brook lamprey; sea lamprey.
Bae Caerfyrddin ac Aberoedd / Carmathen Bay and Estuaries	SAC	Wales – Swansea/ Carmarthenshire/ Pembrokeshire	66101.16	Sandbanks which are slightly covered by seawater all the time; submerged or partially submerged sea caves; Dunes; Spartina swards; Large shallow inlets and bays; Coastal lagoons; mudflats and sandflats not covered by sweater at low tide; *Estuaries; Salcornia* and other annuals colonizing mud and sand; Atlantic salt meadows	Grey seal; European otter; twaite shad; allis shad; river lamprey; sea lamprey.
Twyni Bae Caerfyrddin / Carmarthen Bay Dunes	SAC	Wales – Swansea/ Carmarthenshire	1206.32	Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*); Shifting dunes along the shoreline; embryonic shifting dunes; Humid dune slacks; Fixed dues with herbaceaous vegetation ("grey dunes"); Dunes with *Hippphae rhamnoides*	
Tiroedd Comin Gwyr / Gower Commons	SAC	Wales – Swansea	1776.72	Vegetated sea cliffs	
Kenfig / Cynfigg	SAC	Wales – Vale of Glamorgan	1191.67	Fixed dunes with herbaceous vegetation ("grey dunes"); Dunes with *Hippophae rhamnoides*; Atlantic decalcified fixed dunes; Shifting dunes along the shoreline; Embryonic shifting dunes; Atlantic salt meadows; Spartina swards; Dunes with *Salix repens* ssp. *argentea*; Humid dune slacks; mudflats and sandflats not covered by seawater at low tide;	
Dunraven Bay	SAC	Wales – Vale of Glamorgan	6.47	Vegetated sea cliffs	Shore dock.

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Limestone Coast of South West Wales/ Arfordir Calchfaen de Orllewin Cymru	SAC	Wales – Swansea / Pembrokshire	1594.63	Submerged or partially submerged sea caves; Mudflats and sandflats not covered by seawater at low tide; Humid dune slacks; Fixed dunes with herbaceous vegetation ("grey dunes"); Shifting dunes along the shoreline; Embryonic shifting dunes; Caves.	Grey seal; European otter.
St David's	SAC	Wales – Pembrokeshire	935.47	Vegetated sea cliffs	
Pembrokeshire Marine	SAC	Wales – Pembrokeshire	138069.45	Large shallow inlets and bays; Estuaries; Reefs; Sandbanks which are slightly covered by sea water all the time; Mudflats and sandflats not covered by seawater at low tide; Coastal lagoons; Atlantic salt meadows; Submerged or partially submerged sea caves	Shore dock; grey seal; bottlenose dolphin; sea lamprey; river lamprey; twaite shad; harbour porpoise; European otter; allis shad.
River Usk	SAC	Wales – Newport/Monmouthshore	1007.71	Estuaries; mudflats and sandflats not covered by sweater at low tide; Atlantic salt meadows;	River lamprey; twaite shad; allis shad; sea lamprey; Atlantic salmon; European otter.
River Wye	SAC	Wales – Monmouthshire	2234.89	Atlantic salt meadows; Mudflats and sandflats not covered by seawater at low tide; Estuaries;	Atlantic salmon; twait shad; allis shad; river lamprey; sea lamprey; European otter.
Bann Estuary	SAC	Northern Ireland – Londonderry	347.94	Dunes with sea-buckthorn; Humid dune slacks; Fixed dunes with herbaceous vegetation ("grey dunes"); Shifting dunes along the shoreline; Embryonic shifting dunes; Atlantic salt meadows; Mudflats and sandflats not covered by seawater at low tide.	European otter; Atlantic salmon; river lamprey; sea lamprey.
Magilligan	SAC	Northern Ireland – Londonderry	1058.22	Humid dune slacks; Embryonic shifting dunes; shifting dunes along the shore line; mudflats and sandflats not covered by seawater at low tide; fixed dunes with herbaceous vegetation.	European otter.
River Faughan and tributaries	cSAC	Northern Ireland – Londonderry	293.27		Sea lamprey; Atlantic salmon; river lamprey; European otter.

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Murlough	SAC	Northern Ireland – Down	11902.03	Salicornia and other annuals colonising mud and sand; sandbanks which are slightly covered by sea water all the time; Annual vegetation of drift lines; Large shallow inlets and bays; Mudflats and sandflats not covered by seawater at low tide; Atlantic salt meadows; Dunes with *Salix repens* ssp. *argentea*; Shifting dunes along the shoreline; Fixed dues with herbaceous vegetation; Dunes; Atlantic decalcified fixed dunes; Embryonic shifting dunes.	Common Seal; European otter; Atlantic salmon.
Strangford Lough	SAC	Northern Ireland – Down	15398.54	Large shallow inlets and bays; Atlantic salt meadows; Spartina Swards; Fixed dunes with herbaceous vegetation; Salicornia with other annuals colonising mud and sand; sandbanks which are slightly covered by seawater all the time; Estuaries; Reefs; Coastal lagoons; Mudflats and sandflats not covered by seawater at low tide	
North Antrim Coast	SAC	Northern Ireland – Antrim	314.59	Fixed dunes with herbaceous vegetation; Annual vegetation of drift lines; Vegetated sea cliffs; Shifting dunes along the shoreline; Humid dune slacks; Atlantic salt meadows.	
Luce Bay and Sands	SAC	Scotland	48759.28	Embryonic shifting dunes; Shifting dunes along the shoreline; mudflats and sandflats not covered by seawater at low tide; Atlantic decalcified fixed dunes; Sandbanks which are slightly covered by seawater all the time; large shallow inlets and bays; reefs; Fixed dunes with herbaceaous vegetation ("grey dunes").	European otter; grey seal.
Mull of Galloway	SAC	Scotland	136.39	Vegetated seacliffs	
River Bladnoch	SAC	Scotland	300.02		River lamprey; sea lamprey; Atlantic salmon.

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Solway Firth	SAC	Scotland/England	43636.72	Sandbanks which are slightly covered by seawater at all times; Estuaries; Atlantic salt meadows; Salicornia and other annuals colonising mud and sand; Mudflats and sandflats not covered by sweater at low tide; Reefs; Spartina swards.	Sea lamprey; river lamprey; allis shad; twaite shad; Harbour porpoise; European otter.
Drigg Coast	SAC	England – Cumbria	1397.44	Humid dune slacks; Salicornia and other annuals colonising mud and sand; Annual vegetation of drift lines; mudflats and sandflats not covered by seawater at low tide; Dunes with *Salix repens* ssp. *argentea;* Fixed dunes and herbaceous vegetation ("grey dunes") Atlantic decalcified fixed dunes *(Calluno-Ulicetea)*. Shifting dunes along the shoreline; Embryonic shifting dunes; Atlantic salt meadows; Spartina swards; Estuaries.	
Morecambe Bay	SAC	England – Cumbria/Lancashire	61506.22	Fixed dues with herbaceous vegetation, Reefs, Embryonic shifting dunes; Shifting dunes along the shoreline; Mudflats and sandflats not covered by seawater at low tide; sandbanks which are slightly covered by seawater all the time; estuaries; Atlantic decalcified fixed dunes; Dunes with *Salix repens* ssp. *argentea*; Coastal lagoons; Atlantic salt meadows; Salicornia and other annuals colonising mud and sand; humid dune slacks; Large shallow inlets and bays.	Sea lamprey; twaite shad; grey seal.
Sefton	SAC	England – Sefton	4563.97	Humid dune slacks; Fixed dune slacks with herbaceous vegetation; Dunes with *Salix repens* spp *argentea*; Embryonic shifting dunes.	

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Dee Estuary	SAC	England – Cheshire / Flintshire / The Wirral	15805.07	Fixed dunes with herbaceous vegetation ("grey dunes"); Mudflats and sandflats not covered by seawater at low tide; Shifting dunes along the shoreline; Humid dune slacks; Atlantic salt meadows; Salicornia and other annuals colonising mud and sand; Estuaries; Vegetated sea cliffs; embryonic shifting dunes; Coastal lagoons; Spartina swards; Annual vegetation of drift lines.	River lamprey; twaite shad; European otter; grey seal; sea lamprey.
Severn Estuary	SAC	England	73715.4	Salicornia with other annuals colonising mud and sand; sandbanks which are slightly covered by seawater at all times; Estuaries; Mudflats and sandflats not covered by seawater at low tide; Reefs; Embryonic shifting dunes; Atlantic salt meadows; Spartina swards.	Twaite shad; allis shad; Sea lamprey; river lamprey.
Braunton Burrows	SAC	England – Devon	1346.64	Mudflats and sandflats not covered by seawater at low tide; Shifting dunes along the shoreline; Fixed dunes with herbaceous vegetation ("grey dunes"); Humid dune slacks; Dunes with *Salix repens* ssp. *argentea*.	
Exmoor Heaths	SAC	England – Somerset	10705.87	Vegetated seacliffs.	
Lundy	SAC	England – Devon	3064.53	Submerged or partially submerged sea cliffs; Sandbanks which are slightly covered by seawater al the time; Reefs.	Harbour porpoise; bottlenose dolphin; grey seal.
Tintagel, Marsland to Clovelly Coast	SAC	England – Cornwall	2429.94	Vegetated sea cliffs; Submerged or partially submerged sea caves; mudflats and sandflats not covered by sea water at low tide.	European otter; grey seal.
Isles of Scilly complex	SAC	England – Cornwall/Isles of Scilly	26850.95	Reefs; Sandbanks which are slightly covered by seawater all the time; mudflats and sandflats not covered by seawater at low tide.	Grey seal; bottlenose dolphin; harbour porpoise; shore dock.
Lands End and Cape Bank	cSAC	England – Cornwall	30172	Reefs.	
Lizard Point	cSAC	England – Cornwall	13988	Reefs.	

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
The Lizard	SAC	England – Cornwall	3257.11	Vegetated sea cliffs; mudflats and sandflats not covered by sweater at low tide; Embryonic shifting dunes.	
Loch of Inch and Torrs Warren	SPA	Scotland – Dumfries and Galloway		Large eutrophic freshwater loch (Loch of Inch) and an area of foreshore and sand dunes (Torrs Warren).	Over wintering birds; Greenland white fronted goose.
Upper Solway Flats and Marshes	SPA	Scotland/England – Cumbria; Dumfries and Galloway	2111.04	One of the largest continuous areas of intertidal habitat in Britain. The geomorphology and vegetation of the estuarine saltmarshes or merses are of international importance, with broad transitions to mature 'upper-marsh' being particularly well represented.	Wintering wildfowl (ducks, geese and swans), waders, migratory waterbirds; bar-tailed godwit; barnacle goose; golden plover; whooper swan.
Duddon Estuary	SPA	England – Cumbria	8942.38	A complex site, mostly consisting of intertidal sand and mud-flats. The site is the most important in Cumbria for sand-dune communities. Artificial habitats include slag banks and a flooded iron-ore working known as Hodbarrow Lagoon forms the largest coastal lagoon in north-west England. Saltmarshes, sand dunes and Hodbarrow Lagoon act as important high-tide roosts for wintering waders and wildfowl.	Wintering and passage waterbirds. Breeding birds. sandwich tern; ringed plover; sanderling; knot; pintail and redshank.
Morecambe Bay	SPA	England – Cumbria; Lancashire	43636.73	One of the largest estuarine systems in the UK; Intertidal flats of sand and mud; Mussel *Mytilus edulis* beds and banks of shingle; locally stony outcrops. The whole system is dynamic, with shifting channels and phases of erosion and accretion affecting the estuarine deposits and surrounding saltmarshes.	The site is of European importance throughout the year. Breeding populations of terns in shingle and sand. Overwintering birds and migratory water birds (geese, ducks and waders) autumn through to spring.

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Ribble and Alt Estuaries	SPA	England - Lancashire; Sefton	6806.3	Comprises two estuaries, together with an extensive area of sandy foreshore along the Sefton Coast. Extensive sand- and mud-flats and, particularly in the Ribble Estuary, large areas of saltmarsh. There are also areas of coastal grazing marsh located behind the sea embankments.	The site is of European importance throughout the year. Breeding birds (gulls and terns). Overwintering birds and migratory water birds (geese, ducks and waders). Breeding seabird assemblage includes black-headed gull, lesser black-backed gull, common tern. Over winter wetland bird assemblage includes; grey plover, whooper swan, Golden plover, bar-tailed Godwit, plnk-footed goose, shelduck, wigeon, teal, Bewick's swan, oystercatcher, curlew, knot, sanderling, dunlin, black-tailed godwit, redshank, cormorant, common scoter, lapwing, pintail. Additional Annex I species include: Ruff; Ringed plover; Black-tailed godwit; Knot.
Mersey Estuary	SPA	England - Cheshire; Halton; Liverpool; Wirral	37404.6	Large, sheltered estuary which comprises large areas of saltmarsh and extensive intertidal sand- and mud-flats, with limited areas of brackish marsh, rocky shoreline and boulder clay cliffs.	Overwintering birds and migratory water birds (ducks and waders) Over winter, bird assemblage includes: curlew, black-tailed godwit, lapwing, grey plover, wigeon, great crested grebe, redshank, dunlin, pintail, teal, shelduck, golden plover. Additional Annex I species include: migratory ringed plover.
The Dee Estuary	SPA	England - Cheshire; Sir y Fflint/ Flintshire; Wirral	13084.85	Large, funnel-shaped, sheltered estuary that supports extensive areas of intertidal sand-flats, mud-flats and saltmarsh. Saltmarshes grade into transitional brackish and swamp vegetation on the upper shore. Three sandstone islands of Hilbre provide important cliff vegetation and maritime heathland and grassland.	Breeding Birds (common and little terns); On passage birds (sandwich tern) Over winter, bird assemblage includes: black-tailed godwit, shelduck, teal, pintail, oystercatcher, grey plover, bar-tailed godwit, dunlin, sanderling, curlew, redshank, cormorant, wigeon, mallard, lapwing, knot.

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Traeth Lafan/ Lavan Sands, Conway Bay	SPA	Wales - Conwy; Gwynedd	2642.98	Large area of intertidal sand- and mud-flats with a range of exposures and a diversity of conditions, enhanced by freshwater streams that flow across the flats.	Overwintering waterbirds; oystercatcher; Curlew. An important moulting roost for great crested grebe in late summer/early autumn.
Ynys Feurig, Cemlyn Bay and The Skerries	SPA	Wales - Ynys Môn/ Isle of Anglesey	85.98	Three separate sites: • Feurig is a series of low-lying islands extending about 1 km out to sea from a sandy shore. • Cemlyn Bay, a shingle storm beach forms a bar between a tidal lagoon and the open shore. • The Skerries are a group of sparsely vegetated islets protected by strong currents and exposed to strong westerly and northerly winds. The three separate areas are treated as a single site as a consequence of regular movement by birds between the component parts.	The site is of importance for four species of breeding terns; Arctic tern; common tern, roseate tern; sandwich tern.
Glannau Ynys Gybi/ Holy Island Coast	SPA	Wales - Ynys Môn/ Isle of Anglesey	608.04	Sea cliffs rising to 120m with small offshore stacks and islets.	Throughout the year resident population of chough.
Glannau Aberdaron and Ynys Enlli/ Aberdaron Coast and Bardsey Island	SPA	Wales - Gwynedd	505.03	Island of Bardsey (Ynys Enlli) and part of the tip of the Lleyn Peninsula, together with two smaller islands. Rocky coastline with crags, screes and low cliffs.	Resident population of chough. Breeding colony of Manx shearwater.
Skokholm and Skomer	SPA	Wales - Penfro/ Pembrokeshire	427.71	Three islands off the extreme south-west tip of Pembrokeshire; seacliffs bounded by cliffs that reach 70 m on Skomer. The plateau vegetation is much affected by salt spray, rabbit grazing and nutrient enrichment from seabirds.	Breeding seabirds (petrels, gulls, auks); Manx shearwater; storm petrel; lesser black-backed gull, puffin.

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Castlemartin Coast	SPA	Wales - Penfro/ Pembrokeshire	1122.32	20 km of rocky coast with sea cliffs, Maritime grassland, large calcareous dune system with extensive natural transition to wet communities in dune slacks.	Breeding and overwintering chough.
Ramsey and St David`s Peninsula Coast	SPA	Wales - Penfro/ Pembrokeshire	845.63	Marine areas and sea inlets; Coastal dunes, shingle, seacliffs and islets.	Breeding population of chough.
Bae Caerfyrddin/ Carmarthen Bay	SPA	Caerfyrddin/ Carmarthenshire	33410.03	Estuaries; mudflats and sandflats not covered by seawater at low tide; Atlantic saltmeadows (*Glauco- Puccinellietalia maritimae*) ; *Salicornia* and other annuals colonising mud and sand; Large shallow inlets and bays; Sandbanks which are slightly covered by sea water all the time.	River lamprey, sea lamprey; European otter.
Burry Inlet	SPA	Abertawe/ Swansea; Caerfyrddin/ Carmarthenshire	6627.99	a large estuarine complex including extensive areas of intertidal sand- and mud-flats, together with large sand dune systems at the mouth of the estuary. Wide tidal fluctuations (c.8 m) therefore large intertidal sediments.	Overwintering wildfowl and waders: oystercatcher. Overwinter assemblage includes curlew, black-tailed godwit; dunlin, knot, shoveler, shelduck, oystercatcher, pintail, whimbrel.
Severn Estuary	SPA	Bro Morgannwg/ Vale of Glamorgan; Caerdydd/ Cardiff; Casnewydd/ Newport; City of Bristol; Fynwy/ Monmouthshire; Gloucestershire; North Somerset; Somerset; South Gloucestershire	24662.98	Large funnel shaped estuary with extensive intertidal mud-flats and sand-flats, rocky platforms and islands. Saltmarsh fringes the coast backed by grazing marsh with freshwater ditches and occasional brackish ditches. The seabed is rock and gravel with sub-tidal sandbanks. Extensive intertidal zone as a result of large tidal range.	Spring and autumn migratory periods for waders. Overwintering water birds (swans, ducks and waders) Over winter bird assemblage includes: gadwall, shelduck, pintail, dunlin, curlew, redshank, Bewick's swan, wigeon, lapwing, teal, mallard, shoveler, pochard, tufted duck, grey plover, white-fronted goose, whimbrel.

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Lough Foyle	SPA	Northern Ireland	2204.36	Large, shallow sea lough that includes the estuaries of the rivers Foyle, Faughan and Roe. Extensive intertidal mud-flats and sand-flats (with mussel *Mytilus edulis* beds), saltmarsh and associated brackish ditches.	Spring and autumn migratory periods for waterbirds. Overwintering waterbirds. Swans, geese, ducks and waders; Light-bellied brent goose. Over winter, waterfowl assemblage includes: teal, whooper Swan, golden plover, bar-tailed godwit, light-bellied brent goose, great crested grebe, cormorant, greylag goose, Bewick's swan, wigeon, redshank, mallard, eider, red-breasted merganser, oystercatcher, lapwing, knot, dunlin, curlew, shelduck.
Larne Lough	SPA	Northern Ireland	395.94	Sea lough enclosed to the east by the peninsula of Island Magee. Shallow estuary infilled with sediments of fine muddy sand, and large areas of intertidal mud flats.	Breeding and feed terns. Overwintering site for light-bellied brent goose.
Belfast Lough	SPA	Northern Ireland	432.14	Large intertidal sea lough. Inner part of the lough comprises areas of intertidal foreshore, mainly mud-flats and lagoons. Outer lough mainly rocky shores with some small sandy bays.	Overwintering redshank; shelduck; oystercatcher; purple sandpiper; dunlin; black-tailed godwit; bar-tailed godwit; curlew; turnstone.
Belfast Lough Open Water	SPA		5592.99	Belfast Lough is a large intertidal sea lough situated at the mouth of the River Lagan on the east coast of Northern Ireland. The inner part of the lough comprises a series of mudflats and lagoons. The outer lough is restricted to mainly rocky shores with some small sandy bays. The Belfast Lough open water area comprises the marine area below the mean low water mark.	Overwintering population of great crested grebe.
Strangford Lough	SPA	Northern Ireland	15580.79	Shallow sea lough with an indented shoreline and a wide variety of marine and intertidal habitats. Extensive areas of mudflats and sandflats, saltmarsh and rocky coastline.	Overwintering wildfowl (Light bellied brent geese, knot and redshank); breeding terns (sandwich tern and common tern).

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Carlingford Lough	SPA	Northern Ireland	827.12	A narrow sea lough surrounded by mountains. The northern shore lies in Northern Ireland and includes mudflats and an area of saltmarsh. Rock and shingle islands are present at the mouth of the lough.	Overwinter light-bellied brent goose. Breeding populations terns.
Killough Bay	SPA	Down	104.23	Inter-tidal areas, mudflats, sand dominated beaches, gravel and cobble units and rocky shore.	Overwintering population of light-bellied brent goose.
Outer Ards	SPA	North Down	1410.41	Sheltered stretch of open rocky coast intertidal zone comprises low platforms, up to 200 m across, separated by wide areas of mobile sediments. Also intertidal areas of boulder, cobble, gravel, sand- and mud-flats, together with dune and maritime grassland, maritime heath and cliff ledge vegetation, saltmarsh, tidal and non-tidal fens and wet flushes.	Breeding populations of Arctic Tern. Overwinter bird assemblages include light-bellied brent goose as well as waders (ringed plover and turnstone.
Mynydd Cilan, Trwyn y Wylfa ac Ynysoedd Sant Tudwal	SPA	Gwynedd	372.9	10 km stretch of Atlantic vegetated sea-cliff and exposed sandy shore.	Breeding and overwintering chough.
Dyfi Estuary / Aber Dyfi	SPA	Ceredigion; Gwynedd; Powys	2056.6	Estuary with adjoining saltmarsh, marshy grassland and improved grassland. The estuarine includes sandbanks, mud-flats, saltmarsh, peatbogs, river channels and creeks, with an extensive sand dune complex across the mouth of the estuary.	Overwintering birds: Greenland white-fronted goose.
Ynys Seiriol / Puffin Island	SPA	Ynys Môn/ Isle of Anglesey	31.33	Carboniferous limestone block rising to 55 m with steep cliffs on all sides.	Breeding population of cormorant which feed in the surrounding waters outside the SPA.
Isles of Scilly	SPA	Isles of Scilly	401.64	Archipelago of over 200 low-lying granite islands and rocks. It should be noted that the SPA boundary only encompasses those areas used for nesting. The vast majority of the feeding areas used by the seabirds are marine waters outside the SPA.	Breeding bird assemblage. Storm petrel; lesser black-backed gull.

Table 2.7 (Continued)

Site name	Type	Location	Area (ha)	Designating Habitats	Designating Species
Copeland Islands	SPA		201.52	Copeland Island, Light House Island and Mew Island together with associated islets. The site encompasses the islands down to the low water mark, rocky shores with limited areas of sand/mud and cobble/boulder beaches.	Breeding colonies of Manx shearwater and Arctic tern.
Liverpool Bay / Bae Lerpwl	SPA		170292.9	A sea area which extends from the west coast of Anglesey to the north west of England.	Breeding bird and overwinter bird assemblage; red-throated diver and common scoter.

2.4 Identification of potential impacts

An Environmental Issues Identification (ENVID) exercise involving the SEA Steering Group[2] and independent environmental specialists was carried out during IOSEA4. The purpose of this was to identify where the interactions were likely to occur between the proposed plan and the receiving environment and to highlight where environmental concerns were likely to occur at an early stage. The proposed Draft Plan was considered in terms of the following operations:

- Seismic survey; and
- Exploration drilling.

Of the potentially significant impacts identified by this process (summarised in Table 2.8), only those likely to have an effect on the features and conservation objectives of the identified Natura 2000 sites are considered. These are described and discussed in Sections 2.5 and 2.6. The main threat to coastal sites arises from the potential for an oil spill reaching the coast (in Ireland or elsewhere) and damaging any qualifying habitats or species, especially seabirds and marine mammals.

The noise generated from both drilling and seismic activities also has the potential to cause disturbance to marine mammals which are qualifying species in certain coastal sites. Impacts to the seabed and associated benthos can result from the presence of subsea equipment (including wellhead, anchors, chains etc) and the discharge of drill cuttings, cement and associated chemicals. These potential seabed impacts are therefore potentially relevant to the protection of offshore Natura 2000 sites.

The results of the ENVID exercise are summarised in Table 2.8. The environmental features or receptors to which impacts may occur and which are relevant to the specific conservation features for which the Natura 2000 sites listed in Section 2.3 are highlighted in bold text in the table.

Table 2.8 Key potential environmental issues identified by Environmental Issues Identification (ENVID)

Stage of Project	Significant Issues	Possible significant issues
Seismic Survey	Underwater noise generation from air guns – **Marine Mammals, protected sites**	Underwater noise generation from air guns – on other pelagic organisms, fishing.
		Physical presence of survey vessels and towed equipment– on fishing, shipping
		Atmospheric emissions due to energy requirements – on atmosphere
		Accidental events – on atmosphere, sea water quality, seabed quality and features, plankton, Benthos including demersal fish and shellfish, **marine mammals**, other pelagic organisms, **seabirds**, fishing, marine infrastructure and archaeology, **protected sites**, onshore and coast.
Drilling	Noise generation and vibration including VSP/checkshot surveys – on **marine mammals** and **protected sites**	Noise generation and vibration including VSP/checkshot surveys – on other pelagic organisms, fishing
	Accidental events on atmosphere, sea water quality, seabed quality and seabed features, plankton, benthos including demersal fish and shell fish, **marine mammals**, other pelagic organisms, **seabirds**, fishing, marine infrastructure and archaeology, **protected sites**, onshore and coast.	Accidental events - on shipping.

[2] Petroleum Affairs Division (PAD); Environmental Protection Agency (EPA); Department of Agriculture Fisheries and Food (DAFF); Department of the Environment, Heritage and Local Government (DEHLG); Department of Transport (DOT); Marine Institute; Geology Survey of Ireland (GSI); Irish Defence Forces; Irish Offshore Operators Association; Kinsale Energy; Bord Iascaigh Mahara; Sustainable Energy Authority of Ireland (SEI); Irish Whale and Dolphin Group; Shannon Dolphin and Wildlife Foundation; Sea-Fisheries Protection Agency; International Association of Geophysical Contractors

Table 2.8 (Continued)

Stage of Project	Significant Issues	Possible significant issues
Drilling (continued)		Physical presence of the rig and vessels at surface – on fishing, shipping, marine infrastructure and archaeology, **protected sites**, onshore and coast.
	.	Presence of subsea equipment – on **seabed quality and seabed features**, benthos including demersal fish and shellfish, fishing and marine infrastructure and archaeology.
		Atmospheric emissions due to energy requirements – on atmosphere
		Mud, cement and cuttings discharges – on **seabed quality and seabed features**, benthos
		WBM and WBM-contaminated cuttings discharge from surface, including payzone cuttings – on seawater quality, **seabed quality and seabed features**, benthos
		Onshore disposal of oil-contaminated cuttings – on onshore and coast.
		Well testing emissions from flaring – on atmosphere, **seabirds**, **protected sites**.

Receptors highlighted in red indicate specific Natura 2000 conservation features

2.5 Seismic Survey Impacts

2.5.1 Underwater Sound

Sound energy propagates much more efficiently through the ocean than light and many marine animals consequently use hearing as their primary sense. Marine mammals, particularly cetaceans, make extensive use of sound in foraging, communication, reproduction, detection of predators and navigation (e.g. Weilgart, 2007a; Hildebrand, 2004).

The ocean experiences a number of natural noise inputs (for example, rain, breaking waves, marine life) and, as a result, cetaceans have evolved auditory mechanisms that function well within the context of high natural ambient (or background) noise. However, the introduction of additional anthropogenic noise could interfere with animals' ability to use sound for normal life functions (e.g. OSPAR, 2009a). This disruption could occur to such an extent that the animals experience disturbance to reproduction, migration and other important activities (JNCC, 2010). In addition to disruption of normal behaviour, reports exist in the literature that apparently document injury to marine mammals from some sound sources (e.g. Miller *et al.*, 2009, Gailey *et al.*, 2007, Gordon *et al.*, 2004). As such, the effect of anthropogenic sound on marine mammals and other animals is a topic of key interest to the scientific community and to the general public (e.g. Michael *et al.*, 2010, Compton *et al.*, 2008; IACMST, 2006; OGP/IAGC, 2004; NRC, 2003).

Although there are examples where marine mammals are thought to have responded to anthropogenic sound (e.g. Bailey *et al.*, 2010, Di Iorio & Clark, 2010, Jefferson *et al.*, 2009, Carstensen *et al.*, 2006), these responses are often subtle. Even though it is understood that it is likely that increased stress levels, abandonment of important foraging or calving habitat and the masking of, or interference with, natural sounds may impact upon marine populations, it is unclear how, when, or even if, these effects on the animal's ability to engage in essential activities translate into biologically significant outcomes. The repercussions for the animal beyond the time of disturbance, also termed population-level effects, are particularly hard to detect in cetacean populations (Weilgart, 2007b). In fact, there is a notable absence in the literature of studies conclusively demonstrating links between exposure to sound and adverse effects on marine mammals at the population level (NRC, 2005). In the absence of a clear understanding of the effects of noise on cetacean populations, the precautionary approach is generally adopted.

Sound underwater is, as in air, waves of pressure fluctuations, compression and rarefaction of the molecules in the medium through which the sound waves propagate. Although there is a wide range of pressures and intensities encountered in measurements of sound, the most commonly used method for describing these is the decibel scale (dB). The decibel is a numerical scale used to compare the values of like quantities, usually power or intensity. The decibel provides a compressed scale to represent the large dynamic range of sound in the way sound is experienced by humans (and presumably other animals) in a logarithmic fashion (Chapman & Ellis, 1998). It should be noted that in-air pressure is measured relative to a fixed reference pressure of 20 µPa but that the differences in physical properties of noise in water and air mean that underwater noise is compared to a reference level of 1 µPa. The result is that sound levels in air are not directly comparable with those in water. Where comparisons of sound pressure measurements taken in air and in water are made, a correction factor of 62 dB must be added to the air measurements (OGP/IAGC, 2008).

There are several different methods (or metrics) of measuring sound pressure used in the literature with, for impulsive sounds such as seismic at least, the three most common being peak pressure level, sound pressure level and sound exposure level (MacGillivray & Chapman, 2005). (see Glossary for further details).

When making a comparison between quoted sound levels it is important to understand which metric has been used to describe the sound levels since the difference between the various descriptors may be as large as 20 dB (MacGillivray & Chapman, 2005).

Another facet of sound is its frequency (measured in hertz or Hz), and some species may only be able to generate or detect sound of a certain frequency or over a certain frequency band.

Ambient noise includes the broad range of individual sound sources present in the ocean, both natural and anthropogenic (Hildebrand, 2004). The dominant source of naturally occurring noise across the frequencies 1 Hz to 100 kHz is associated with surficial waves generated by the wind acting on the sea surface (NRC, 2003). Other natural sound sources in the marine environment include currents, rain, ice movements, plate movements and echo-location and communication by marine organisms.

In addition to natural sound sources, there are anthropogenic inputs to the marine environment. These can be generated by air traffic, shipping activity and the oil and gas industry (including drilling, seismic activity, construction and decommissioning, production, and associated vessels) amongst others. Of these, shipping is considered the dominant source of sound in the world's oceans in the range of five to a few hundred Hertz (Hildebrand, 2009; NRC, 2003).

Numerous authors report that ambient noise levels in the oceans have increased significantly over the last few decades (e.g. Hatch & Wright, 2007; Andrew *et al.*, 2002) giving marine animals (some of which, including the large baleen whales, may have relatively long life spans) little time to adapt to these changes in evolutionary terms; short-term changes in behaviour may be one of only a few possible solutions available to affected animals.

Table 2.9 provides examples of natural and biological sounds within the marine environment. Table 2.10 provides examples of some common anthropogenic sources and received levels of sound in the marine environment.

Table 2.9 Examples of natural and biological sounds in the marine environment (Southall *et al.*, 2007; NRC, 2003; McCauley, 1994)

Sound Source	Dominant frequency range (kHz)	SPL (dB re µPa @ 1m)	Noise characteristics
Physical			
Wind	1 - 25 kHz	Force 3 - 65 dB Force 12 - 85 to 95 dB	Greatest levels at higher wind speeds, noise is continuous on a scale of hours to days
Rain	Broad spectrum	No rain - 0 dB Heavy rain - 80 dB	Flat frequency spectra (white noise)
Earthquake events	5 - 15 Hz	Earthquake of magnitude 4 to 6 - 200 to 240 dB at 10 km	Short-term transitory events on a scale of minutes, noise levels may be high
Biological			
Baleen whales	16 to a few hundred Hz	128 to 190	Communication (low frequency moans, grunts, down sweeps)
	2 kHz - 25 kHz	151 dB	Communication (clicks)
Toothed whales	100 Hz - 20 kHz	180 dB	Communication
	6 kHz - 325 kHz	120 to 228 dB	Echo-location

Table 2.10 Sound sources from various maritime activities (OSPAR, 2009d; Evans & Nice, 1996; Richardson *et al.*, 1995)

Activity	Dominant frequency range (kHz)	Source Level (dB re µPa @ 1m)	Temporal Nature
Low resolution geophysical seismic survey; seismic air gun	0.008 - 0.2	248[a]	Short-term exploration activity
Super tanker	0.02 - 0.1	187 – 232	N/A
High resolution geophysical survey; pingers, side-scan, fathometer	10 - 200	<230	Short-term exploration activity
Drill ship	0.01 - 10	179 - 191	Short-term installation activity
Large merchant vessel	0.005 - 0.9	160 – 190	N/A
Tanker	0.015	179 – 181	Operational activity
Dynamic Positioning (DP) installation vessel	0.029 - 0.07	154 – 180	Short-term installation activity
Rock placement vessel	0.01 – 0.1	179	Short-term installation activity
Semi-submersible drilling rig	0.016 - 0.2	154 – 171	Short-term installation activity
Anchor handling tugs	0.05 – 1	164 – 170	Short-term installation activity
Production drilling	0.25	163	Short-term installation activity
Supply vessel (with thrusters)	0.02 – 1	121 – 146	Installation and operation activity
Supply vessel (without thrusters)	0.02 – 1	110 – 135	Installation and operation activity
Jack-up drilling rig	0.005 - 1.2	85 – 127	Short-term installation activity

2.5.2 Effects of anthropogenic noise on marine mammals

Available information regarding the effects of noise on marine mammals indicates that different species of cetaceans and pinnipeds may react differently to the introduction of additional noise into the marine environment. Reactions appear to be attributable to variables including, but not necessarily limited to, sound source level, propagation conditions, ambient noise levels, animal age, sex, habitat, individual variation and previous habituation to noise (Richardson *et al.*, 1995). In addition, whilst most concern is focused on marine mammals, many of the lower frequency sounds may affect fish (Popper, 2003) and other marine groups.

Hearing and Vocalisation of marine mammals

Marine mammals use sound in various important contexts including social interaction, foraging and responding to predators (Southall *et al.*, 2007). Marine mammals' well-developed ear and neural auditory centre suggest that hearing is the primary sensory system; whales and dolphins devote three times more neurons to hearing than any other animal group (Ketten *et al*., 2007). Indeed, the temporal lobes which control higher auditory processing dominate the brain and they appear to have faster auditory and signal processing capabilities than any other mammal (Ketten, 2004). The hearing capabilities of marine mammals are summarised in Table 2.11 along with species from that group which may be present in the IOSEA4 area.

Table 2.11 Functional marine hearing in groups of marine mammals potentially present in the IOSEA4 area (Southall *et al.*, 2007)

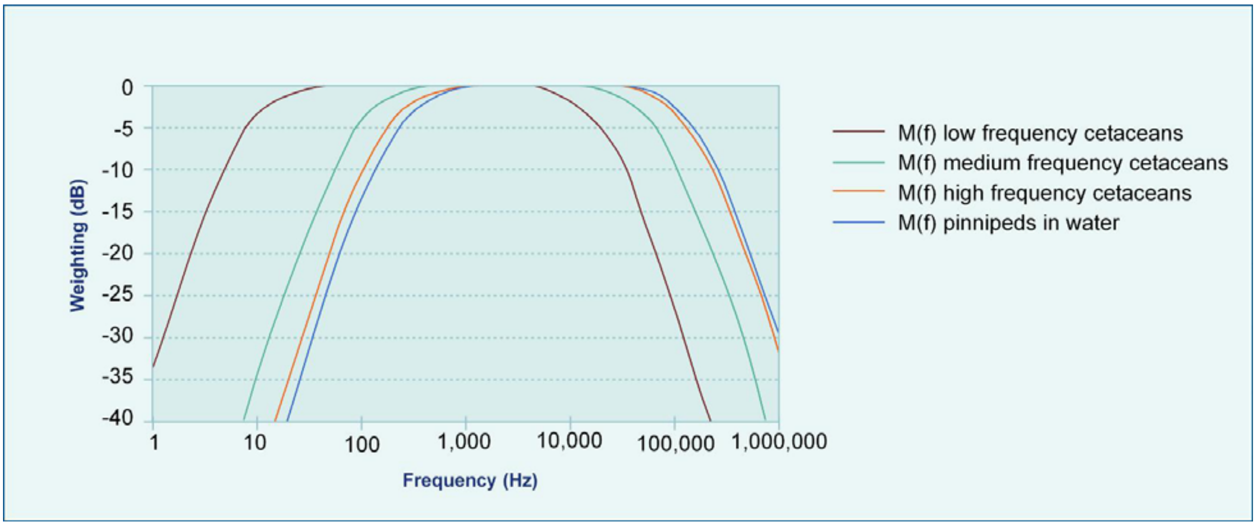
Functional hearing group	Estimated auditory bandwidth	Potentially present in the IOSEA4 area
Low-frequency cetaceans	7 Hz to 22 kHz	*Balaenoptera* and *Megaptera*
Mid-frequency cetaceans	150 Hz to 160 kHz	*Delphinus*, *Globicephala*, *Grampus*, *Lagenorhynchus*, *Orcinus*, *Physeter* and *Tursiops*.
High-frequency cetaceans	200 Hz to 180 kHz	*Phocoena*
Pinnipeds in water	75 Hz to 75 KHz	*Halichoerus*, *Odobenus* and *Phoca*
Pinnipeds in air	75 Hz to 30 kHz	

Categorisation of Marine Mammals to assess impact of anthropogenic noise

Marine mammal ears have evolved to function well within the context of the ambient noise levels of the marine environment but relatively little information from controlled examples exists to describe how marine mammals respond physically and behaviourally to intense sounds and to long-term increases in ambient noise levels (NRC, 2003). Despite the great diversity in hearing and in the biological effects of noise among marine mammals, current knowledge supports an approach to categorise animals, based on functional and phylogenetic characteristics in order to better assess the impact of anthropogenic noise (Table 2.11; Southall *et al.*, 2007).

Marine mammals do not hear equally well at all frequencies within the functional hearing ranges described in Table 2.11 and Southall *et al.* (2007) have thus developed frequency weighting functions for each group to compensate (Figure 2.5). The so-called 'M-weighting functions' assume a logarithmic reduction in auditory sensitivity outside the range of best hearing sensitivity, with the function reduced by 6 dB from its peak sensitivity at the lower and upper auditory bandwidth limits presented in Table 2.11. Southall *et al.* (2007) consider that these functions are of a conservative nature, following on from the limited or non-existent datasets for most species.

Figure 2.1 M-weighting functions for marine mammals (Southall *et al.*, 2007)



To determine the consequences of noise emissions on marine mammals, it is necessary to relate the levels to known or estimated impact thresholds. A number of thresholds or methods for determining thresholds exist (e.g. the dBht method described by Nedwell *et al.*, 2007) and each has advantages and disadvantages. Some, JNCC (2010) for example, propose the use of Southall *et al.* (2007) precautionary criteria for determining injury impact on species. For disturbance, Southall *et al.* (2007) recommend that the only currently feasible way to assess whether a specific sound could cause disturbance is to compare the circumstances of the situation of concern with empirical studies that have carefully controlled variables.

With regards to possible injury from noise, although there is no conclusive evidence of a link between seismic surveys and mortality of any marine mammals (OSPAR, 2009c), Southall *et al.* (2007) developed a set of injury criteria for individual marine mammals exposed to discrete noise events such as seismic survey operations. These criteria aim to set threshold values above which the continual exposure to significant sound levels, or brief sound pulses with extremely high noise levels, could create permanent hearing impairment in marine mammals. The sound thresholds for pulse sounds in terms of SPL are 230 dB re: 1 μPa for low-. mid- and high-frequency cetaceans and 198 dB re: 1 μPa^2-s for SEL in all groups. These threshold levels lie at the top end of the sound levels produced by large 2D or 3D seismic survey arrays (Table 2.11). It is unlikely that these kinds of sound levels will be reached during a VSP or check-shot survey, even in the near-field region of the individual airguns. It is generally considered unlikely that marine mammals would remain for any length of time close to any noise source that causes discomfort (Richardson *et al.*, 1995) assuming the initial noise levels received did not cause injury that prevented such movement.

The complexity and uncertainties of animal reactions to underwater noise and the variability of the strength of noises in the marine environment mean that it is difficult to establish definite areas of influence around an anthropogenic sound source. However, several general zones of noise influence have been described as follows (Richardson & Malme, 1995):

- **Zone of audibility** – This is the largest zone in spatial terms. Within this zone an animal can hear the man-made noise because it is louder than the ambient noise and within the animal's auditory frequency range. At this level it is unlikely that the sound will have any significant deleterious effects on the animal. The size of this zone can vary greatly depending on specifics of the operation and on natural fluctuations of ambient noise levels between seasons and between locations.
- **Zone of responsiveness** – This zone is more localised around a sound source; within this behavioural responses to noise may be observed. The size of this zone is a combination of the sound source level, propagation conditions and ambient noise, in addition to animal species, age, sex, habitat, individual variation, and previous habituation to noise. As a result, the maximum radius of responsiveness can vary widely among individuals, locations and over time. Even for a specific type of anthropogenic sound and a particular species, this radius will

vary (Richardson *et al.*, 1995). In this zone individuals and even entire populations may show almost no sign of disturbance as a result of habituation to, or tolerance of, the sound, or because the noise may be outwith the best hearing sensitivities of a particular animal. If a response is elicited then the effects can vary greatly between species and individuals; common responses include changes in dive behaviour, respiration and surfacing rates. Variation in responsiveness among different individuals, or for one individual at different times, may greatly affect the radius of responsiveness. It should be noted that marine mammals may react differently to stationary noise, sudden bursts of noise, and noises that appear to be coming towards them. Studies suggest that most cetaceans will alter their course or display avoidance reactions to a noise that appears to be moving directly towards them. Stationary noises, such as drilling and production noises, outwith an immediate zone of discomfort to the animal, may have a lesser effect in disturbing migration patterns and animal feeding, although data and observations are limited (Davis *et al.*, 1990).

- **Zone of masking** – An area in which some noises produced by the animals can be masked by noises of a similar frequency and sufficiently high source level. Any increase in background noise, either man made or naturally occurring, can interfere with an animal's ability to detect a sound signal, especially if the sound signal is weak relative to the total noise level (Richardson *et al.*, 1995). Marine mammals subject to masking effects are likely to be able to detect other noises present in the marine environment (for example, communication calls from conspecifics or auditory clues to prey presence) between sound pulses. This would reduce the likelihood of negative impact on activities such as communication, echolocation and predator avoidance. Furthermore, masking depends on the amount of energy that the call and the noise input share in the critical frequency bands that are characteristic of the animal's auditory capacity (Gisiner, 1998). Although little is known about the importance of low-level sounds in background noise to marine mammals, the fact that species have developed such sensitive hearing and seem to be adept at detecting signals in background noise suggest that this is an important ability (Gordon *et al.*, 2004).

- **Zone of discomfort or hearing loss** – an area in which there is a possibility of auditory injury to an animal from underwater noise emissions. The extent of this zone will, as with other zones, depend on key variables related to the nature of the sound emissions and the status of the receiver (the marine mammal). Even where modelling of the extent of this zone occurs, distances are still somewhat speculative due to the lack of a comprehensive set of direct measurements on marine mammal hearing systems, particularly in the field. However, it is considered likely that prolonged exposure to significant sound levels or brief exposure to extremely high noise levels could create permanent or temporary threshold shifts in marine mammal hearing abilities. Seismic exploration produces noise pulses that are intermittent but considerably more intense than the continuous noise emitted by most industrial noises in the ocean. Although few controlled studies of the potential for these pulses to damage the auditory systems of marine mammals exist, information on the impacts of anthropogenic sound and zones of discomfort on marine mammals is available (e.g. Richardson *et al.*, 1995; Gordon *et al.*, 2004). There is little or no evidence currently available that directly links seismic pulses to acute physical damage (Gordon *et al.*, 2004).

Cetaceans

Injury

Seismic surveys produce intermittent sound pulses which are considerably more intense than the continuous noise emitted by most industrial noise sources in the ocean. Unfortunately, there are few direct examples regarding the effects of intense sound on cetaceans, making it difficult to predict safe exposure levels for these mammals (Finneran *et al.*, 2000). Indeed, sound exposures that elicit temporary threshold shift (TTS[3]) in cetaceans have been measured in only two mid-frequency species (bottlenose dolphin and beluga) and there are no published TTS data for any other odontocete cetaceans (either mid- or high frequency) or for any mysticete cetaceans (Southall *et al.*, 2007). Nonetheless, Southall *et al.* (2007) have developed a set of injury criteria for individual marine mammals exposed to discrete noise events such as seismic surveys. These criteria aim to set threshold values above which the continual exposure to significant sound levels, or brief sound pulses with extremely high noise levels, could create permanent hearing impairment in marine mammals. The sound thresholds for pulse sounds in terms of SPL are 230 dB re: 1 μPa for low-. mid- and high-

[3] Moderate levels of underwater noise can induce temporary reduction of hearing sensitivity (Section 7.2.6)

frequency cetaceans and 198 dB re: 1 μPa^2-s for SEL in all groups. Considering the seismic array as a point source and from previous experience of modelling the impacts of seismic airguns, it is likely that such levels would be limited to the immediate vicinity (tens of metres, rather than kilometres) of the airgun array. However, at such close range sound levels are expected to be much lower due to interference of the individual airgun signals with each other which cancel out much of the perceived noise. OSPAR (2009a) report Finneran *et al.* (2005) who conducted studies on impacts on hearing of odontocetes and concluded that TTS might occur if animals were exposed to airgun discharges within 5 metres of the gun.

Physiological stress

Nowacek *et al.* (2007) report an example of noise-induced stress in belugas and bottlenose dolphins exposed to seismic surveys that showed detrimental changes in various parameters increased with increasing sound levels. However, Nowacek *et al.* (2007) note that studies investigating impacts of noise as a potential 'stressor' are difficult to interpret since stress is a difficult concept to define, and differences between studies, such as the type, intensity and duration of sounds used, make it difficult to compare results between studies.

Behavioural response of small odontocetes

Although it is unlikely that any seismic survey operations will cause injury, it is possible that they will initiate some behavioural responses from cetaceans in the vicinity of such operations. In a review of the effects of seismic surveys on marine mammals Gordon *et al.* (2004) report a study which showed no change in the detection of harbour porpoises during two seismic surveys. However, studies on the behaviour of small odontocetes to seismic survey sound generally do show some form of avoidance to operations or disruption of normal behaviour. For example, Goold (1996) reports general avoidance behaviour of common dolphins to airgun sound up to and above 1 km during a 2D seismic survey off the coast of Pembrokeshire in the Irish Sea (adjacent to the IOSEA4 area). Stone & Tasker (2006) found sighting rates of white-sided dolphins, white-beaked dolphins, a grouping of "all small odontocetes" and a grouping of "all cetaceans" were significantly lower during periods of shooting compared with non-shooting periods on surveys with large airgun arrays. Throughout the course of the surveys, however, sighting rates were not found to differ significantly, indicating that any behavioural responses were short-term in nature. Comparable behaviour was observed for Atlantic spotted dolphins by Weir (2008) during seismic exploration offshore Angola. All three of these authors suggest that the avoidance behaviour appeared to be limited to within a few kilometres from the seismic air gun array. A similar effect was reported by Parente & de Araújo (2005) who reported a reduction in cetacean diversity, mainly among members of the family delphinidae, during seismic surveying offshore Brazil. In a rare controlled experiment, Lucke *et al.* (2009) reported movement of harbour porpoise away from airguns.

Pinnipeds

There have been few studies of the effects of airgun noise on seals even though they are known to have good underwater hearing and their feeding grounds often overlap with seismic survey areas (Gordon *et al.*, 2004). In their review, Gordon *et al.* (2004) quote a single study by Thompson *et al.* (1998) on the behavioural and physiological responses of grey and harbour seals to small airguns, a study which indicated that harbour seals show initial fright responses generally followed by strong avoidance behaviour, a cessation of feeding but that the behaviour of the harbour seals seemed to return to normal soon after the air guns were switched off. Similar avoidance responses were documented during trials with grey seals (changed from making foraging dives to v-shaped transiting dives moving away from the sound source). The grey seals returned to normal behaviour within 2 hours of the air guns being switched off. Gordon *et al.* (2004) report partial avoidance by ringed seals up to 3.6 km from the sound source.

OSPAR (2009a) report the work of Bain & Williams (2006) that showed California sea lions and steller sea lions exhibited general avoidance behaviour at exposure levels above 170 dB (p-p) re 1 μPa whereas harbour seals generally stayed at the surface with their heads outside the water and looked towards the airguns. Although many seals appeared to be responding to the airguns, some seemed to be at least equally concerned with the acoustic monitoring vessel, and those observed at low exposure levels did not show a detectable response to the airguns (Bain & Williams 2006, in OSPAR, 2009a).

In addition to any direct response reactions, it has also been shown that moderate levels of underwater noise can induce temporary reduction of hearing sensitivity (TTS) in some pinnipeds, provided that the exposure duration is relatively long (Kastak *et al.*, 2005). Although such individual exposure events are not likely to have dramatic long-term or fitness consequences (except for cases of extremely high exposure levels resulting in acoustic trauma), they may result in short-term impairment in the ability to communicate, navigate, forage and detect predators. Additionally, behavioural reactions to noise exposure such as startle responses or avoidance may interrupt ongoing behaviours as severe as mother-offspring separation (Kastak *et al.*, 1999).

It seems likely that marine seismic exploration activity has the potential to impact upon both species of seal (harbour and grey) commonly residing in Irish waters. The degree of impact within and adjacent to the IOSEA4 area is as yet unknown but it may be that the impact is higher compared to other locations further offshore since the IOSEA4 area includes specific coastal sites at which seal are known to be present.

SACs have been designated for seal species at points on the coast bordering the IOSEA4 area. The possible impacts described above could, if being experienced by a significant proportion of the seal populations linked to these protected sites, result in a reduction in quality of those areas. However, much of the seismic activity is likely to take place in waters that are further offshore where seal density is likely to be lower, even if such waters have been identified as possible foraging areas. In addition, as with cetaceans, population level impacts on seals from seismic activity are not necessarily expected and impact on protected sites is by no means a likely result. Protected sites outwith Irish waters are considered in Section 2.7.

Seabirds

Seabirds have traditionally not been considered susceptible to the impacts of underwater noise emission from seismic survey since they generally spend the majority of time at or above the surface. However, evidence suggests that some species may spend extended periods of time underwater; for example, some of the auk species recorded from the IOSEA4 have been reported to spend up to 78% of foraging time underwater (Wanless *et al.*, 1988). Stemp (1985, in Turnpenny & Nedwell, 1994) considered the effects of seismic surveys on three seabird species and concluded that emissions caused no fatalities and that the variations in abundance seen between control and seismic observations were less than the normal variation caused by weather and seasonal conditions. Lacroix *et al.* (2003) report a study on long-tailed ducks (*Clangula hyemalis*) that found no effect of seismic activity on movements and diving behaviour. Although diving birds that conduct such activity very close to the airguns may be exposed to high sound levels, the vessel from which seismic surveying is conducted is likely to disturb rafting birds as it approaches the groups, causing the birds to fly or swim out of the path of the vessel and, as the air gun is towed behind the vessel, there is likely to be a clear, bird-free route in front of the air gun array.

Were seismic activities to impact upon a significant proportion of the seabirds foraging in the area, there could be a knock-on effect on the protected areas (the SPAs) on the coastline bordering the IOSEA4 region. This could happen if, for example, foraging seabirds with chicks were unable to locate prey or experienced injury from seismic emissions. Since the seismic emissions will be underwater, an area within which seabirds would be expected to spend only a portion of time and the impact on prey species (fish) is unlikely to be great, such knock-on effects to the SPA are considered unlikely and the quality of the sites would not be affected. Any possible impact is likely to be very small when considered against the changes in seabird populations that have been attributed to changes in water temperature and from over fishing. Protected sites outwith Irish waters are considered in Section 2.7.

Fish

The inner ear of fishes (including elasmobranchs) is very similar to that of terrestrial vertebrates and hearing is understood to be present among virtually all fishes (NRC, 2003). Most species of fish are able to detect sounds from well below 50 Hz (some as low as 10 or 15 Hz) to upward of 500 - 1,000 Hz. Moreover, a number of fish species have adaptations in their auditory systems that enhance sound detection, enabling them to detect sounds to 3 kHz and above and have better sensitivity than non-specialist species at lower frequencies (NRC, 2003; Popper, 2003). The sensory receptors used by fishes to detect sounds are very similar to those of marine and terrestrial mammals, and, as a consequence, sounds that damage or in other ways affect marine mammals may have similar consequences for fishes (Popper, 2003).

Existing mitigation

Reducing the noise that enters the marine environment in the first instance is the main measure in minimising the impacts of seismic survey operations. Therefore, all seismic operations should use the lowest practicable power levels throughout the survey and only discharge pressure waves into the marine environment when strictly necessary.

Pursuant to the Rules and Procedures for Offshore Petroleum Exploration and Appraisal Operations (DCENR, 2010) applicants are required to submit an 'Application for Approval' to the DCENR to conduct any Geophysical or other Exploration Survey, Site Survey or Route Survey at least three weeks prior to the planned commencement of the survey. Operators are required to include information on the type of sources to be used and the specific impact mitigation and monitoring practices in relation to marine mammals that will be applied during the survey such that the possible impact may be determined. The application should also include a risk assessment of the impact of the proposed survey on Annex IV species (relating to the EU Habitats Directive) that takes account of area-specific cetacean sensitivities likely to be present, both in terms of timing and spatial extent. During all seismic, site and route surveys, the Operators must ensure that current best industry practices are applied with regard to impact mitigation and monitoring measures.

In order to meet the requirements of the EU Habitats Directive (92/43/EEC), Ireland, as for all other EU Member States, is required to establish a system of strict protection for a number of animal species, including all cetaceans. The NPWS has issued guidelines entitled 'Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters Version 1.1' (NPWS, 2007) that have been developed to assist in mitigating against potential impacts on marine mammals from seismic noise. It is a DCENR requirement (DCENR, 2011) that all Operators incorporate these into seismic survey plans. These guidelines highlight a number of measures that should be applied, including:

- The minimum source level required to achieve results should be used and frequencies chosen to minimise impacts on marine mammals;
- Qualified and experienced Marine Mammal Observers (MMOs) must be present on board all vessels conducting seismic surveys;
- MMOs must be engaged solely in monitoring the Operator's implementation of these guidelines and conducting visual/acoustic observation of mammals during the survey;
- The MMO must submit a report to the relevant Licensing Authority;
- MMOs must scan for cetaceans 30 minutes before a soft start and there must be no cetaceans within 1km of the array. If animals are spotted, the operation must be delayed until none have been sighted within the 1km zone for 30 minutes. If water depth exceeds 200 m then the scanning period must last for 60 minutes; and
- The soft start should involve the power in the air guns being built up slowly over 20 - 40 minutes to give marine mammals adequate time to hear the noise and leave the vicinity. This 'soft' start process should be adopted every time air guns are used, even if no marine mammals are seen, and if air guns have stopped and not restarted after five minutes.

In the event that there is a requirement for multiple surveys in the same area and at the same time, it is recommended that these are combined into consecutive surveys through appropriate planning and cooperation. If surveys must be carried out simultaneously, consideration should be given to the location of surveys in relation to each other, so that marine mammals have the chance to avoid these areas where necessary and migration routes are not impeded. Seismic surveys tend to interfere with each other if carried out simultaneously and within 100 km of each other, so the issue of survey co-ordination in this respect should also meet this concern.

Potential additional mitigation measures

In addition to the requirements outlined above, there are a number of additional measures that should be considered when planning a seismic survey. Importantly, the timing and location of cetacean calving and migration should be considered and if possible such areas or time periods avoided. The likelihood of impact will have to be assessed during the planning stage of seismic surveys on a site specific basis but a review should make use of all available sightings data for the region in which the seismic survey is proposed. It should be noted that potential calving grounds for harbour porpoise occur offshore in the Irish Sea over the period March to June each year, and that sightings of minke whales in the Irish Sea are concentrated over the months of May to July. In order to avoid these sensitivities as presently understood, consideration could be given to planning seismic survey work to avoid the months of March to July in the Irish Sea In addition it is thought that migratory baleen whales forage or pass through the IOSEA4 area along the shelf off the south coast in the Celtic Sea and over the Celtic Deep from June to February (see Section 5 and Annex). Therefore surveys timed for the period March to May would avoid interaction with this sensitivity.

Fontana & Zickerman (2010) state that the correct approach prior to initiating a survey programme is to conduct seismic source testing at the beginning of a survey to actually document the minimal level of sound required to produce acceptable seismic signal-to-noise for a given area and geophysical objective. A complementary approach is to engineer sources that only output sound in the useable frequency range for the particular objective, all other frequencies being noise in both the environmental and seismic sense (Fontana & Zickerman, 2010).

The NPWS guidelines are regularly reviewed, alongside other similar guidelines from other countries, as new data, technologies and approaches emerge in order to ensure their continuing status as embodying best practice. In addition, all means of assessing cetacean presence or absence in an area during seismic survey (e.g. passive acoustic monitoring (PAM) and other acoustic systems) should be assessed continuously through research programmes and workshops. Guidelines for offshore areas in other waters (e.g. UK, JNCC, 2010) raise the possibility of deploying PAM in addition to MMO. Such systems make use of hydrophones and software to provide real-time information on cetacean presence (based on vocalisations) to PAM operators onboard vessels. PAM can determine presence or absence of marine mammals in conditions where it may be difficult or impossible for MMOs to operate effectively, for example in heavy sea states or during hours of darkness. It may be that seismic contractors in the region adopt PAM to enhance mitigation measures (e.g. Hedgeland *et al.*, 2010). Parvin *et al.* (2007), however, state that the systems that have been fielded to date are of generally poor quality, have left-right ambiguity (i.e. cannot determine which side the signal is from) and have no range-finding ability, although they conclude that, for vocalising marine mammals, PAM generally offers a more reliable approach than might be expected using visual detection by MMOs alone.

In addition, the application of modelling could be used to refine the size of observation zones using more biologically sound estimates of impact. It is possible to utilise modelling to consider cumulative impacts arising from coincident seismic surveys to better estimate the separation distances that should be applied between surveys. Such distances are impossible to estimate without knowing the specifics of the survey methodology and hardware and cannot be estimated at this stage.

2.5.3 Accidental Events

Oil may enter the marine environment during seismic operations as a result of accidental streamer rupture or collision with another vessel. The most likely scenario is that of small spillages, i.e several hundred litres of kerosene-like oil entering the environment from a streamer parting whilst deployed. The potential is exacerbated for vessels with numerous streamers deployed, although streamer design is now heading towards solid cables with no oil content. Accidental collision with another vessel and complete loss of fuel and streamer oil inventory would be the worst case scenario. The quantities of oil spilled into the marine environment would be relatively low in all but a worst case scenario involving vessel collision. The relatively low volumes of oil involved in most streamer accidents and light nature of the oil involved means that it would be expected to evaporate and disperse within a few hours.

The risk of interaction or collision with another vessel in the IOSEA4 area is considered to be moderate due to the comparatively high levels of routine shipping off the east and southeast coasts of Ireland and, based on Irish Navy sightings data, relatively high commercial fishing effort over the greater proportion of the IOSEA4 area. However, the increase in offshore vessel traffic due to seismic survey work resulting from the Draft Plan will amount to the equivalent of two to three vessels per year (Section 4.4.1) on top of the 44,000 vessels per year using the IOSEA4 area (Anatec, 2010).

2.6 Drilling Impacts

2.6.1 Noise generation

The effect of anthropogenic sound on marine mammals and other animals is a topic of key interest to the scientific community and to the general public (e.g. Compton *et al*., 2008; IACMST, 2006; OGP/IAGC, 2004; NRC, 2003). The IOSEA4 ENVID exercise highlighted the potential for both seismic and drilling activity noise to impact negatively on species in the marine environment.

It has been assumed that each well will be drilled using a semi-submersible rig or drill ship, and that the drilling period will be 50 days. During drilling operations, the rig or drill ship will be attended continuously by a safety boat. In addition, supply boats and helicopters will visit the rig or drill ship, typically three times each week for replenishment of equipment and materials. Tugs and anchor handling vessels may also be required.

Sources of noise related to activities of the semi-submersible rig include pumps, non-propulsion engines, generators, ventilators and other onboard machinery (Richardson *et al*., 1995). Machinery is mounted on decks raised above the sea but semi-submersible drilling rigs are inherently quieter than other, more traditional, drill ships as they lack a large hull area through which noise can be transmitted. Sound and vibration paths on semi-submersible ships are mainly through air or through the risers, in contrast to the direct paths through the hull of a drill ship (Richardson *et al.*, 1995). However, both semi-submersibles and drill ships are noisier under water than fixed platforms or jack-up drilling rigs since there is still a greater area of structure in contact with the water column (Simmonds *et al.*, 2004; Richardson *et al.*, 1995). Onboard operations typically emit low frequency noise into the water column.

In addition to the emissions from machinery onboard vessels, noise will also be produced by the thrusters of the semi-submersible rig and the supply and guard vessels that will serve alongside. Emissions from ships are a major contributor to noise in the world's oceans, especially at low frequencies between 5 and 500 Hz (NRC, 2003). Sound levels and frequency characteristics are roughly related to ship size and speed but there is a significant individual variation among vessels of similar classes. The primary sources of shipping sound are the sounds produced by the propeller and noise from the ships engines and associated propulsion machinery. Shipping operations associated with drilling operations in the IOSEA4 area will typically include the tugs involved with the mobilisation and demobilisation of the semi-submersible rig, supply vessel visits for the duration of the operations and the standby vessel that will act as guard for the duration of the drilling operations.

Typical source levels associated with shipping range between 160 and 190 dB re 1μPa @1m (Richardson *et al.*, 1995). Ships moving to site will generally produce more noise than stationary vessels because of propeller cavitation noise. However, if a supply vessel is required to refuel a drilling rig, the boat will have to maintain its position alongside the rig by dynamic positioning (DP). Indeed, it is likely that a number of vessels including the semi-submersible rig/drill ship will utilise DP. DP involves the use of a number of thrusters that improves position handling of the vessel but that also results in increased noise levels. There is relatively little information on either emitted noise levels or frequencies associated with these activities, although the measurements which do exist include:

- LGL (2006) report that in the operation of an offshore liquefied natural gas facility the dominant sound sources are vessel movements and the thrusters used for dynamic positioning;
- Nedwell & Edwards (2004) report the majority of noise from an operational drill ship to be in the band 40 to 600Hz. At a range of 5km there was no perceptible noise above ambient;
- Subacoustech Ltd has undertaken noise measurements of an FPSO to the west of Shetland and results indicate that source noise level is approximately 160 dB re1 μPa @ 1 m (Nedwell *et al.*, 2002);
- Lawson *et al.* (2001) report source levels used for dynamic positioning thrusters to be 162 to 180 dB re 1μPa @ 1 m;
- Other research undertaken on thruster noise indicates that source noise levels may be in the region of anywhere between 121 – 197 dB re1 μPa @ 1 m (e.g. reported in AT&T, 2008); and

- McCauley (1998) reports sound generated by DP rig supply vessels to be significantly greater than during drilling operations.

Semi-submersible rigs will be visited several times a week for personnel transfers and since such transfers routinely occur by helicopter there may be a localised increase in underwater noise levels. Helicopter noise originates from the disturbance of the sea surface by the down wash from the blades and by coupling of blade noise directly into the sea. Few measurements have been made of the underwater noise generated by helicopters during approach and take-off from platforms but the down wash noise is very similar to wind noise in frequency characteristics and is greatest in the 2 - 20 kHz region. Additional strong tonals in the 10 - 100 kHz range and around 10 kHz are associated with the rotor operation and turbine blades rate respectively (Harland *et al.*, 2005).

The penetration of airborne sound energy from the rotor blades is largely reflected from the surface of the water and only a small fraction of the sound produced by the helicopter enters the seawater. Although helicopter sound is fairly broad band (0 - 20 kHz), the lower frequency sound is much more pronounced (up to 200 Hz) (Berrow *et al*., 2002). Richardson *et al*. (1995) suggest dominant tones in the noise spectra from helicopters are generally below 500 Hz. The angle at which a line from the aircraft to the receiver intersects the water's surface is also important. At angles above 13° from the vertical, much of the incident sound is reflected and does not penetrate into the water (Richardson *et al*., 1995). In general, peak received level in the water as an aircraft passes directly overhead decreases with altitude (Richardson *et al.*, 1995).

The drilling itself may result in noise emissions to the marine environment. Sound produced by the drilling operations (including the drill bit as it drills through the seabed) will be a fairly continuous background noise in the main noise production areas, with the sound produced being mostly low frequency (JNCC, 2010). Nedwell & Edwards (2004) report that drilling noise measured in 100 m of water around a platform is in the order of 10 to 20 dB above ambient noise over the frequency range 20 Hz to 100 Hz with clear evidence of tones at 130, 200, 350 and 600 Hz which probably originated from resonant frequencies of the drill shaft. No noise from drilling could be detected below 10 Hz. OSPAR (2009b) report the source level to be in the region of 145 - 190 dB re 1µPa @ 1 m (rms) and over a bandwidth of 10 - 10,000 Hz.

As most of the frequency of the acoustic energy radiated from such activities is below 1 kHz, the greatest potential for that noise to mask the hearing of marine organisms is for the marine animals that produce and receive sounds in this range.

Exploration and appraisal drilling operations are temporary activities, which will only occur for a relatively short time period of around 50 days, within which specific noise emitting activities will only occur for some of that period. For example, helicopter and supply vessels will occur only a few times per week and DP thrusters will not be activated at all times. Considering the source levels likely to be involved, it is considered that behavioural impacts on marine mammals are the subject of highest concern.

There are numerous documented examples of cetacean responses to boat traffic; often, however, these have been to small vessels and responses may be as a result of physical presence rather than noise. Few examples attributed solely to vessel noise emissions exist. However, sufficient evidence exists to consider that attention must be given to the possible impacts. It is likely that exploration and appraisal drilling in the IOSEA4 area will result in a maximum of 2,592 vessel days per annum, such that one or more vessels will be operating in the IOSEA4 area on most days, although activity will be higher in summer months.

This vessel activity will not be concentrated around one location and it is likely that noise from no more than a few vessels will be present in an area at any one time. The small increase in noise as a result of the additional vessels that will be on site during the project, plus the fact that the vast majority of additional vessels will be on-site for only a short period means that significant impacts from vessel noise at one location are unlikely.

However, vessel noise emissions may overlap with those from other developments, or with other sources within the same development, such as drilling noise, raising the likelihood of impact on marine mammals. As such, it is important that the use of modelling such emissions is considered to ensure that any overlap in areas of possible behavioural impact is limited. This is especially pertinent when it is considered that mitigation measures for limiting the impact of vessel noise (and other non-pulse sound sources) are much less well defined than those for pulsed sounds such as seismic. Careful selection of drilling rigs and vessels will be key in limiting impact, but it is important that the number of vessels associated with exploration and appraisal drilling is restricted also.

Noise emissions from the actual drilling activity and from associated helicopter movements are likely to be limited temporally in comparison to vessel noise emissions; the main impact is likely to be on marine mammal behaviour and only cumulatively with other noise sources. The comment made in terms of modelling is therefore key.

The assessment of available information, taking into account the limited number of wells forecast as a result of the Draft Plan, together with the short duration of each drilling scenario (50 days), does not indicate any significant impacts from underwater noise generated during drilling operations. However, this assumes appropriate mitigation measures are implemented and it should be considered in the light of the poor understanding of the effects of drilling noise on marine animals. As further information is gathered on the effects of drilling noise, and the distribution of marine mammals in the IOSEA4 area, the potential interactions should be reconsidered.

In conclusion, with mitigation, the direct, short-term environmental impact of noise, from individual exploration and appraisal drilling events within the IOSEA4 area is likely to be negligible and non-significant.

2.6.2 Discharge of drill cuttings

During drilling of exploration and appraisal wells, drill cutting and spent drilling muds require disposal.

Cuttings and particulate material from spud mud (usually seawater with high viscosity bentonite sweeps) used to drill the top hole section(s) is always deposited at the seabed close to the wellhead. A small quantity of the cement used to secure the first set of casing in the borehole is also deposited here.

Cuttings generated from subsequent sections of a well are contaminated with residual drilling muds and associated chemicals following cleaning on the drilling rig. As discussed in Section 2.1.3, the discharge of OBM from cuttings and centrifuges is not permitted, and these are shipped to shore for disposal. However, it is usual for Water Based Mud (WBM) cuttings to be disposed of at sea, by discharge from the drilling rig or ship through a caisson just below the sea surface. Drilling muds recovered from the cuttings cleaning process are re-used, but used WBM may also be discharged overboard upon completion of each well section.

Most of the discharged material will end up deposited on the seabed, where the main potential for impact to the environment occurs. In addition, discharges from caissons create plumes of suspended fine sediment, which may cause localised chemical changes as sediment passes through the water column. The impacts of drilling discharges on both the seabed and its associated fauna, and on marine organisms in the water column, therefore need to be considered. Chemicals are added to drilling muds and to cement used to secure well casings, and drilling rigs and ships also carry contingency chemicals which might be used in the event of an abnormal occurrence. The potential for such chemicals to be toxic to benthic and water column organisms after discharge therefore needs to be assessed.

Impacts on water column

Discharge of cuttings and WBM at the seabed will cause localised increases of suspended solids in the near-seabed water layer. Changes in the amount and type of suspended sediment in the benthic boundary layer may directly affect marine organisms, through abrasion of protective mucous coatings which may increase their susceptibility to parasites and infections, as well as affecting growth, reproduction and feeding. This is discussed below under impacts on benthic organisms.

Cuttings and residual WBM discharged at the sea surface will be suspended in sea water. A discharge 'plume', which may initially be a visible area of turbid water near the discharge caisson, will be subject to rapid dilution and dispersion. The temporary increases in suspended sediment levels within the water column could potentially affect primary production locally through reduction of light levels. Chemical additives in WBM are generally water-soluble and dissolve and degrade naturally in the water column.

Experimental evidence suggests that, where dilution is rapid, discharges of muds containing additives will not significantly alter primary production in the vicinity of drilling platforms (Alldredge *et al*., 1986). The same authors found that, following exposure of marine phytoplankton assemblages to various drilling muds and mud additives for periods of 1 to 120 hours, phytoplankton composition was not altered. Fish and other mobile species are known to actively avoid areas where conditions are not optimal and have the potential to affect survival. They are therefore likely to avoid any plume created during mud discharge. Overall, with the low toxicity of water based mud, and rapid dispersion due to the tidal streams, the environmental impact of drilling discharges on the water column is likely to be minimal.

Deposition on the seabed

The cuttings and drilling fluids discharged from the riser-less top sections of the wells are expected initially to form small cuttings piles in the immediate vicinity of each wellhead, together with small amounts of excess cement from setting the top hole sections. They will then spread out gradually in the vicinity of the well heads under the influences of gravity and the moderately strong seabed currents.

As the cuttings and drilling fluids from the remaining well sections are discharged from near the sea surface, they are likely to disperse over a wider area. The deposition pattern tends to reflect the particle size distribution, with larger and heavier (cuttings) particles landing on the seabed relatively close to the discharge point, and small (mud) particles travelling much further before they reach the seabed. The area and depth of deposition is highly dependent on water depth and currents; in continental shelf areas a recognisable footprint may be detectable, whereas in deep water there may be no detectable deposition pattern. Drill cuttings modelling is sometimes used to predict the likely deposition pattern, but must be interpreted with due regard to the limitations of the input data and the assumptions of the model.

Alteration of sediment structure

The discharge of cuttings, muds and cement will initially alter the seabed topography and sediment structure of a small area close to the wellhead. The material deposited will be a mixture mostly of cuttings (rock fragments and sediment removed from the well) of various sizes and drilling mud including particles of barite (barium sulphate; $BaSO_4$) and bentonite, a mineral clay. The natural sediments in the IOSEA4 area encompass a range of sediment types, generally dominated by sandy gravel, sand and mud and generally becoming finer with increasing water depth.

An understanding of the persistence of WBM cuttings piles is available from experience in the North Sea. In the southern North Sea, near-bed current velocities and sediment mobility are generally sufficient to prevent detectable local accumulation of cuttings. It has been predicted that any surface-hole cuttings piles in the southern and central North Sea area will be dispersed typically over a timescale of one to five years, mainly through re-suspension and bedload transport due to tidal and wave-induced currents (DTI, 2002), while those in the more quiescent northern North Sea will typically be dispersed over a timescale of one to ten years (DTI, 2001).

Contamination of sediments

From post-drilling environmental surveys on cuttings piles contaminated purely by WBM in the North Sea, impacts to the seabed sediments in the immediate vicinity of the well can be summarised as follows:

- Elevated levels of barium;
- Elevated levels of some trace metals associated with the barium; and
- Mild organic enrichment of the sediment at some locations.

Barium inputs arise from the use of barium sulphate (or barite) as a weighting agent in drilling mud. Barium sulphate is an insoluble, chemically inert mineral powder that normally also contains measurable concentrations of several trace metals. In this form, the barium is 'biologically unavailable' and will have no measurable effect, in chemical terms, on the benthic fauna (Jenkins *et al*., 1989; Hartley, 1996). The environmental impact of other trace metals will depend on their concentration in the WBM-contaminated cuttings, which depends to some extent on the geological source of the barite. However, studies have shown consistently that metals associated with WBM are virtually unavailable to marine organisms that might come into contact with discharged drilling fluids (Neff *et al*., 1989; McKelvie, 1996).

WBMs contain very small amounts of organic material. Slightly elevated concentrations of hydrocarbons have been recorded at some sites in the North Sea drilled with WBMs. Although the origins of such inputs have not always been clear, diesel has often been implicated in the past. Its presence could arise from the now outdated practice of using diesel to free stuck drill strings or when formation problems were encountered. Payzone cuttings could also have been the cause in some cases. In the IOSEA4 area, the data available from seabed sampling at offshore fields and well sites indicates that contamination by hydrocarbons and metals has been negligible to date.

Impacts on benthic organisms and habitats

Considerable data have been gathered from the North Sea and other production areas, indicating that physical disturbance is the dominant mechanism of ecological disturbance where WBMs and cuttings are discharged (DTI, 2001). Biological effects on seabed faunal communities in sedimentary habitats from the discharge of WBM and associated cuttings are usually subtle or undetectable, although the presence of drilling material at the seabed is often chemically detectable (see above). Monitoring studies around well sites drilled with WBMs have rarely shown any effects to benthic infauna (at a community level) detectable beyond 50 m or so (eg OSPAR, 2007). Subtle impacts to the benthos were identified at up to 750 m from a production site developed using WBMs, but these were associated with hydrocarbon contamination (Hartley & Bishop, 1986).

The sedentary fauna in the immediate vicinity of the wellheads may well be buried by the accumulation on the seabed of cuttings and WBM particles from the tophole sections. In addition, enhancement and altered particle size distribution of suspended particles in the water near the seabed may impair respiratory and feeding processes, inducing metabolic stress and reducing growth and survival rates in individuals of some species outwith this area. Laboratory studies have shown that elevated concentrations of bentonite and barite, the two major constituents of WBMs, can affect the growth of suspension feeding organisms (Cranford & Gordon, 1992; Cranford *et al*., 1999; Barlow & Kingston, 2001), and some species are more sensitive than others. It is also feasible that changes in sediment particle size characteristics could affect the suitability of the seabed for re colonisation by species normally characteristic of the area, although in a dynamic area it is probable that the sediments will rapidly return to their original composition under the influence of seabed currents and natural sediment transport regimes.

The net result can be expected to be a short-term reduction in productivity just after drilling, and medium-term change in the composition of the benthic community over a small area centred on the wellheads. Long-term effects can be expected to be minimal due to both the overall low toxicity of the WBM, and the currents close to the seabed that will enable (most of) the cuttings to disperse over a wide area so that any impacts are indistinguishable from natural background variation. No detectable effects on the benthic community are expected outside of the area affected by materials discharged at the wellheads.

Of the benthic habitats and communities known to occur in the IOSEA4 area, the main sensitivities with respect to drilling activities will relate to some of those highlighted on Annex 1 of the Habitats Directive (large inlets and bays, estuaries, shallow sandbanks, structures made by leaking gases and both rocky and biogenic reefs) and those listed on the OSPAR list of threatened or declining species for Region III Celtic Seas (seapen and burrowing megafauna communities and horse mussel *Modiolus modiolus* beds). In principle, the concentration of benthic sensitivities increases towards the coast, which has many protected sites. Currently there are no sites with designated protection for benthic species or habitats offshore in the IOSEA4 area. A small number of coastal designations extend offshore to a limited extent, for example Wicklow Reef, though this will change with impetus from Europe and as detailed knowledge of the area improves.

Seabed features resulting from gas leaks that are still active and which include methane derived authigenic carbonates (MDAC) are likely to be particularly important because they provide suitable substrata for diverse sessile communities that include sponges, anemones and hydroids, in addition to infaunal communities with unique species, thereby greatly enhancing local diversity. Such habitats would be potentially sensitive to impacts from cuttings discharges and anchoring or other seabed disturbance. On the other hand, gas leak features that are no longer active are likely to support faunas indistinguishable from the normal adjacent seabed. Therefore whether or not areas of seabed with gas leak structures actually qualify as Annex I features could only be answered through specific targeted survey work incorporating both high resolution photography and sediment sampling.

Disposal of OBM or SBM cuttings onshore

Exploration drilling of the type likely to predominate in the IOSEA4 area as a result of the proposed Draft Plan tends to involve straightforward vertical well designs that use WBM rather than OBM or SBM. Nevertheless, well design, geology and drilling conditions may dictate that OBM or SBM is used in some of the drilling likely to result from the proposed Draft Plan.

Routine discharges of OBMs from cuttings or centrifuges are not permitted in Irish waters. The DCENR rules and procedures manual (DCENR, 2010) states that such material must be circulated back up from the wellbore to the drilling deck and stored for shipment ashore to appropriate treatment and disposal facilities (often termed 'skip and ship') typically in Scotland. Storage on the rig pending transport ashore is usually in lidded skips with a capacity of approximately five tonnes. Depending on the well design, there may be in the order of 150 skips of mud, cuttings and adhering oil requiring disposal, with the oil component amounting to approximately 50 tonnes in total. This material is sent to a treatment facility certified to deal with OBM waste, where the oil is removed and recovered as far as possible, and the cuttings and mud residue either re-used (eg as a road-building material) or sent to landfill. Apart from the complex logistics associated with the skip and ship option, particularly transboundary shipment, concerns centre on the use of and contamination of limited landfill space and tightening EU waste legislation (SLR, 2010). Disposal approaches involving a greater degree of re-cycling are continually being sought.

2.6.3 Direct seabed disturbance

Localised areas of seabed will be disturbed during installation and subsequent removal of the drilling rig, principally by manoeuvring and dragging of anchors and their chains. Depending on the rig, eight to twelve anchor lines may be used, each radiating 2 to 3 km from the rig. For each anchor several hundred metres of chain will rest on the seabed. Equivalent disturbance would result from jack-up rigs also through placement of rig legs (with spud can footings) on the seabed, though without the anchoring requirement seabed disturbance will be localised to the rig location.

Effects to the benthos include localised direct disturbance and damage through placement of anchors and chains. Resettlement of disturbed sediment could lead to some minor smothering effects as described above for drilling discharges, but on a much smaller scale. Such impacts need to be assessed in the context of the nature of species and communities affected and the scale of the activities. As outlined above, the overall nature of the benthic environment in the IOSEA4 area is dynamic, and impacts associated with the scraping and dragging of anchors and chains in most areas are likely to be minor with good potential for rapid recovery. However, impacts to benthic organisms in gas related seabed structures (particularly sessile organisms associated with MDAC) from anchor and chain scraping may be slow to recover if the habitat is physically damaged and due to the length of time required for sessile organisms to recover from smothering or to recolonise from other habitats. Organisms associated with the sediment in these habitats will be able to recover more rapidly as they are able to cope with some degree of smothering and will recolonise more rapidly by migration from undisturbed areas closeby.

The majority of the protected sites in Ireland are close to the coast and consist of dynamic environments that readily recover from disturbance and damage. For instance Long Bank SAC in Wexford consists of *Sandbanks which are slightly covered by sea water all the time*. Again, the impacts associated with the scraping and dragging of anchors and chains in these areas are likely to be minor with good potential for rapid recovery due to the dynamic nature of tidal, wave and sediment transport regimes in coastal areas and associated with sandbanks.

Implementation of the Draft Plan may result in up to 180 wells being drilled over the period 2011 to 2020. The impacts of activities such as anchoring, and the discharge of drilling wastes, will be primarily to the seabed rather than to the sea surface or water column. Impacts on the benthic communities from discharges of WBM and cement may occur in the immediate vicinity of each well, with likely recovery within months to years depending on the local hydrographic regime. Assuming an area of measurable ecological impact of 50 m radius (see above) around each of 180 wells, a total area of approximately 1,419,712 m^2, or 1.42 km^2, would be affected to some extent by burial or smothering impacts.

In the event that drilling is conducted via an anchored drilling rig, direct disturbance and damage to benthic animals will arise mostly from the anchors and anchor chains. Assuming eight chains per rig each impacting an area of seabed 600 m long and 2 m wide, 9,600 m^2 of seabed may be subject to varying degrees of disturbance over the estimated drilling period of 50 days for each well. For the maximum of 180 wells drilled, a total of 1,728,000 m^2, or 1.73 km^2, of seabed could be temporarily affected. As a very rough estimate, therefore, the direct seabed disturbance involved from anchoring and discharge of solid wastes at up to 180 well sites could total 3.15 km^2. However, of this potential total for the IOSEA4 area as a whole, it is likely that only a small proportion would be close to or overlap with any coastal Natura 2000 sites, especially since the main areas of known prospectivity occur offshore.

Existing mitigation measures

- All chemicals used are regulated under the OSPAR HOCNF scheme and approved by use of a PUDAC. Selection of all chemicals that may be used in drilling the proposed wells should be based upon both their technical specifications and their environmental performance, and the use of all chemicals minimised where practicable;
- Mud and chemical usage must be monitored during drilling operations, and subsequently reported to the DCENR. On completion of drilling a mud audit will be prepared showing the quantity of mud brought to the offshore facility, the quantities returned to shore, the quantities left downhole and the quantities discharged;
- The discharge of cuttings contaminated with OBM or SBM to sea is prohibited. Cuttings shipped to shore for treatment and disposal will be dealt with under the local authority waste management plan;
- Best practice should be followed to minimise the amount of excess cement deposited on the seabed;
- Mud recovery systems should be used, thus minimising the amount of drill fluids eventually discharged;
- Site surveys are undertaken with regard to geological hazards such as seabed stability, shallow gas and gas hydrates and other hazards such as historic wrecks;
- In addition to this AA, site-specific AA may be required for operations in or adjacent to SACs in conjunction with Environmental Area Assessments (EAA);
- Best practice should be followed in order to limit dragging of anchors and chains;
- An environmental area assessment (EAA) is required with any application for drilling, and therefore is carried out prior to all exploration drilling activities. Any subsequent field development will be subject to full environmental impact assessment and reported in an EIS. The EAA, using available information and where necessary site-specific surveys, should describe the existing environmental conditions in sufficient detail to permit assessment of spatial and temporal changes in contamination of the sea bed, water column and biota resulting from subsequent exploration and production development activities;
- Site-specific surveys as part of EAA should be carried out in advance of drilling in accordance with the OSPAR Guidelines for Monitoring the Environmental Impact of Offshore Oil and Gas Activities (Agreement 2004-11, OSPAR, 2004). These should describe the existing physical, chemical and biological conditions (and where necessary archaeology).

Potential additional measures

- Consideration should be given to drilling slimhole wells (ie thinner than usual wellbore) where possible. These generate fewer cuttings, require less drilling fluid and chemicals, and are generally faster than a conventional drilling programme;
- Consideration should be given to requesting that modelling of the dispersion of discharged drill cuttings be undertaken for sensitive locations. This would necessitate collection of tidal stream information at different depths through the water column, depending on the overall water depth, and validation of the predictions once drilling was complete;

- As insufficient information is available on the precise occurrence and distribution of key habitats, megafaunal species and historic wreck sites, site-specific survey data will be required in order to assess the impacts resulting from direct disturbance during the installation and removal of drilling structures. This could be carried out as part of the site survey normally undertaken prior to all drilling activities. Careful consideration needs to be given to the design of such surveys, making use of non-destructive survey methods (e.g. drop down video and stills photography) where appropriate;

The discharges of cuttings and muds near the sea surface are expected to have a minor impact on both the water column and the seabed. The substantial water depths (depths increase gradually from the shoreline to approximately 90 m at the transboundary line and down to 360 m depth at the western edge of IOSEA4), the tidal, current and wave regimes in the area enable good dispersion and dilution.

The discharges of drill cuttings, muds and cement from the top sections of the wells, which are deposited close to the seabed at the wellheads, are expected to have a moderate impact at each well site. However, the area affected will be very small, and any adverse effects on the benthic communities, seabed features and sediment quality are expected to be limited to the immediate vicinity of the wellheads (generally within 50 m). The cuttings piles are expected to be dispersed completely over a timescale of one to ten years, and the overall impact is not likely to be significant.

The greatest potential for significant impact at the seabed arises from direct damage to benthic communities and habitats and historic shipwreck sites or cultural heritage, by placement and scouring of anchors and chains, resulting in a moderate impact. The total area affected represents a small proportion of the total area considered as part of IOSEA4 and as a result the impact will be relatively minor. If wells and anchors are sited using adequate site-specific data on benthic habitats and communities and potential shipwreck sites or cultural heritage, these impacts can be further minimised or negated.

2.6.4 Accidental events

The risk of accidental hydrocarbon and/or chemical spillage to the sea is one of the main environmental concerns associated with oil industry drilling activity, particularly after the explosion and loss of well control at the Macondo well in the Gulf of Mexico in 2010. Spilled oil and chemicals at sea can have a number of environmental and economic impacts, the most conspicuous of which are on seabirds and marine mammals. The actual impacts depend on many factors, including the volume and type of oil spilled, and sea and weather conditions. During exploration and appraisal drilling, there is a risk of spillage of oil (fuel/crude), and spillage or leakage of chemicals. Evidence of both gas and oil prospects has been recorded from within the IOSEA4 licensing area.

Specific wildlife-related issues in the IOSEA4 area include the vulnerability of seabirds, seals and cetaceans offshore, and in the coastal areas a large number of habitats and species of international and national conservation importance. Potential economic issues include impacts on coastal fisheries, mariculture and tourism. The scoping and consultation exercise determined the potential for a high impact with all of the receptors listed above as well as maritime infrastructure and archaeology.

2.6.5 Likelihood of hydrocarbon spill occurrence

OSPAR (2010) provides a summary of the number and size of oil spills reported from offshore oil and gas activities between 1994 and 2008. During this period, only nine spills have been reported as occurring in Irish waters, although it should be noted that all but one of these spills have been estimated as less than 1 tonne. Only a very small number of installations, a maximum of seven per year, have been recorded as having discharges to sea in Irish waters.

Due to the limited nature of available data from Irish operations, statistics obtained from the UK oil and gas sector have instead been used to demonstrate the likelihood of hydrocarbon spill occurrence during exploration and appraisal drilling in the IOSEA4 area. Analysis of the UKCS historical data between 1975 and 2005 (UKOOA, 2006) shows that the majority of spills are small, i.e. less than 1 tonne. Historical data indicate that the probability of a large hydrocarbon spill from a mobile drilling unit (MODU) operating on the UKCS is very low. The most likely spills are small leaks (<1 tonne) arising from loading and bunkering oils between the drill rig and supply vessels. Crude oil spills have been the largest source of hydrocarbon spills during drilling operations on the UKCS, accounting for

75% of all hydrocarbons spilled between 1975 and 2005 (Table 2.12). Oil based muds account or 14.8% of hydrocarbons spills within this period. The discharge of oil based muds is not permitted in Irish waters. It should be noted that while there has been an increase in the number of reported oil spills from 1975 to 2005, since 1990 (with the exception of 1997) the overall volume of oil spilled has been substantially reduced.

Table 2.12 UKCS oil spill summary for drilling operations between 1975 to 2005 (UKOOA, 2006)

Hydrocarbon	Total spilled (tonnes)	Number of spills	% by volume	% by number of spills
Condensate	33.86	110	0.2	2.1
Crude oil	12,697.50	2,398	75	45.9
Oil based muds	2,505.64	340	14.8	6.5
Diesel	711.06	961	4.2	18.4
Lube oil	50.79	162	0.3	3.1
Hydraulic fluid	84.65	413	0.5	7.9
Other/unknown	846.50	841	5	16.1
Total	**16,930**	**5,225**	**100**	**100**

Potential accidental causes of hydrocarbon spills include collision events with other vessels and well control incidents or 'blowouts'. Between 1980 and 2006 the Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology (SINTEF) database recorded a total of 63 blowout events on the UK and Norwegian continental shelves during drilling operations (SINTEF, 2010). During this period 13,762 wells were drilled which gives a risk of a blowout occurring once every 218 wells. The SINTEF database defines a blowout as an incident where formation fluid flows out of the well or between formation layers after all the predefined technical well barriers or the activation of the same have failed. The figures include a range of well control incidents from the loss of a few litres of hydrocarbon to major events. The chances of a major hydrocarbon blowout involving spillage of crude in any significant quantity are therefore very low. The amount of hydrocarbon released from a blowout varies widely and depends on the characteristics of the reservoir and also the reason for the loss of containment. In deeper water, flow rates for crude oil blowouts are limited by the hydrostatic pressure of overlying water.

The probability of a ship collision with a drilling rig is very low. Between 1990 and 2007 for the UK continental shelf, the mean incident frequency for all ship collision incidents with semi-submersible drilling rigs was 0.0134 incidents/year (one every 75 years; Oil & Gas UK, 2009). The frequency with which a collision will cause an oil spill will be even less.

Historically, most crude oil spills to the marine environment from exploration drilling activity have been from hydrocarbon drop-out during flaring as a result of incomplete combustion of hydrocarbons during well testing. High efficiency burners are now used to maximise the combustion of hydrocarbons which, in turn, minimises the probability of hydrocarbon drop-out to the sea surface.

Table 2.13 highlights the number and frequencies of explosions, collisions and vessel contacts per unit year for MODUs. These data indicate a reduction in the frequency of such incidents between the two time periods compared: while not indicating whether or not a spill occurred from the explosion, collision or vessel contact, the data indicates that the likelihood of incidents which could lead to a spill is decreasing.

Table 2.13 Number and frequencies of occurrences per unit per year of accidents from explosions, collisions and vessel contacts for MODU in the UKCS, 1990-2007 (Source: Oil and Gas UK, 2009)

	Period					
	1990 - 1999		2000 - 2007		Overall	
Facility	Number	Frequency	Number	Frequency	Number	Frequency
Vessel Contact - MODU	108	0.166	25	0.055	133	0.120
Collision -MODU	14	0.021	1	2.2 E 10^{-3}	10	0.014
Explosion - MODU	10	0.015	-	-	10	9.0 E^{-3}

During the period 1994 - 2008, only nine spills have been reported as occurring in Irish waters, although it should be noted that all but one of these spills have been estimated as less than 1 tonne, compared to 10,381 spills across the whole OSPAR maritime area (OSPAR, 2010) of which 9,942 were <1 tonne. For comparison the amount of crude spilt in the 1993 *Braer* coastal tanker accident was 85,035 tonnes; 72,000 tonnes from the *Sea Empress* in 1996; and approximately 730,000 tonnes of oil released by the Macondo well in the Gulf of Mexico in 2010.

Diesel oil spills account for 4.2% of oil spilled on the UKCS and generally occur during bunkering operations. Diesel will be the main fuel for power generation on the drilling unit, and will therefore be the most significant hydrocarbon type stored on the rig whilst on station.

As most diesel spills tend to occur during bunkering operations, the volumes spilled tend to be relatively small. The worst case scenario, complete loss of the diesel inventory, will only occur in the event of a major event, such as a catastrophic collision with a ship or explosion. The probability and frequency of such an event occurring is low (as outlined in Table 2.13).

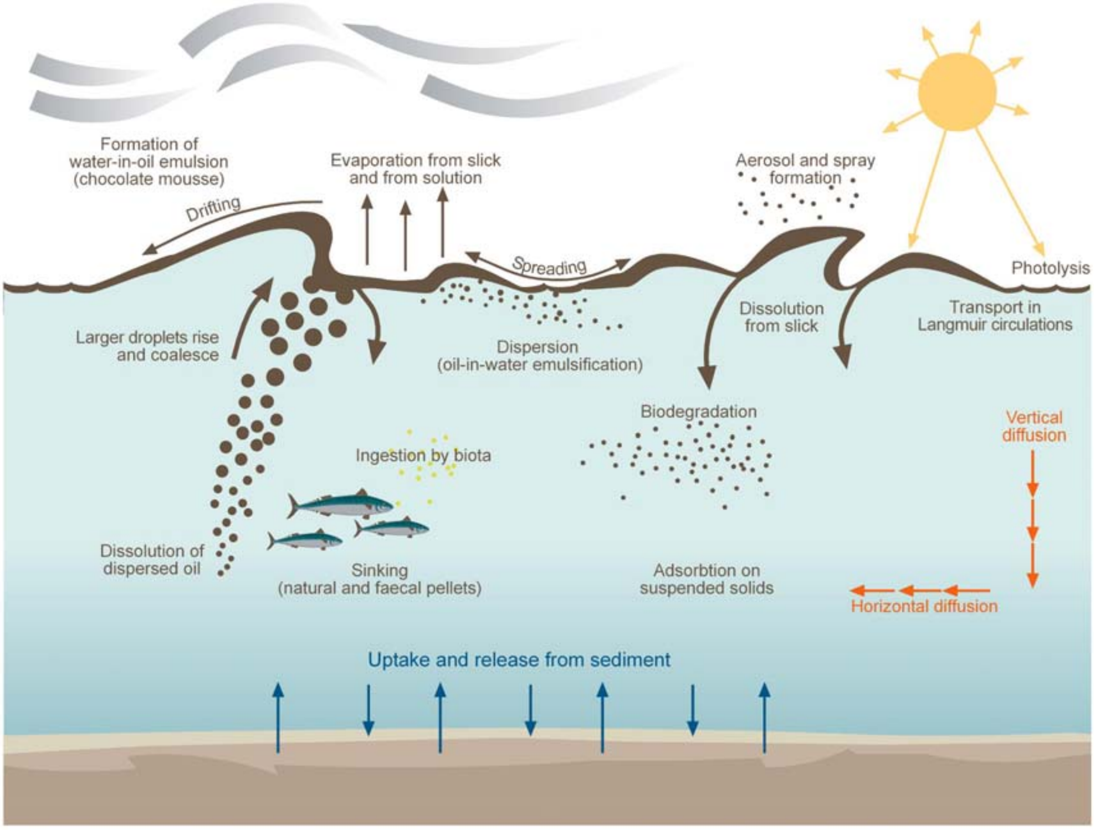
The behaviour of hydrocarbons at sea

When oil is released into the marine environment it undergoes a number of physico-chemical changes, some of which assist in the degradation of the spill, while others may cause it to persist; these processes are commonly referred to as 'weathering'. These changes are dependent upon the type and volume of oil spilled, and the prevailing weather and sea conditions. An overview of the main processes influencing the fate and behaviour of spilled oil at sea is given in Figure 2.6.

Evaporation and dispersion are the two main mechanisms that act to remove oil from the sea surface. Following a hydrocarbon spill, evaporation is the initial predominant mechanism of reducing the mass of oil, as the light fractions (including aromatic compounds such as benzene and toluene) evaporate quickly. If the spilled oil contains a high percentage of light hydrocarbon fractions, such as diesel, a large part of the spilled oil will evaporate relatively quickly in comparison to heavier (crude) oil. The evaporation process will be enhanced by warm air temperatures and moderate winds and can produce considerable changes in the density, viscosity and volume of the spill.

After the light fractions have evaporated from the slick the degradation process slows down and natural dispersion becomes the dominant mechanism in reducing slick volume. This process is dependent upon sea surface turbulence which in turn is affected by wind speed. Water soluble components of the oil mass will dissolve in the seawater, while the immiscible components will either emulsify and disperse as small droplets in the water column (an oil-in-water emulsion) or, under certain sea conditions, aggregate into tight water-in-oil emulsions, often referred to as 'chocolate mousse'. In practice, usually only one of the two processes will take place at any one time.

Figure 2.2 Fate and behaviour of spilled oil at sea



The rate of this emulsification is dependent upon the oil type, sea state and the thickness of the oil slick. Thick (large) oil slicks tend to form water-in-oil emulsions, where thin (smaller) slicks tend to form oil-in-water emulsions that usually disappear by natural dispersion.

When a water-in-oil emulsion (chocolate mousse) is formed, the overall volume of such a water-in-oil emulsion increases significantly, as it may contain up to 70 or 80% water. This chocolate mousse will form a thick layer on the sea surface reducing slick spreading and inhibiting natural dispersion. By diminishing the surface area available for weathering and degradation, these chocolate mousses will be difficult to break up using dispersants. In their emulsified form, with drastically increased volume, they can cause difficulties for mechanical recovery devices as well.

Wind and surface current speed and direction are the main parameters involved in affecting where a slick travels. The slick will roughly travel at the same speed and direction as the surface water current. Additionally, the prevailing wind drives a slick downwind at 3 to 4% of the wind speed. The weathering behaviour of spilled oil influences the potential environmental impact of an oil spill.

Spill modelling in the oil and gas industry is undertaken as a matter of course as there is usually a requirement, prior to drilling, that an Oil Spill Contingency Plan (OSCP) is prepared (OSCP is a requirement in Ireland, and subject to approval by the Irish Coast Guard). A range of oil spill scenarios are modelled including both crude/condensate and diesel. Deterministic 'worst case scenario' modelling is used to determine the shortest beaching time using predetermined weather conditions. Single trajectory modelling for an instantaneous release of around 1,200 m^3 of diesel (a common standard roughly equivalent to the fuel inventory of a drilling rig) shows that, under a constant 30 knot wind, the released diesel would normally evaporate and disperse rapidly into the water column within eight hours. These calculations assume that there is no intervention of the slick although, in practice, oil spill response resources would be mobilised immediately, and do not take into account weather conditions that may enhance the dispersion process. As a result these calculations are conservative.

For crude oil spills, modelling has to be based on the expected characteristics of the crude ie heavy/light, which are determined by the reservoir the crude originated from. Therefore site-specific modelling should be undertaken where drilling is expected to take place in an oil-bearing formation. The OSCP produced for all drilling operations will specify the level of spill response equipment and facilities present both offshore and onshore.

Potential impacts of a hydrocarbon spill

Factors important in determining oil spill impacts and recovery rates include the type of oil, the thickness of shore deposits, climate and season, the biological and physical characteristics of the area, the relative sensitivity of species and communities and the type of clean-up response. The potential for environmental damage caused by an oil spill varies with different areas of the marine environment. Oil spills, being infrequent and relatively short-term events rarely cause much damage to organisms in deep water, but there can be severe and long term impacts on organisms living in shallow water near the shore. The impacts arising from oil spills are well documented, and a summary of these impacts and their effects is given in Table 2.14.

Table 2.14 Summary of the potential impacts of hydrocarbon spills

Group	Comments
Birds	Shearwaters, gannets, gulls, terns and auks are common in the IOSEA4 area. The majority of these birds breed in colonies located on the southwest, south and east coasts of Ireland while others overwinter in Irish waters. Other species such as some species of shearwater and skua are passage migrants that use the area as a migratory corridor. Potential fatalities of some sensitive offshore species particularly auks and divers, may arise, although this tends to be dependent on species present at the time of the spill. Birds are sensitive to physical effects of fouling and toxicity by ingestion. The impact on breeding colonies and bird populations depends upon the existence of a reservoir of young non-breeding adults from which they can be replenished and the reproductive rate of the impacted species. There is no evidence that oil spills have permanently damaged any seabird populations, but any small indigenous populations, or species that are clustered into a few dense colonies (such as gannets) could potentially be at risk.
Benthos	Effects on the benthos include smothering, acute toxicity and possible organic enrichment. Offshore impacts are likely to be minimal, and influenced by water depth and local hydrography. Shallow inshore areas and the shoreline are susceptible to heavy mortalities if coated with fresh crude oil. Recovery times are variable, dependent on many environmental factors, and may be in the region of 1 to 10+ years.
Mammals and reptiles	Irish waters are some of the most important in Europe for a wide range of cetacean species. To date 24 cetacean species (or 28% of species described worldwide) have been recorded in Irish waters. Many are not known to breed in Irish waters but migrate annually along the western seaboard (Charif & Clark, 2000). It has been rare for cetaceans to be affected following a spill; they may be able to avoid affected areas and are not believed to be susceptible to the physical impacts of oil and oil emulsion lowering their resistance to the cold. Contact with oil may cause irritation of the skin and mucus membranes. Volatile hydrocarbon fractions may also cause respiratory problems. Chronic ingestion of subtoxic quantities of oil may have subtle effects which would only become apparent through long-term monitoring. The transfer of hydrocarbons through the mother's milk to suckling young is another way oil affects cetaceans. It is also possible that oil pollution impairs cetacean immune systems and causes secondary bacterial and fungal infections.

Table 2.14 (Continued)

Group	Comments
Mammals and reptiles (continued)	The grey seal *Halichoerus grypus* is native to Irish waters. Both species have established themselves in terrestrial colonies (or haul-outs) along all coastlines of Ireland. Seals are susceptible to oiling and the contamination of food sources, particularly in the coastal areas around their colonies, where their density is highest. While they come ashore throughout the year, the majority of grey seals remain close to shore during the breeding and moulting seasons, September to April. Harbour seals undergo a similar cycle between June and September, although they continue to forage at sea throughout their breeding season. New born pups are considered most at risk from oil coming ashore. Otters are found on the southern and eastern shores of Ireland where the numerous rivers and estuaries that flow into the Celtic and Irish Seas provide a suitable habitat for them. There is little evidence of impact on European otters by oil spills, although food sources may be contaminated. However, thermoregulatory abilities of otters (and seals) can be impaired when their fur comes into contact with oil. Sea turtles are of particular concern because their numbers are declining worldwide. Impacts on marine turtles in the study area are considered to be similar to those for cetaceans. There are no nesting turtle beaches in Ireland.
Fish	Fish populations remain relatively unaffected by oil pollution in the offshore environment, as oil concentrations below the slick are generally low. There is also evidence that fish are able to detect and avoid oil-contaminated waters. This avoidance may cause disruption to migration or spawning patterns. Heavily contaminated sediments may have an adverse affect on local populations of demersal fish species, due to the impact it has on the food chain. Fish eggs and larvae are more vulnerable to oil pollution than adults. In many fish species, these stages float to the surface where contact with spilt oil is more likely. However, as most fish species have extensive spawning grounds and produce large numbers of pelagic young, there is unlikely to be any effect on numbers in the adult populations. Stocks may be at risk from a spill if it is very large, coincides with spawning periods, or enters the grounds of species with restricted spawning areas. Peak spawning periods for fish species within the IOSEA4 area and adjacent coastal areas occur from February to June. There are increased risks to some species and life stages of fish in shallow nearshore waters. These foreshores are believed to function as essential feeding and "nursery" breeding grounds for many fish.

The following measures are already in place, either integral with good practice, or with regulatory systems, or both.

- The crew of the drilling rig/ship should undergo environmental awareness and safety training. All equipment used on the rig/ship should have safety measures built in to minimise the risks of any oil spillage. All operations where appropriate, shall apply best available technologies, best environmental practice and clean technology. This is the aim of the requirement of DCENR (2011) for operators to have accredited and verified environmental management systems;

- A two-barrier well control policy should be implemented at all times as a minimum. Primary well control (i.e. mud hydrostatic) and secondary well control (blow-out preventers or BOPs) should be maintained throughout the drilling of a well. A full risk assessment should be performed as part of the planning phase of the well;

- As the highest risk of diesel spillage occurs during re-fuelling (bunkering) operations at sea, all bunkering should take place during suitable weather conditions, preferably in daylight hours, and a continuous watch should be posted during the operations. The bunkering hoses should be segmented and have pressure valves that, in the event of a drop in pressure within the line as a result of loss of diesel, will close, preventing the further release of diesel;

- An Oil Spill Contingency Plan (OSCP) is required under the Sea Pollution (Amendment) Act 1999, and this requirement is re-stated in the DCENR Rules and Procedures Manual (DCENR, 2011). The OSCP is designed to assist the decision-making process during an oil spill, indicate what resources are required to combat the spill, minimise any further discharges and mitigate its effects. The OSCP must be submitted to the Irish Coastguard for approval;
- As the IOSEA4 region encompasses sites of international and national importance, some of which are designated under the EC Directive 92/43/EC (Habitats Directive) and EC 2009/147/EC (Birds Directive), appropriate assessment may be required to determine if there could be any 'likely significant impacts' from any proposed plans or projects within the region.
- Any oil spill must be reported immediately, however small. The level and manner of the required oil spill response will be overseen by the Irish Coast Guard, and determined by the volume and type of oil spilled, and the weather and sea conditions at the time; and
- Any oil spill likely to have impacts in UK waters will be reported by the Irish Coast Guard to the relevant UK authorities. The Irish Coast Guard has a close working relationship with the UK Maritime and Coast Guard Agency (MCA) and the two have a draft Service Level Agreement for co-operation on search and rescue and oil spill response in place. The Irish Coast Guard and the UK MCA also regularly conduct joint search and rescue and oil spill response exercises.

Chemical spills

Chemical spills to the marine environment can have a number of environmental and economic impacts. Apart from drilling muds, and oil based drill fluids in particular, the chemical inventory on drill rigs and supply vessels may include a variety of materials for use in drilling, completion, cementing and contingency operations. All chemicals used on drilling units must have prior approval according to a system in which chemical formulation is continually reviewed and revised to eliminate or minimise harm to the environment through factors such as toxicity and bioaccumulation (Appendix 3 of DCENR *et al*, 2011. OSPAR (2010) also reports on the frequency of chemical spills offshore. In 2008, there was one chemical spill recorded offshore in Irish waters and this amounted to 70 kg of PLONOR material (material categorised in the HOCNF system as posing little or no risk to the environment).

The environmental implication of a chemical spill is largely dependent on the type of chemical involved, the size and location of the spill and the weather conditions at the time. The actual hazard presented by a spill will depend on the exposure concentration, which is determined by the quantity and rate of spillage and the dilution and dispersion rates. These factors will differ according to whether the spill takes place at the sea surface or seabed.

The dilution and dispersion of a sea surface spill will depend on the sea state at the time: larger waves will be more effective at dispersing the spill than calm sea states. The spill will be diluted as it sinks and will be moved by tidal currents and wave activity. Diluted chemicals would be carried with the body of ambient seawater and gradually disperse and degrade. Although it may be detectable within a circle of a tidal motion, it will only be toxic within a very limited area and for a short period of time.

The fate of a spill at seabed level will depend on the properties of the chemical. If the chemical is denser than seawater it may spread over the seabed and become mixed within the substrate causing potential harm to the benthic community. A lighter chemical will move into the water column and be dispersed with the currents.

With the auditable regulatory and reporting system in place for offshore chemical usage, the continual improvements required in the environmental performance of chemicals, the small quantities involved in most spills, and the dispersive nature of the offshore environment, it is most likely that impacts from this source will be insignificant.

Gas releases

A gas 'blowout' may be caused when the drill bit encounters a shallow or a deep pressurised gas zone or an over-pressured rock layer in the subsurface without being prepared to counter the pressure. This allows the gas or the fluid from the rock layer to enter the drilling pipe and up towards the surface. Any gas zone penetrated before a blowout preventer (BOP) has been installed is called a shallow gas blowout.

Shallow gas blowouts occur in approximately one in every 200 wells drilled (UNEP, 1997). Whilst potentially dangerous, there are few studies available on gas interactions with the marine environment. Naturally occurring gas seeps have been linked to gas hydrates and form a potential natural geohazard in the marine environment. Within the Irish Sea, Croker *et al.* (2005) identified the presence of a number of seabed features that occur due to the presence and migration of shallow gas in the marine sediments. Pockmarks in the IOSEA4 area are distributed within muddier sediments, including those in the north of the Irish Sea. The majority of these lie outside the IOSEA4 boundary but a small number of pockmarks have been identified within the IOSEA4 area. A number of seabed doming features have been identified in the north of the IOSEA4 area. The Codling Fault, within the Kish Bank Basin, located offshore from Dublin, is an area of sandy sediments with a high density of seep mounds with MDAC. Only one mud diapir has been documented in the IOSEA4 area, located in the Lambay Deep.

In addition to planned operations such as power generation, atmospheric emissions may also occur as a result of a blowout in an emergency situation. Emissions would be reservoir specific and likely to contain a large proportion of methane (CH_4) with smaller amounts of volatile organic compounds. In the unlikely event of an explosion and hydrocarbons being burnt then combustion products including carbon dioxide (CO_2) and carbon monoxide (CO) will be emitted.

The following measures are already in place, either integral with good practice, or with regulatory systems, or both.

- The potential for shallow gas should be identified and minimised by site survey prior to drilling;
- The BOP is installed to prevent gas blowout once drilling has progressed beyond the riserless stage;
- Gas detection systems are installed on mud shakers to give early indication of any potential for gas blowout;
- Training in safety awareness and response procedures for drilling crews will ensure that the risk of a blowout will be minimised, and that the appropriate responses will be made should one occur.

Outputs from the ENVID exercise rate the significance of environmental impact from worst case accidental spillages of hydrocarbons as High with potential Major or Severe effects. A review of the vulnerability of the ecology and economic interests summarised in Section 5 against the possible impacts of a major hydrocarbon spill suggests overall Moderate or Major effects in both offshore and coastal areas.

On the basis of accidental events statistics compiled for offshore exploration activity, the risk of a major crude oil spill or gas blowout during exploration, appraisal and development drilling is considered to be very low. Historical data suggest that small diesel spills from rigs and vessels of less than one tonne represent the most likely oil spill scenario. Impacts from diesel spills of this magnitude and frequency would be negligible.

2.7 Cumulative and Transboundary Impacts

Cumulative impacts may occur as a result of a number of activities, discharges and emissions combining or overlapping, potentially leading to a significant impact. Potential cumulative impacts could arise as a result of impacts from seismic and exploration activities interacting or combining with those from other activities taking place in the IOSEA4 area. These may include, for example, seismic survey and exploratory drilling from the Draft Plan interacting with marine scientific research, commercial fishing, shipping or military activities.

Transboundary impacts are those which could potentially have an impact on the environment beyond Irish waters. Figure 2.3 earlier in this document shows all SAC, SPA and Ramsar sites designated for coastal and or marine habitats or species present along the western UK coastline in close proximity to the IOSEA4 area. Of the likely impacts arising from seismic survey and drilling activity under the Draft Plan, the ones potentially capable of extending across national boundaries into the territories of other

EU nations are underwater noise from seismic survey, accidental hydrocarbon spills, and atmospheric emissions

2.7.1 Noise

Both seismic and offshore drilling operations contribute to anthropogenic sound in the marine environment, although the sound levels generated by the former are inherently more significant than the latter. Other sources of sound in the IOSEA4 area that are not related to offshore oil and gas include merchant shipping, fishing, recreational, research and military activity and the developing offshore renewable energy industry which, at times, will all emit relatively high levels of sound into the water column.

It is estimated that there could be as much as 500 days of 2D and 3D seismic activity annually and, as such, it is highly likely that two or more vessels will be operating on most days between 2011 and 2020. However, the timing of seismic survey is weather dependent and much of the activity is likely to be concentrated during the summer months when weather conditions will be most favourable. As a result, multiple seismic surveys may take place in the IOSEA4 area at the same time. This will add to existing noise levels from other sea users including shipping, the oil and gas industry, and offshore wind farm construction in the wider area.

Simultaneously generated sound sources from different directions of a sufficiently high level, such as those generated by multiple seismic surveys or piling for offshore construction, have the potential to negatively affect marine mammal behaviour; noise emissions could result in disruption to marine mammal behaviour such that reproduction, migration and other important activities could be disrupted (JNCC, 2010). Gordon *et al.* (1998) suggest that marine mammal migratory pathways could be interrupted and feeding grounds disrupted if several seismic surveys occur at the same time; numerous marine mammals are sighted in the IOSEA4 region and evidence of both calving grounds and migratory routes exists.

In the event that there is a requirement for multiple surveys in the IOSEA4 region at the same time it is advised that these are combined into consecutive surveys through appropriate planning and co-operation between Operators and Contractors. Where surveys must be carried out simultaneously, a minimum separation distance of 100 km should be observed between survey vessels in order to create a likely corridor of lower noise levels between the surveys through which marine mammals (and other species which may be affected) may travel. This should minimise impacts on larger scale migration routes. Depending on the nature of the programme, it may also be necessary to model the cumulative impacts, whether those be within-project (e.g. seismic and vessel noise) or between-project (e.g. two seismic programmes in close proximity).

Other users of the IOSEA4 area are many and varied and, in general, the sound levels emitted by these users are below those expected to cause injurious effects on marine mammals or other marine species. The transitory and temporary nature of noise from seismic and drilling exploration activities, as well as that from other sea users (mainly fishing and shipping which will pass by and then away from drilling and seismic activity), means that the in-combination impacts from these will be short-lived and consequently less likely to cause significant cumulative impacts. The following potential for cumulative effects should be noted, however:

- shipping density in the IOSEA4 region is relatively high and the potential for cumulative impacts relating to underwater noise is thus elevated compared to less intensively traversed regions;
- The OREDP Plan identifies the potential for between 5,700 and 6,600 MW of offshore wind development within the three areas of the plan which overlaps with the IOSEA4 Draft Plan (Aecom & Metoc, 2010). It is advised that appropriate planning and co-operation between Developers, Operators and Contractors associated with the range of uses proposed in any particularly part of the IOSEA4 area be implemented to minimise risk of cumulative effects from underwater noise.

The eastern and southern extent of the IOSEA4 area is contiguous with the UK international boundary line; hence the potential exists for noise from seismic and drilling activity to be audible in UK waters. Should cetacean (or other marine species) behaviour be affected by any aspect of seismic or drilling activity in the IOSEA4 area, whether cumulative or from a specific source, it is possible that transboundary effects will occur since cetaceans (or other marine species) are mobile in nature, ranging over many hundred or thousands of kilometres (e.g. Atlantic white-sided dolphins, Reid *et al.*, 2003) and their populations and subpopulations are not limited by human maritime boundaries.

Indeed, grey seals are known to travel in excess of 200 km from shore and will move between Irish and UK waters.

Thus, a cetacean that is somehow affected by an activity occurring as part of exploration activity in the IOSEA4 area may well cross boundaries into waters of other nations. However, since impacts within the IOSEA4 region are likely to be short-term and non-significant, it follows that effects would be lower, or at worst the same outwith Irish waters. Indeed, the Strategic Environmental Assessment for the UK waters adjacent to the IOSEA4 region concluded that transboundary impacts would be insignificant (DTI, 2005). In addition, the pinniped species here are relatively coastal in habit and thus transboundary effects are even less likely for this group.

Transboundary impacts on protected sites are a possibility. Although noise emissions, especially from multiple seismic surveys in the IOSEA4 area, may be audible to marine mammals and their prey within designated sites, the distance makes it likely that noise levels will have attenuated to such a level that impacts are negligible. The same is likely to be true with regards to the protected areas for seabirds that exist along the parts of the UK coast closest to the IOSEA4 area.

Overall, the long term, cumulative impacts of sound emissions to the marine environment are poorly understood and firm conclusions cannot be made at this stage. As a result, the impact of the introduction of additional low frequency noise into the marine environment from seismic surveys and drilling activity in the IOSEA4 area must be considered as a worst case and treated as having the potential to negatively affect some marine species. However, the relatively short duration of the individual seismic surveys and drilling operations and the directional character of most of the produced sound suggests that, with mitigation, any potential cumulative and transboundary impacts will be minor.

2.7.2 Discharge of drill cuttings and disturbance to seabed

Drilling activity within the Irish and Celtic seas, historically, has been very low, with only about 130 wells drilled to date since 1970. The extent of any sea bed disturbance impacts which may potentially arise from the oil and gas industry will amount to a very small proportion of the 78,096 km^2 IOSEA4 area. In addition, the temporary nature of cuttings and anchoring impacts, the dynamic nature of much of the benthic environment, and the localised extent of impacts and low toxicity of inputs, lead to good recovery potential. However, the significance of any impact depends on the nature of the benthic environment at the sites concerned. No areas of seabed within the IOSEA4 area are currently designated as offshore SACs, although an area of seabed structures made by leaking gases with MDAC has been identified near the Codling Fault east of Dublin as potential Annex I habitat, and is being considered for designation.

Other activities taking place within the IOSEA4 area which lead to physical disturbance of the sea bed include commercial fishing for demersal or benthic species, telecommunications cable installation, and latterly a developing offshore wind and renewable energy industry. To date only non-commercial marine aggregate extraction has occurred in Ireland (Sutton, 2008). Near-shore sandbanks such as those off the Counties of Wexford, Wicklow and Cork have been exploited for some years by local authorities for beach replenishment and as infill for harbour developments. However, due to the depletion of onshore sources of aggregates, 11 potential offshore resource blocks for future marine aggregate extraction have been identified. Furthermore, the marine wind and renewable energy sector is mainly coastal in nature and, for the time being, the potential for interaction with the oil and gas industry situated further offshore in the main is limited. The 'seabed take' for exploitation of marine and offshore resources is increasing and the potential for cumulative impacts lies in the almost imperceptible nibbling away of habitats and resources by many diverse interests. Apart from natural storm events and wave action, the main source of physical disturbance impacts on the seabed historically has probably been the demersal fishing sector. Although there are no readily available data quantifying the area of seabed affected by fishing activity using trawl or dredging gear in the IOSEA4 area, it is likely that the additional effect resulting from implementing the Draft Plan would be relatively small.

Exploration drilling activity will be taking place in an environment that has long been used for a variety of economic activities, some of which disturb the seabed. As the potential impacts from drilling discharges and physical disturbance to the marine environment tend to be localised, of short duration and with generally good recovery potential, the risks of cumulative (in-combination) impacts are considered to be low for this level of exploration and appraisal activity. For these reasons, transboundary impacts from drilling on European Sites are also likely to be negligible and will therefore not be considered further within this document.

2.7.3 Accidental events

The total activity forecast for the IOSEA4 area Draft Plan indicate a maximum of 180 exploration, appraisal and development wells will be drilled between 2011 and 2020. Based on the probabilities outlined in Section 2.6.5, the incremental risk of a significant hydrocarbon spill is low.

The cumulative level of hydrocarbons entering the marine environment from spills associated with exploration, appraisal and development drilling is likely to be negligible when considered against other natural and anthropogenic sources. While the impacts from oil spills will differ from those of hydrocarbon inputs from rivers, sewage and shipping for example, even large oil spills associated with tanker accidents do not appear to have had long term chronic impacts on marine ecosystems.

Transboundary impacts on the UK marine environment are considered to be the same or less than for Ireland. The IOSEA4 area covers an area of approximately 78,096 km^2, extending from the east and south coasts of Ireland out to the Ireland-UK international line which runs down the centre of the Irish Sea, the St Georges Channel and southwest across the Celtic Sea towards the edge of the continental shelf. The Pembrokeshire coastline in Wales lies approximately 36 km to the east of the IOSEA4 area; the Isle of Man approximately 45 km to the northeast; and the Isles of Scilly and Lands End approximately 99 km and 120 km to the southeast respectively. In relation to adjacent transboundary areas listed under the Habitats Directive, the closest are the Pembrokeshire Marine/Sir Benfro Forol SAC located 17 km to the east, and the Ramsey and St David's Peninsular SPA located 26 km southeast of the IOSEA4 region. Given the relatively short distances between the IOSEA4 area and the UK coastline, a review has been conducted of all Natura 2000 sites along the UK coastline between the Isle of Man to the north and the Scilly Isles to the south. There are 43 SACs and 37 SPAs specifically designated for the protection of marine species which may be potentially sensitive to hydrocarbon spills including: cetaceans, pinnipeds, seabirds and otters, and/or are particularly designated for the protection of marine habitats.

In the area to the east of the IOSEA4 region, identified under UK legislation as the SEA 8 area, there is little interest in oil and gas extraction from offshore sources because no economic reserves have been shown to exist. This situation may change as a result of technological and economic changes. Coastal tourism is important throughout the SEA 8 area and is a major economic factor in these largely rural regions. A considerable portion of the SEA 8 coastline is listed as of either National or World Heritage Value. The recent threat to the coasts of south Devon and Dorset through pollution following the wrecking of the MV *Napoli*, and damage to the Bristol Channel coast following the *Sea Empress* grounding some years ago, highlights the vulnerability of coastlines in general. The scale and consequences of accidental environmental impacts in adjacent States resulting from implementing the Draft Plan could be similar to those resulting from the same incidents in Irish waters.

The spill from the Macondo well in the Gulf of Mexico in 2010 has been a spur for governments in Europe to review regulatory frameworks for oil and gas exploration, and to reassess national contingency plans and provision for response and clean up following accidental events such as oil spills.

The risk of oil spill having transboundary impact is recognised by all governments in the European Union. Of the 14 European countries considered in a review of International Co-operation in Oil spill response in European waters (O'Brien *et al*, 2004), all have clearly identified national competent authorities for at-sea oil spills. Any oil spill likely to have impacts in UK waters will be reported by the Irish Coast Guard to the relevant UK authorities. The Irish Coast Guard has a close working relationship with the UK Maritime and Coast Guard Agency (MCA) and the two have a draft Service Level Agreement for co-operation on search and rescue and oil spill response in place. The Irish Coast Guard and the UK MCA also regularly conduct joint search and rescue and oil spill response exercises.

Cumulative and transboundary impacts from a shallow gas blowout would be reservoir specific. Atmospheric emissions could potentially have cumulative effects, although they would be dependent on the type and volume of gas released into the atmosphere. Similarly, transboundary impacts could possibly occur in the UK and other European States.

In conclusion, the degree of activity predicted to take place under the IOSEA4 Draft Plan, particularly when set against the oil and gas activity already taking place in Irish and UK offshore waters, is small. Additionally, there is an existing framework regulating offshore activities and for co-ordination of resources in the event of transboundary incidents. Finally, statistics for accidental events indicate that spills and releases from seismic survey and exploration drilling are minor and have control measures in place for clean-up and limiting impacts. Overall therefore, the risk of significant cumulative or transboundary impacts from accidental events is likely to be negligible.

2.8 Assessment of Significance

This section considers the initial 'long list' of European sites identified in Section 2.3 and analyses through an assessment of potential significance, which sites can be excluded from further assessment on the basis that it can be demonstrated that the Draft Plan will have no adverse effects on the integrity of the site as defined by their status and conservation objectives. The Managing Natura 2000 Guidelines (European Commission: 2000) states that:

> *"A site can be described as having a high degree of integrity where the inherent potential for meeting site conservation objectives is realised and the capacity for self-repair and self-renewal under dynamic conditions is maintained."*

The site(s) for which there is reasonable doubt that some details of the plan may compromise the integrity as defined above will be considered further in the Appropriate Assessment stage (Section 3), where all impacts significant to the site(s) are addressed.

European sites within the IOSEA4 area

The IOSEA4 area is defined by the Irish coastline to the north and west and the territorial waters boundary with the UK to the east and south. An extensive area of the adjacent Irish coastline is of international and national conservation importance, and the coastline within the IOSEA4 area includes 44 SACs.

The diverse coastline supports a rich variety of habitats and species and is designated as SACs for a range of marine features including intertidal sandflats and mudflats, salt meadows, coastal dunes, estuaries, sea cliffs, coastal lagoons, large shallow inlets and bays and submerged or partially submerged caves. Species covered by SAC designations include grey seal, river lamprey, sea lamprey, shad, Atlantic salmon, European otter and harbour porpoise.

A number of sites for breeding and overwintering Annex 1 bird species have also been designated along this coastline as SPAs (42 in total).

European Sites within the IOSEA4 area at risk of accidental hydrocarbon spills

Given the proximity of the coast, many of the European sites on the Irish south and east coasts have been identified as potentially affected by the plan in the event of accidental hydrocarbon spills reaching near shore waters and beaching. In such a scenario, coastal sites would be damaged and recovery time largely dependent on the characteristics of the accident.

In the unlikely event of a major hydrocarbon spill reaching the coastal zone, further consideration of potential impacts on SACs and/or SPA designations has been given to those sites which include:

- for protection of Annex II marine species:
  - seabirds;
  - cetaceans;
  - pinnipeds;
  - otters; and
  - fish species.
- for the protection of specific qualifying marine habitats:
  - Estuaries and coastal lagoons;
  - Mudflats and sandflats not covered by seawater at low tide;

- Vegetated sea cliffs
- Subtidal reefs
- Large shallow inlets and bays;

Some 28 of the 44 SAC designations along the south and east Irish coastline fall into one or more of these categories (see Section 3). The other sites will not be discussed further within this assessment.

Many of the SPA areas identified have breeding colonies of seabirds of conservation value. Shearwaters, gannets, gulls, terns and auks are common in the IOSEA4 area. Potential sensitivities to hydrocarbon spill are discussed in Table 2.14. Notwithstanding the low probability of a spill occurring, all SPA designations along the Irish south and eastern coastline within the IOSEA4 area provide protection for sensitive seabird species and so have been taken forward for further consideration within the AA section of this report.

Two cetacean species, bottlenose dolphin (*Tursiops truncatus)* and harbour porpoise (*Phocoena phocoena*) are Annex II species (i.e. animal species of Community interest, whose conservation requires the designation of SACs). Harbour porpoise is an Annex II Species in the designation citation for Roaringwater Bay and Islands SACs. The harbour porpoise is the smallest cetacean in Irish waters (IWDG, 2010) and the most abundant and widespread cetacean species occurring over the continental shelf and all around the Irish coast. Notwithstanding the low probability of a spill occurring, the potential impact on the harbour porpoise has been taken forward for further consideration within the AA.

Grey seals *(Halichoerus grypus)* and also harbour seals (*Phoca vitulina)* are the two seal species native to Irish waters. Both species have established themselves in terrestrial colonies (or haul-outs) along all coastlines of Ireland. The grey seal is specifically listed as an Annex II Species in the designation citations for Lambay Island, Saltee Island and Roaringwater Bay and Islands SACs. Notwithstanding the low probability of a spill occurring, the potential impact on SACs designated for grey seals has been taken forward for further consideration within the AA.

Otters are found on the southern and eastern shores of Ireland where the numerous rivers and estuaries that flow into the Celtic and Irish Seas provide a suitable habitat for them. Notwithstanding the low probability of a spill occurring, the potential impact on SAC designated for the European Otter (*Lutra lutra*) has been taken forward for further consideration within the AA.

Atlantic salmon (*Salmo salar*) is an anadromous species, i.e. individuals live mostly in the ocean but breed in freshwater. Salmon are native to rivers all around the Irish coast although recently almost all of the rivers supporting healthy stocks (57 out of 148 rivers) are to be found in the southwest, west and northwest of the country (Standing Scientific Committee, 2009). Salmon is listed as a protected species under Annex II of the Habitats Directive and the National Parks and Wildlife Service overall assessment of its Conservation Status is listed as Bad. The potential impact on SACs designated for Atlantic salmon has been taken forward for further consideration within the AA.

Sea lamprey (*Petromyzon marinus*) is considered an indigenous species widely recorded in the rivers of Ireland (Kurz & Costello, 1999). It spawns and matures in freshwater before returning to the sea. It is an Annex II species. The sea lamprey's overall conservation status was described in 2007 by the National Parks and Wildlife Service as Unfavourable. The River lamprey (*Lampetra fluviatilis*) is also an Annex II species and despite its name occurs in fresh and saltwater. The potential impact on SACs designated for sea and or river lamprey has been taken forward for further consideration within the AA.

Also of relevance to the IOSEA4 area are the Twaite shad (*Alosa fallax*) and Allis shad (*Alosa alosa)*. Both of these species move between coastal, estuarine and freshwater environments and are listed on Annex II of the Habitats Directive. The conservation status of Twaite shad was assessed in 2007 by the National Parks and Wildlife Service as Unfavourable, whilst the status of Allis shad was Unknown. The potential impact on SAC designated for shad species has been taken forward for further consideration within the AA.

European Sites within the IOSEA4 area at risk of acoustic disturbance from seismic activity

As detailed above, a number of the designated sites provide for the protection of marine mammals (specifically grey seals, harbour porpoise and European otter). These species are potentially sensitive to noise disturbance either from discrete seismic survey activities or in-combination with other noise sources / other noise generating activities.

Previous studies relating to airgun noise on marine mammals indicate various, albeit temporary, avoidance responses. It is therefore likely that marine seismic exploration activity has the potential to impact upon these Annex II marine mammal species. The degree of impact within and adjacent to the IOSEA4 area is as yet unknown but it may be that the impact is higher compared to other locations further offshore since the IOSEA4 area includes specific coastal sites at which these marine mammals (particularly seals and otters) are known to be present. Seismic survey activity is considered most likely within offshore sedimentary basins (refer to Figure 2.2) although seismic survey activity close to the coastline can not be ruled out.

Impact on grey seals and harbour porpoise is most likely to affect individuals at sea. Consideration of impacts on marine mammals at sea is documented within the Environmental report (DCENR *et al*, 2011).

SACs specifically designated for grey seal, harbour porpoise and European otter have been identified for further consideration within this Appropriate Assessment. These comprise:

- Lambay Island;
- Saltee Island;
- Roaringwater Bay and Islands SACs;
- Lower River Suir SAC;
- River Barrow and River Nore SAC; and
- Blackwater River SAC;

European Sites within the IOSEA4 area at risk of direct disturbance from drilling activity

Potential impacts from drilling discharges and disturbance to the seabed through anchoring, whilst generally minor or moderate, assume a higher significance in the context of potential Annex I habitats within the IOSEA4 area including reefs and gas-related seabed structures. The risk of adversely affecting the integrity of the benthic ecological features within these habitats is potentially significant.

As documented earlier, the majority of the protected sites in Ireland are close to the coast and consist of dynamic environments that readily recover from disturbance and damage. The impacts associated with the scraping and dragging of anchors and chains in these areas are likely to be minor with good potential for rapid recovery due to the dynamic nature of the coastal and inshore environment.

Wicklow Reef SAC is designated for subtidal biogenic reef at a depth of 12-30 m. The feature of interest is the honeycomb worm (*Sabellaria alveolata*) which consolidates sand grains into the tubes in which they live; the reef is formed from dense aggregations of its sandy tubes which reach a thickness of at least 0.3-0.5 m over the surrounding seabed. Wicklow Reef is of high conservation value as it is the only documented example in Ireland of a biogenic reef.

Roaringwater Bay and Islands SAC is designated for its shallow subtidal rocky reefs and kelp community, whilst Hook Head SAC is designated for its rocky reefs with tideswept communities and species richness in both shallow and deep-water. Further offshore near the Codling Fault east of Dublin, an area of seabed structures made by leaking gases with hard substrata formed from methane derived authigenic carbonate (MDAC) has been identified; this could be potential Annex I habitat, and is being considered for designation. However, as this area has not been formally proposed as an SAC it is given no further consideration within the AA.

The potential for impact of direct disturbance from drilling activities on Wicklow reef, Roaringwater bay and Islands, and Hook Head SACs has been taken forward for further consideration in the AA.

Offshore European sites outwith IOSEA4 boundary

Ireland currently has no offshore SACs or SPAs within the IOSEA4 area (Figure 2.4).

The Belgica Mound Province (IE002327) is the closest of the Irish offshore cSACs and is located off the Irish west coast, approximately 50 km northwest of the IOSEA4 area. The site has also been selected as a cSAC for reefs (biogenic) and it is located on the eastern edge of the Porcupine Seabight.

Three additional offshore cSAC have been designated within proximity of the IOSEA4 area:

- The Haig Fras cSAC (UK0030353) located approximately 17.7 km southeast of the IOSEA4 area in UK waters. Haig Fras is designated as a cSAC due to the presence of reefs, an Annex I habitat.
- The Croker Carbonate Slabs dSAC is an area in the mid-Irish sea where extensive areas of the Annex I feature 'submarine structures made by leaking gases' have been identified, including MDAC. The site is located in the Irish regional sea.
- The Pisces Reef Complex dSAC is located in the western Irish sea in the north-west mud basin. This is designated for the presence of three areas of Annex I bedrock and boulder reef.

Offshore European Sites/Species at risk of acoustic disturbance from seismic activity

The ENVID exercise completed for the IOSEA4 Environmental Report (DCENR *et al.*, 2011) identified that noise generation from 2D/3D seismic operations (airguns) would not be expected to result in any significant impact on the benthos within the study area. The discussion of potential impacts from airgun operations also identified that the natural attenuation and divergence of noise through the water column means that there is little likelihood of discernible impact from air gun noise on the reef structures which make up the designating features for the offshore SACs Belgica Mound, Haig Fras, Croker Carbonate Slabs and Pisces Reef Complex which lie outside the IOSEA4 boundary.

Offshore European Sites/Species at risk of accidental hydrocarbon spills

Potential effects of hydrocarbon spills on the benthos include smothering, acute toxicity and possible organic enrichment, particularly in the event of beaching. However, since oil spills primarily affect the surface water layers, impacts to the seabed and benthos will be minimal offshore. Potential impacts on the Belgica Mound, Haig Fras, Croker Carbonate Slabs and Pisces Reef Complex SACs have therefore been discounted from further consideration within this Appropriate Assessment.

Offshore European Sites/Species at risk of disturbance from drilling activities

As the potential impacts from drilling discharges and physical disturbance to the marine environment (from anchoring etc) tend to be localised, of short duration and with generally good recovery potential, the risks of transboundary impacts from drilling on identified offshore SACs outwith the IOSEA4 area are likely to be negligible. Potential impacts on the Belgica Mound, Haig Fras, Croker Carbonate Slabs and Pisces Reef Complex SACs have therefore been discounted from further consideration within this Appropriate Assessment.

Other European Sites considered for possible transboundary impacts

European Sites outside IOSEA4 area at risk of accidental hydrocarbon spills

The same criteria for defining Natura 2000 sites potentially affected by a hydrocarbon spill has been apply to those transboundary sites which may be affected.

All of the 43 SAC designations which include marine features along the adjacent UK coastline between Dumfries and Galloway to the north and the Isles of Scilly to the south fall into one or more of these categories. These sites have therefore been given further consideration within the AA.

European Sites outside IOSEA4 area at risk of disturbance from drilling activities

As a result of their localised nature, the potential impacts associated with individual drilling activities including drilling discharges and impacts from the placement of rigs or their anchors and chains are not expected to affect any UK Natura 2000 designations. Potential for transboundary impacts as a direct result of drilling activity have therefore been discounted from further consideration within this AA.

European Sites outside IOSEA4 area at risk of disturbance from seismic survey activities.

The ENVID exercise completed for the IOSEA4 Environmental Report (DCENR *et al*., 2011) identified that noise generation from 2D/3D seismic operations (airguns) would not be expected to result in any significant impact on the benthos within the study area.

The discussion of potential impacts from airgun operations in the same report documents available evidence in respect of marine mammal response to acoustic disturbance and in particular identifies distances away from source at which avoidance behaviour has been observed in a number of key species, including grey seals and bottle-nosed dolphin. Consideration has been given to possible impacts on the resident population of bottlenose dolphin, for which Cardigan Bay SAC, Pembroke Marine SAC and Lleyn Peninsula SAC (Wales) are designated, along with Isles of Scilly Complex SAC and Lundy SAC (England).

Distance from the IOSEA4 boundary to the closest Natura 2000 sites along the Welsh coastline coupled with the predominantly low frequency nature of the sound generated (which is less likely to affect the bottlenose dolphin medium to high frequency auditory range) through the water column will ensure that there is little or no discernible impact from the noise generated by the air guns within the IOSEA4 area on key designating species of any UK Natura 2000 sites, whilst within the SAC boundaries. However, within the context of known foraging patterns and observed avoidance behaviour in marine mammals further consideration is given to the possible impact on foraging behaviour of bottlenose dolphin whilst outside the SAC boundaries for which they are designated along the UK coastline.

Further consideration of the potential for transboundary impacts as a result of seismic survey activities within the IOSEA4 area has therefore been limited to the possible impacts on the transboundary SAC designations which include the Annex II species, bottlenose dolphin.

Section 3

Appropriate Assessment

3 Appropriate Assessment

3.1 Introduction

Following the discussion of potential significance set out within Section 2.8 of this report, a number of Natura 2000 sites have been brought forward for further consideration within this Appropriate Assessment. These sites have been identified for further consideration based on the potential for significant impact from specific and identified elements of the Draft Plan.

Table 3.1 below details those sites which are subject to further consideration and the specific potential impacts that have been considered.

Table 3.1 Natura 2000 sites for further consideration

Element of the Plan with potential to cause impact	Elements of the Site with potential to be impacted	Natura 2000 Site Details	
		Irish Coastline	Transboundary (UK Coastline)
Coastal Natura 2000 sites			
Accidental hydrocarbon spills	Estuaries and coastal lagoons; Mudflats and sandflats not covered by seawater at low tide; Vegetated sea cliffs Subtidal reefs Large shallow inlets and bays;	Carlingford Shore SAC; Dundalk Bay SAC; Clogher Head SAC; Boyne Coast and Estuary SAC; Baldoyle Bay SAC; Howth Head SAC; Lambay Island SAC; Malahide Estuary SAC; Rogerstown Estuary SAC; South Dublin Bay SAC; Ireland's Eye SAC; Bray Head SAC; Wicklow Reef SAC; Ballyteige Burrow SAC; Bannow Bay SAC; Lady's Island Lake SAC; Saltee Islands SAC; Tacumshin Lake SAC; Raven Point Nature Reserve SAC; Hook Head SAC; Long Bank SAC; Carnsore Point SAC; Helvick Head SAC; Tramore Dunes and Backstrand SAC; Ardmore Head SAC; River Barrow and River Nore SAC; Blackwater River SAC; Reen Point Shingle SAC.	Afon Teifi SAC; Cemlyn Bay SAC; Bann Estuary SAC; Braunton Burrows SAC; Cardigan Bay SAC; Carmarthen Bay and Estuaries SAC; Dee Estuary SAC; Drigg Coast SAC; Dunraven Bay SAC; Anglesey Coast Saltmarsh SAC; Holy Island Coast SAC; Gower Common SAC; Isles of Scilly Complex SAC; Kenfig SAC; Limestone Coast of South West Wales SAC; Lizard Point SAC; Luce Bay and Sands SAC; Lundy SAC; Magilligan SAC; Morecambe Bay SAC; Morfa Harlech a Morfa Dyffryn SAC; Murlough SAC; Pembrokshire Marine SAC; Lleyn Penninsula SAC; Red Bay cSAC; River Usk SAC; River Wye SAC; Sefton Bay SAC; Severn Estuary SAC; Solway Firth SAC; St David's SAC; Strangford Lough SAC; The Lizard SAC; Tintagel, Marsland to Clovelly Coast SAC; Menai Straits and Conwy Bay SAC.
	Grey seal	Lambay Island SAC; Saltee Islands SAC	Cardigan Bay SAC; Carmarthen Bay and Estuaries SAC; Dee Estuary SAC; Holy Island Coast SAC; Isles of Scilly Complex SAC; Limestone Coast of South West Wales SAC; Luce Bay and Sands SAC; Lundy SAC; Morecambe Bay SAC; Pembrokshire Marine SAC; Lleyn Peninsula SAC; Strangford Lough SAC; Tintagel, Marsland to Clovelly Coast SAC; Menai Straits and Conwy Bay SAC.

Table 3.1 (Continued)

Element of the Plan with potential to cause impact	Elements of the Site with potential to be impacted	Natura 2000 Site Details	
		Irish Coastline	Transboundary (UK Coastline)
Coastal Natura 2000 sites			
Accidental hydrocarbon spills (continued)	Harbour porpoise	Roaringwater Bay and Islands SAC	Cardigan Bay SAC; Isles of Scilly Complex SAC; Lundy SAC; Pembrokshire Marine SAC; Lleyn Peninsula SAC; Solway Firth SAC
	European otter	Lower River Suir SAC; River Barrow and River Nore SAC; Blackwater River SAC; Roaringwater Bay and Islands SAC	Afon Gwyrfai a Lyn Cwellyn SAC; Afon Teifi SAC; Bann Estuary SAC; Carmarthen Bay and Estuaries SAC; Cladagh River SAC; Coedydd Aber SAC; Meirionnydd Oakwoods and Bat sites SAC; Cors Focho SAC; Anglesey Fens SAC; Dee Estuary SAC; Exmoor and Quantock Oakwoods SAC; Glynifon SAC; Limestone Coast of South west wales SAC; Magilligan SAC; Murlough SAC; Pembrokshire Bat Sites and Bosherston Lakes SAC; Pembrokeshore Marine SAC; Lleyn Peninsula SAC; River Dee and Bala Lake SAC; River Derwent and Bassenthwaite Lake SAC; River Faughan and Tributaries SAC; River Foyle and Tributaries SAC; River Roe and Tributaries SAC; River Usk SAC; River Wye SAC; Strangford Lough SAC; Tintagel, Marsland and Clovelly Coast SAC; Solway Firth SAC;
	Bottlenose dolphin	None anticipated	Cardigan Bay SAC, Pembrokeshire Marine SAC, Lleyn Peninsula SAC, Isles of Scilly Complex SAC; Lundy SAC
	Sea lamprey, river lamprey, Twaite shad, Allis shad and Atlantic salmon	Lower River Suir SAC, River Barrow and River Nore Sac, Blackwater River SAC	Menai Straits and Conwy Bay SAC; Lleyn Peninsula and the Samau SAC, Cardigan Bay SAC; River Teifi SAC; Carmarthen Bay and Estuaries SAC; Pembrokeshire Marine SAC; River Usk SAC; River Wye SAC; Bann Estuary SAC; River Faughan and tributaries SAC; Murlough SAC; River Bladnoch SAC; Solway Firth SAC; Morecambe Bay SAC; Dee Estuary SAC; Severn Estuary SAC

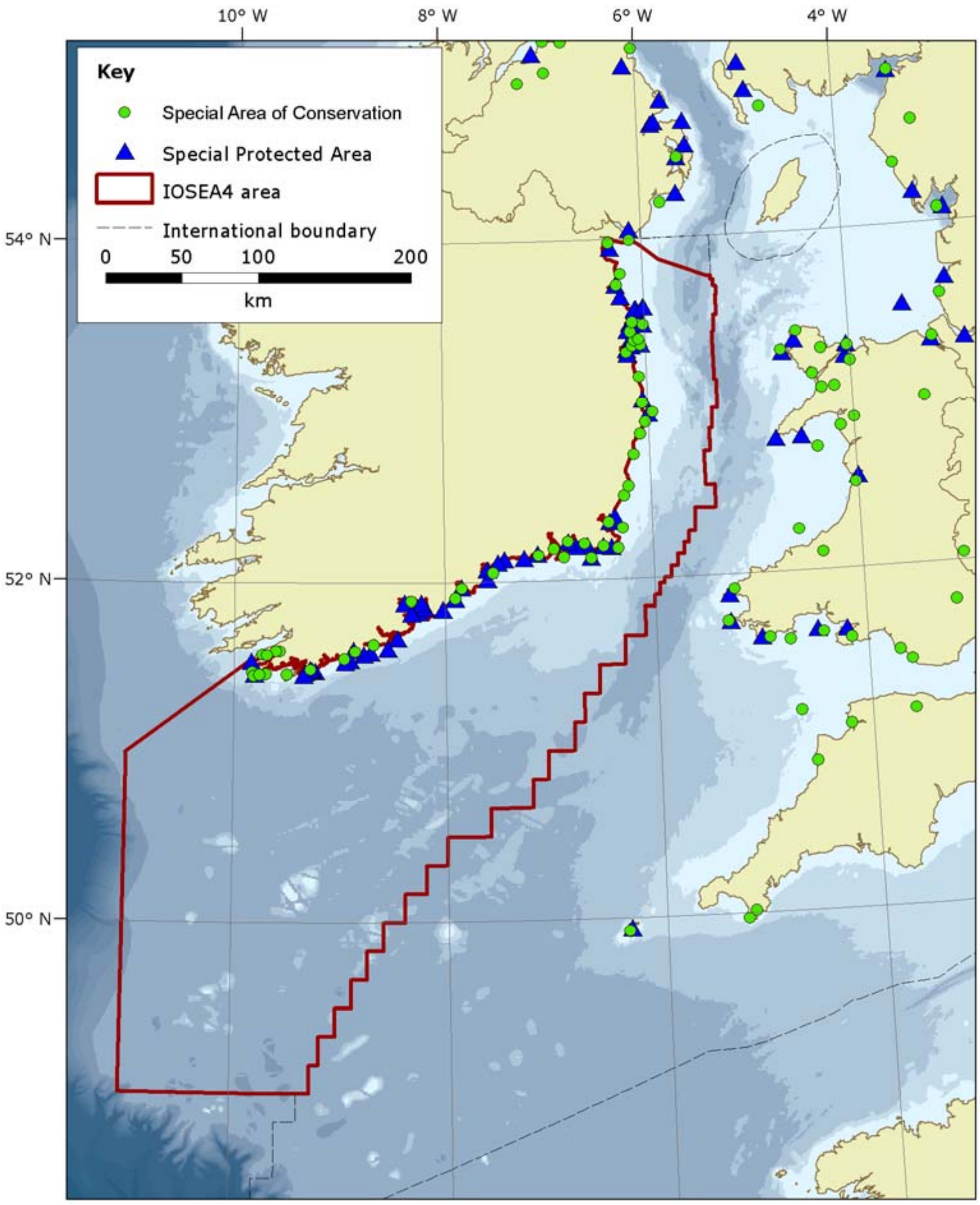
Table 3.1 (Continued)

Element of the Plan with potential to cause impact	Elements of the Site with potential to be impacted	Natura 2000 Site Details	
		Irish Coastline	Transboundary (UK Coastline)
Coastal Natura 2000 sites			
Accidental hydrocarbon spills (continued)	Overwinter and/or Breeding seabirds	All SPAs listed in Table 2.6 of this document	All SPAs listed in Table 2.7 of this document.
Seismic survey, acoustic disturbance	Grey seal	Lambay Island SAC; Saltee Islands SAC	None anticipated
	Grey seal; harbour porpoise	Roaringwater Bay and Islands SAC	None anticipated
	European otter	Lower River Suir SAC; River Barrow and River Nore SAC; Blackwater River SAC; Roaringwater Bay and Islands SAC	None anticipated
Disturbance from drilling activities	Subtidal biogenic reefs	Wicklow Reef	None anticipated
	Subtidal reefs	Roaringwater Bay and Islands SAC; Hook Head SAC	None anticipated

3.2 Sites Description

Given the proximity of the coast in the IOSEA4 area, 28 of 44 SACs on the Irish south and east coasts and all SPAs have been identified as having the potential to be affected by the Draft Plan, as a result of the possibility of accidental hydrocarbon spills reaching nearshore waters and beaching. In addition, consideration of possible transboundary impacts has identified a further 43 SAC sites along the UK coastline, together with 31 SPAs requiring consideration. The identified sites are shown in Figure 3.1.

Figure 3.1 Coastal Natura 2000 sites potentially affected by the Draft Plan



3.3 Potential Impacts

3.3.1 Accidental hydrocarbon spills affecting designated sites/species

Both the likelihood of hydrocarbon spill occurrence and the behaviour of hydrocarbons at sea are discussed in section 2.5.3 of the screening section of this report, which also highlights the importance of numerous variable factors in determining the significance of potential oil spill impacts on the environment. These factors will include; type of oil, thickness of shore deposits; climate and season; biological and physical characteristics of the area and sensitivity of the affected species and community. The potential for environmental damage caused by an oil spill therefore varies with different areas of the marine environment.

Special Areas for Conservation

These habitats provide feeding and roosting grounds for a substantial list of native and visiting waterfowl and seabirds including a number of Annex I designated bird species within the SAC citations.

The estuaries, mudflats and sand flats listed in Table 3.1 are also of importance for migrant waterfowl in spring and autumn.

Potential impacts affecting SAC habitats in the event of an accidental hydrocarbon spill could be expected to include (IPIECA, 1999):

- Physical smothering of organisms (particularly in the event of formation of asphalt pavements or oil crusts);
- Penetration of oil into soft sediments potentially causing toxic conditions for resident species (worms, molluscs, crustaceans) with resultant impacts on viability of sediments as feeding grounds, affecting food source for bird and other species;
- Sub-lethal toxicological effects which may be magnified up the trophic levels;
- Direct oil contact affecting a range of species; bird species flight ability, thermoregulation capacity and resulting in potential toxicological and respiratory impacts.
- Impacts on breeding success of designating species.

Based on data relating to hydrocarbon spill risks from both Irish and the adjacent UK oil and gas sectors (section 2.6.5), the probability of significant quantities of hydrocarbons reaching the Irish coast and posing a threat to the integrity of European sites is small and is further reduced by mitigation measures in place and by the requirements set out within the Oil Spill Contingency Plan (OSCP) which will be applied to each individual drilling activity.

Designating marine species within these SACs comprise: harbour porpoise, grey seal and European otter; also certain species of lamprey and shad, along with Atlantic salmon which use the SACs identified within Table 3.1 as freshwater spawning grounds.

- Harbour porpoise: It has been rare for cetaceans to be affected following a spill; they may be able to avoid affected areas and are not believed to be susceptible to the physical impacts of oil and oil emulsion lowering their resistance to the cold. However on an individual level contact with oil may cause irritation of the skin and mucus membranes. Volatile hydrocarbon fractions may also cause respiratory problems. Chronic ingestion of subtoxic quantities of oil may have subtle effects which would only become apparent through long-term monitoring. The transfer of hydrocarbons through the mother's milk to suckling young is another way oil affects cetaceans. It is also possible that oil pollution impairs cetacean immune systems and causes secondary bacterial and fungal infections.
- Grey seal: Seals are susceptible to oiling and the contamination of food sources, particularly in the coastal areas around their colonies, where their density is highest. While they come ashore throughout the year, the majority of grey seals remain close to shore during the breeding and moulting seasons, September to April. Harbour seals undergo a similar cycle between June and September, although they continue to forage at sea throughout their breeding season. New born pups are considered most at risk from oil coming ashore. Further details of potential impacts on seals are set out in section 2.6 of this report. The potential for significant impact of hydrocarbon spills on seal populations is expected to be seasonal and limited to those periods of time when the population is close to shore, during breeding and moulting.
- European otter: There is little evidence to qualify possible impact on European otters by oil spills, although food sources may be contaminated. However, thermoregulatory abilities of otters (and seals) can be impaired when their fur comes into contact with oil.
- Freshwater spawning fish species: These fish species are migratory, utilising the three SACs identified within the IOSEA4 area only at certain times of year whilst returning to freshwater spawning grounds above the zone of tidal influence. Peak spawning periods for fish species within the IOSEA4 area and adjacent coastal areas occur from February to June. Fish populations remain relatively unaffected by oil pollution in the offshore environment as oil concentrations below the slick are generally low. The potential for significant impact of hydrocarbon spills on designated fish species is therefore expected to be seasonal and limited to those periods of time when these species are in shallow, near-shore waters. Nursery breeding grounds for these designated fish species are identified in freshwater above the

zone of tidal influence and therefore outwith the coastal zone considered most at risk of oil pollution from an oil spill at sea.

Special Protection Areas

All SPAs along the adjacent Irish Coastline have been identified for further consideration. There are 44 SPAs designated along the IOSEA4 area coast. Many of these sites are also covered by other European or international designations including SAC and Ramsar. Notwithstanding the very low likelihood of a hydrocarbon spill event occurring, the bird populations within the SPAs are considered vulnerable both to:

- direct physical effects of fouling affecting capacity for flight, thermo-regulation etc, impacting potentially large numbers of individual birds; and
- toxicological impacts of spilled hydrocarbons washing up onto the coastal zone creating a pathway for toxicity to enter the lower trophic levels supporting the designating bird assemblages.

Impact on SPA objectives for many sites could also be expected to be seasonal in nature.

Fifteen SPAs are designated for their breeding seabird assemblages. These designations include for the protection of breeding assemblages of various species currently (or previously) of conservation concern including herring gull, kittiwake and cormorant. In addition, within 12 of these, peregrine falcon (*Falco peregrinus*), and chough (*Pyrrhocorax* spp) are listed as Annex I species. These sites are; Ballyteige Burrow SPA, Bannow Island SPA, Helvick Head Coast SPA, Helvick Head to Ballyquin SPA, Mid Waterford Coast SPA, Howth Head Coast SPA, Irelands Eye SPA, Wicklow Head SPA, Old Head of Kinsale SPA, Seven Heads SPA, Galley head to Duneen Point SPA and Sheep's Head to Toe Head SPA.

The impact on breeding colonies and bird populations depends upon the existence of a reservoir of young non-breeding adults from which they can be replenished and the reproductive rate of the impacted species. There is no evidence that oil spills have permanently damaged any seabird populations, but any small indigenous populations, or species that are clustered may be at risk. (DCENR *et al*., 2011).

The peregrine falcon is known to breed in early spring on sea cliffs and ledges and feed largely on other birds. Although a designating species based on concerns as a result of severe population decline in 1960s and 1970s, the peregrine falcon is now a green-listed species, no longer of European Concern (Lynas *et al*., 2009). The chough, resident along rocky coasts is amber-listed in Ireland due to a moderate decline in population. Given the known nesting and feeding habits of the peregrine falcon, this species is considered most vulnerable to impacts affecting the food sources on which they rely. The chough, as a species feeding directly on insects and larvae and on worms and other subterranean invertebrates, is considered vulnerable to direct impacts of oiling from hydrocarbons in the intertidal zone during feeding and also the toxicological effects of food source contamination.

A further 27 SPAs are designated for their overwintering bird assemblages (both waterfowl and seabirds). Direct impacts from oiling on individual birds could occur within any of the SPA designations in the event that spilled oil is carried into the inshore zone. Outwith the designated area of the SPAs, particularly sensitive offshore birds such as auks and divers may be at greatest risk whilst at sea. A number of SPAs along the Irish coastline within the IOSEA4 area are designated particularly for their overwintering populations of a number of diver species of conservation concern including red throated diver and the great northern diver. On this basis, risk of impact on the SPA designation for overwintering birds and the species which they are designated to protect is considered to be most likely for SPAs designated for red throated diver and or great northern diver. These SPAs comprise: Dundalk Bay SPA, Murrough SPA, The Raven SPA, Courtmacsherry Bay SPA.

3.3.2 Acoustic disturbance from seismic activity affecting designated sites/species

Potential for acoustic disturbance from seismic activity has been identified affecting the following Annex II species: harbour porpoise, grey seal and European otter; also a number of anadromous fish species. The SACs with which these species are associated along the IOSEA4 Irish coastline are set out in Table 3.1 above.

As discussed in section 2.5.2 the well-developed ear and neural auditory centre of marine mammals suggest that hearing is the primary sensory system (Ketten *et al.*, 2007). Marine mammals do not however hear equally well at all frequencies. The harbour porpoise is considered to be a high frequency cetacean (200 Hz to 180 Hz) with the grey seal hearing frequency estimated at a much lower frequency (c. 75 Hz in water and ranging between 75 Hz and 30 Hz in air) (Table 2.11).

Southall *et al* 2007 developed a set of injury criteria for individual low, mid and high-frequency marine mammals which indicate that the sound threshold for pulse sounds including for high-frequency cetaceans such as the harbour porpoise lie at the top end of the sound levels produced by large 2D or 3D seismic survey arrays. In addition, Gordon *et al* (2004) report a study which shows no change in the detection of harbour porpoises during two seismic surveys. OSPAR (2009a) reports Finneran *et al* (2005) which concludes that Temporary Threshold Shifts (TTS) might occur within odontocetes if animals were exposed to airgun discharges within 5 m of the gun. Other studies demonstrate avoidance activity up to and above 1 km from the noise source. (see section 2.4.2 for further details). Whilst the Irish Sea is considered particularly sensitive for harbour porpoise calving between February and June, there is no evidence of temporary avoidance behaviour affecting calving success.

Seismic survey activity within or close to the Roaringwater Bay and Islands SAC may affect the population of harbour porpoise for which the site is designated.

Grey seals spend most of the year at sea, and may range widely in search of prey. A study on the foraging behaviour of grey seals in southwest Ireland is currently underway; telemetry devices attached to grey seals from the Blasket Island colony will provide information on their offshore distribution, range and behaviour (Cronin, Coastal and Marine Research Centre (CMRC), *pers comm*). Data collected during Irish Whale and Dolphin Group (IWDG) and Galway-Mayo Institute of Technology (GMIT) cetacean surveys show grey seals may be found throughout the Irish Sea and up to 200 km from land over the Irish Shelf and Porcupine Bank (Wall, (IWDG) *pers comm*). Section 2.5 documents the few studies on the effects of airgun noise on seals and other pinniped species that have been carried out to date which indicate an initial fright response followed by temporary alteration in feeding behaviour but with normal behaviour returning within a few hours of the air guns being switched off.

Seismic survey activity within or close to Lambay Island SAC; Saltee Islands SAC and Roaringwater Bay and Island SAC may affect population of grey seals for which the sites are designated. Any proposed survey activity within or adjacent to these SAC boundaries should be subject to a site specific Appropriate Assessment study, and give consideration to the possible mitigation measures set out below.

The European otter is largely a freshwater mammal. Individuals occupying coastal territories tend to remaining within a 3 to 4 km area of coastline, where freshwater is also readily available for cleaning their fur after exposure to saltwater (Chanin, 2003). When diving, an otter closes both its nostrils and ears and is estimated to remain underwater for no more than 20 seconds for each dive.

Chanin (2003) also acknowledges unpublished observations which indicate that otters will rest under roads, in industrial buildings, close to quarries, and at other sites close to high levels of human activity. These observations suggest that otters are reasonably flexible in their behaviour and do not necessarily avoid 'disturbance' in terms of noise (or proximity to human activity). There is no available evidence specifically related to reaction of otters to seismic survey noise.

Based on these key characteristics of species behaviour and considered within the context of the temporary, short term and subsurface nature of seismic survey acoustics within the IOSEA4 area, it is considered likely that only otter territories within the immediate IOSEA4 area are likely to experience any sort of acoustic influence from these activities, if conducted close to or within the SAC boundaries (see Table 3.1 for list of SAC sites to which this may apply).

River and sea lamprey, Twaite and Allis Shad and Atlantic salmon are all identified as designating species in Lower River Suir SAC, River Barrow and River Nore SAC, and the Blackwater River SAC. Popper (2003) identifies significant similarities between the sensory receptors used by fishes to detect sounds and those of marine and terrestrial mammals, and, as a consequence, sounds that damage or in other ways affect marine mammals may have similar consequences for fishes. Physiological damage to hearing apparatus of some fish species has been reported (e.g. damage to hair cells at less than 500 m from a seismic array, (McCauley *et al.*, 2003). It should however be noted, in contrast to McCauley *et al.* (2003), that Popper *et al.* (2005, in Song *et al.*, 2008) exposed several different species of fish to shots from a small seismic air gun array in a river and found no damage to sensory hair cells of the ear.

Seismic survey activity within or close to the three SACs listed, within sensitive times of the year, may therefore affect the individuals of the fish species for which the site is designated, although the current evidence is inconclusive.

3.3.3 Disturbance from drilling activity

Three Natura 2000 sites designated for subtidal reef features within the IOSEA4 area have been identified as potential at risk from direct disturbance from drilling activities. These are Wicklow Reef SAC, Roaringwater Bay and Islands SAC, and Hook Head SAC.

As documented within Section 2.6, physical disturbance is the dominant mechanism of ecological disturbance where WBMs and cuttings are discharged (DTI, 2001). Physical disturbance will result from both the drilling activities and associated deposition of WBM drill cuttings, and also from localised disturbance and damage through placement of anchors and chains.

This activity conducted within the boundaries of these SACs could have significant and direct detrimental effect on the reef structures and the communities which they support, both within the vicinity of the wellhead and at anchor placement points.

Potential impacts on the benthic communities in close proximity to specific wellheads are also documented in Section 2.6. Localised increases in suspended solids as a result of WBM discharge in the near-seabed water-layer may affect marine organisms through abrasion of protective mucous layers, respiratory impairment and disruption to feeding processes. Filter feeding fauna such as the reef building honeycomb worm within the Wicklow Reef SAC would be particularly at risk from these effects as a result of suspended matter foul the ciliary feeding mechanism (Wells, 1970 in UK Marine SAC Project, 2011).

The majority of the protected sites in Ireland are close to the coast and consist of dynamic environments that readily recover from disturbance and damage. For example numerous SACs are identified here for *mudflats and sandflats not covered by seawater at low tide.* Impacts associated with scraping and dragging of anchors and chains in these areas are likely to be minor with good potential for rapid recover due to the dynamic nature of tidal, wave and sediment transport regimes in coastal areas and associated with sandbanks.

3.3.4 Cumulative Effects

The total activity forecast for the IOSEA4 area Draft Plan indicates a maximum 180 exploration, appraisal and development wells will be drilled between 2011 and 2021. Based on probabilities outlined in Section 2.6.5 the incremental risk of significant hydrocarbon spill is low. The cumulative effect of hydrocarbons entering the marine environment from spills associated with exploration, appraisal and development drilling is likely to be negligible when considered against other natural and anthropogenic sources. A corresponding accumulated impact on Nature 2000 sites is also likely to be negligible.

How different noise sources might act cumulatively upon marine mammals, and specifically the harbour porpoise for which Roaringwater Bay and Islands SAC is designated, has been identified as a key data gap in current understanding (e.g. Wright, 2008).

3.3.5 Transboundary Effects

Transboundary impacts on the UK marine environment are considered to be the same, or more usually less than for Irish Natura 2000 sites (as discussed above). Given the distance to any European designation on the UK coastline, the risk of significant disturbance to the European protected species at any UK site from seismic survey activity is considered to be low.

As a result the potential for UK Natura 2000 sites to be affected by accidental hydrocarbon spills is the only potential transboundary impact brought forward for consideration within the appropriate assessment. The likelihood of a large spill occurring is considered to be very low. Potential impacts on designated sites, along with the Annex I bird species and Annex II species grey seals, harbour porpoise and European otter are discussed in section 3.3.1. The discussion applies equally to the transboundary sites which may be affected as listed within Table 3.1.

In addition, potential impacts on the Annex II species bottlenose dolphin may occur in relation to a number of SAC designations along the UK coastline, as listed in Table 3.1.

Considered within the context of hydrocarbon behaviour at sea as discussed in section 2.5.4, it is unlikely that anything other than a large ‘worst case' spill would have implications for transboundary

Natura 2000 sites along the UK coastline. However, risk of impact to protected population of bottlenose dolphin is considered to be greatest within or associated with the three closest SACs designated for this species in Wales; the Cardigan Bay, Pembrokeshire Marine and Lleyn Peninsula SACs. The other two UK SAC designations which include the bottlenose dolphin are the Isles of Scilly Complex and Lundy. Both of these sites are also considered to be theoretically within reach of a major hydrocarbon spill event within the IOSEA4 area.

3.4 Mitigation Measures

3.4.1 Accidental hydrocarbon spills affecting designated sites/species

It is clear that numerous sensitive Natura 2000 sites exist within the potential zone of influence of the IOSEA4 area. The likelihood of a large spill occurring is considered to be very low. Considered within the context of the site-specific modelling requirements for each individual exploration drilling project, which will identify any additional spill control measures required to supplement those already in place (either integral with good practice or with regulatory systems or both) (section 2.6), it is unlikely that the Draft Plan will compromise the integrity of these sites or species populations.

Wide ranging measures are already in place, either integral with good practice or with regulatory systems, or both. These are discussed in more detail in section 2.6 of this report. All operations, where appropriate, shall apply best available technologies, best environmental practice and clean technology. In addition an OSCP is required under the Sea Pollution (Amendment) Act 1999, and this requirement is re-stated in the DCENR Rules and Procedures Manual (DCENR, 2011). The OSCP is designed to assist the decision-making process during an oil spill, indicate what resources are required to combat the spill, minimise any further discharges and mitigate its effects. The OSCP must be submitted to the Irish Coastguard for approval.

It is however recommended within the IOSEA4 Environmental Report (DCENR *et al*, 2011) that further site-specific environmental assessment be carried out for individual drilling activities within the parts of the IOSEA4 area in close proximity to designated European sites. This recommendation also applies in this instance, and states:

> *The Minister should, in certain circumstances, consider requesting the submission of a more detailed assessment up to and including an EIS. Criteria which might indicate or support this greater level of assessment could include:*
>
> - *Distance from distance from offshore European sites, coastline and international boundaries;*
> - *proximity to vulnerable concentrations of marine mammals or seabirds;*
> - *the presence of spawning, nursery and fishing grounds for commercially valuable fish and shellfish species;*
> - *proximity to features of ecological interest identified within Annexes to the Habitats Directive and OSPAR;*
> - *where proposed operations may significantly interfere with other sea users, including recognised areas of high density shipping and offshore developments relating to energy generation.*

3.4.2 Acoustic disturbance from seismic activity affecting designated sites/species

Roaringwater Bay and Islands SAC is designated in part for the Annex II species, harbour porpoise.

Lambay Island SAC and Saltee Islands SAC are designated in part for the Annex II species, Grey seals.

Lower River Suir SAC, River Barrow and River Nore SAC, and Blackwater River SAC are designated in part for various fish species.

The NPWS has issued guidelines entitled '*Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters Version 1.1*' (NPWS, 2007) that have been developed to assist in mitigating against potential impacts on marine mammals from seismic noise. It is a DCENR requirement that all Operators incorporate these into seismic survey plans. These guidelines highlight a number of measures that should be applied, including:

- The minimum source level required to achieve results should be used and frequencies chosen to minimise impacts on marine mammals;
- Qualified and experienced Marine Mammal Observers (MMOs) must be present on board all vessels conducting seismic surveys;
- MMOs must be engaged solely in monitoring the Operator's implementation of these guidelines and conducting visual/acoustic observation of mammals during the survey;
- The MMO must submit a report to the relevant Licensing Authority;
- MMOs must scan for cetaceans 30 minutes before a soft start and there must be no cetaceans within 1km of the array. If animals are spotted, the operation must be delayed until none have been sighted within the 1km zone for 30 minutes. If water depth exceeds 200 m then the scanning period must last for 60 minutes; and
- The soft start should involve the power in the air guns being built up slowly over 20 - 40 minutes to give marine mammals adequate time to hear the noise and leave the vicinity. This 'soft' start process should be adopted every time air guns are used, even if no marine mammals are seen, and if air guns have stopped and not restarted after five minutes.

Further site-specific Appropriate Assessment should be conducted for a specific seismic activity proposed within or close to the boundary of the Roaringwater Bay and Islands SAC, prior to any survey commencing.

3.4.3 Disturbance from drilling activity

Site-specific Appropriate Assessments should be required for operations in or adjacent to the identified SACs in conjunction with environmental area assessment (EAA) which is required at an individual application stage for exploratory drilling activities.

Site specific AA should look at anticipated deposition pattern for a specific drilling activity based on water depth and current and the use of drill cutting deposition modelling should be considered (subject to the limitations of input data and modelling assumptions.

3.4.4 Cumulative and Transboundary Mitigation

In the event that there is a requirement for multiple surveys in the same area and at the same time, it is recommended that these are combined into consecutive surveys through appropriate planning and cooperation. If surveys must be carried out simultaneously, consideration should be given to the location of surveys in relation to each other, so that marine mammals have the chance to avoid these areas where necessary and migration routes are not impeded. Seismic surveys tend to interfere with each other if carried out simultaneously and within 100 km of each other, so the issue of survey co-ordination in this respect should also meet this concern.

With regard to accidental events, any loss of well control likely to result in transboundary impacts will be reported to the UK authorities. The Irish Coast Guard has a close working relationship with the UK Maritime and Coast Guard Agency (MCA) and a draft Service Level Agreement for co-operation on search and rescue and oil spill response is in place. The Irish Coast Guard and the UK MCA also regularly conduct joint search and rescue and oil spill response exercises.

3.5 Residual Potential Impacts

3.5.1 Accidental hydrocarbon spills affecting designated sites/species

On the basis of accidental events statistics compiled for offshore exploration activity, the risk of a major crude oil spill or gas blowout during exploration, appraisal and development drilling is considered to be very low. Historical data suggest that small diesel spills from rigs and vessels of less than one tonne represent the most likely oil spill scenario. Impacts from diesel spills of this magnitude and frequency would be negligible.

The risk of a major accident during seismic survey activity, such as a collision with another vessel, causing the loss of the streamer oil reservoir and/or diesel fuel from the vessel is considered to be very low. Historical data suggest that small diesel spills and streamer oil spills of less than one tonne will represent the most likely oil spill scenario. Impacts from these spills are likely to be Minor offshore, but Minor to moderate in coastal situations.

However, although unlikely, the residual impact of a worst case scenario major hydrocarbon spill affecting any or many Natura 2000 sites remains potential significant, regardless of mitigation.

3.5.2 Acoustic disturbance from seismic activity affecting designated sites/species

On the basis of this discussion and the required and established mitigation measures set out above, the risk of significant impact of seismic activity on marine mammals associated with designated SAC sites is considered to be low. A detailed assessment of potential impacts of the IOSEA4 Draft Plan on cetacean species is also set out within the IOSEA4 Environmental Report (DCENR *et al*., 2011)

3.5.3 Disturbance from drilling activity

Potential impacts from drilling discharges and disturbance to the seabed through anchoring, whilst generally minor or moderate, assume a higher significance in the context of potential Annex I habitats within the IOSEA4 area, particularly gas related seabed structures. In the event of drilling occurring directly through designated reef features, the risks of adversely affecting the integrity of the benthic ecological features within these habitats remain potentially significant regardless of mitigation.

3.5.4 Transboundary and Cumulative Impacts

The eastern edge of the IOSEA4 area is confluent with the Irish-UK boundary line. Despite this proximity, both the nature of exploration drilling activities and their anticipated small scale mean that the potential for significant transboundary impacts on UK Natura 2000 sites is limited to underwater noise arising from seismic survey activity near the border and to accidental events.

Any transboundary impacts with regard to noise during seismic surveys and drilling activity will be limited in scale and of very short duration. With appropriate notification and cross-border co-operation between departments and agencies, and knowledge of the environmental sensitivities in an area, the potential for transboundary and or cumulative impacts should be minor or negligible.

3.6 Recommendations

Areas that include or may include habitats or species listed in Habitats Directive Annex I, II and IV and OSPAR Annex V in the Irish and Celtic Seas should be included for licensing at this stage, but treated as sensitive areas. Subject to the additional recommendation (below) being adopted, exploration drilling in these specific areas should be subject to EIA and regulated to avoid direct damage to such features and their biological communities. This will require appropriate site-specific survey.

Site-specific Appropriate Assessment should be carried out for specific seismic survey proposals or drilling activities proposed in or close to the following SAC boundaries:

- Wicklow Reef SAC;
- Roaringwater Bay and Islands SAC;
- Hook Head SAC;

In addition to site specific AA, the Minister should, in certain circumstances, consider requesting the submission of a more detailed assessment up to and including an EIS. Criteria which might indicate or support this greater level of assessment could include (inter alia):

- Distance from offshore European sites, coastline and international boundaries;
- Proximity to vulnerable concentrations of marine mammals or seabirds; and
- Proximity to features of ecological interest identified within Annexes to the Habitats Directive and OSPAR.

All specific seismic survey proposals should be drawn up following the guidelines set out within the NPWS guidelines entitled 'Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters Version 1.1' (NPWS, 2007).

Section 4

Conclusions

4 Conclusions

During this Appropriate Assessment it has been established that under normal operating circumstances and taking account of the mitigation measures already in place relating to individual exploration activities the Draft Plan will not compromise the integrity of the sites under consideration.

However, it is recommended that site specific Appropriate Assessment studies should be carried out for the following activities:

- Seismic survey activities in, or in close proximity to the Roaringwater Bay and Islands SAC;
- Direct drilling activities proposed within, or in close proximity to the Wicklow Reef SAC and also the Hook Head SAC and the Roaringwater Bay and Islands SAC.

Whilst it is considered that the risk of a major hydrocarbon spill as a result of the Draft Plan activities is considered to be very low, given the close proximity of the IOSEA4 area to the sensitive coastlines, not only of Ireland but also to the Welsh coastline and other sensitive locations along the UK western coastline between the Isle of Scilly to the south and the Dumfries and Galloway coast to the north, the consequence of a spill is unpredictable at this stage and should be subject to further specific oil spill risk assessment at individual project level.

Taking into account all the matters discussed, and provided that the above measures are implemented, it can be concluded that continued assessment is required at individual project level to ensure that the proposed plan will not adversely affect the integrity of any relevant Natura 2000 sites

Section 5

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5 References

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Section 6

Abbreviations

6 Abbreviations

AA	Appropriate Assessment
BOP	Blow out preventer
CRI	Cuttings re-injection
cSAC	candidate Special Area for Conservation
SAC	Special Area for Conservation
SPA	Special Protection Area
dB	Decibel
DCENR	Department of Communications, Energy and Natural Resources
DP	Dynamic Positioning
DTI	Department for Trade and Industry
EAA	Environmental Area Assessment
EC	European Commission
EIS	Environmental Impact Statement
ENVID	Environmental Issues Identification
EOSG	Expanded Offshore Support Agency
EPA	Environmental Protection Agency
GSI	Geological Survey of Ireland
HOCNF Scheme	Harmonized Offshore Chemical Notification Scheme
HSE	Health and Safety Objective
Hz	Hertz
IOSEA4	Fourth Irish Offshore Strategic Environment
IROPI	Imperative reasons of overriding public interest
kHz	kilohertz
km	kilometre
MCA	Maritime and Coast Guard Agency
MDAC	Methane-derived authigenic carbonate
MMO	Marine Mammal Observer
MODU	Mobile Drilling Unit
NPWS	National Parks and Wildlife Service
NUIG	National University of Ireland, Galway
OBM	Oil Based Mud
OSCP	Oil Spill Contingency Plan
OSPAR	Oslo and Paris Convention
Pa	Pascal
PAD	Petroleum Affairs Division
PIP	Petroleum Infrastructure Programme
PLONOR	Posing Little Or No Risk
PUDAC	Permit for Use and Discharge of Added Chemicals
ROV	Remote operated vehicle
SBM	Synthetic Based muds
SINTEF	Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology
TTS	Temporary Threshold Shift
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UNEP	United Nations Environment Programme
VSP	Vertical Seismic profile
WBM	Water based muds
µPa	Micro pascal

Section 7

Glossary

7 Glossary

Acoustic: Producing or related to sound.

Appraisal drilling: Drilling carried out after the discovery of a new hydrocarbon reserves to obtain more information on their physical extent, quantities and likely production rates.

Assemblage: A group of organisms living together.

Benthic: of or relating to the seabed.

Benthic community: The assemblage of organisms living in or on the seabed.

Biogenic Reef: A mass consisting of the hard parts of organisms, or of a biogenically constructed frame enclosing detrital particles, in a body of water; most biogenic reefs are made of corals or associated organisms.

Blow out: A blowout occurs when gas, oil or saltwater escapes in an uncontrolled manner from a well.

Blow out preventer: or BOP. A hydraulically operated wellhead device that can actuated to close a well in order to prevent an uncontrolled release of fluids (blow out).

Bunkering: Refuelling a ship or drilling rig.

Cetacean: A member of the order Cetacea, which are aquatic mammals comprising porpoises, dolphins and whales.

Check-shot survey: - A type of borehole seismic survey designed to measure the seismic travel time from the surface to a known depth.

Crude oil: - A general term for unrefined petroleum or liquid petroleum.

Cuttings re-injection: A method for the disposal of drill cuttings where they are mixed with water to form a slurry and pumped at high pressure down a separate injection well.

Drill cuttings: Rock chips produced by chipping and crushing action of the drill bit.

Drilling mud: Drilling muds are fluids circulated down a well during drilling. They are usually water- or oil-based and contain clay (bentonite or barium sulphate). The main functions of drilling mud/fluid are to lubricate the drill bit, remove cuttings and to maintain down-hole pressure.

Dynamic position system (DP): A system of computer controlled propulsion units called thrusters that allow the stationing of a vessel without the use of anchors.

Exploration drilling: See exploration well. In Ireland, this is subject to an exploration license.

Exploration licence: A licence to explore for hydrocarbon reserves, issued by the government to an oil and gas operating company and typically including requirements for undertaking seismic survey and drilling. The area of exploration licence shall be expressed in terms of blocks and/or part blocks of the Williams grid.

Exploration well: A well drilled in an unproven area; also known as a wildcat well.

Flare: The burning of produced gas (or sometimes oil) on a flare stack.

Geophysical: Relating to application of physics and its methods to geological problems such as the search for petroleum.

Hydrocarbon: A compound containing only the elements of hydrogen and carbon. May exist as a solid, liquid or gas. The term is mainly used in a catch-all sense for oil, gas and condensate.

Hydrophone: Microphones used at sea to detect sound energy.

Hydrostatic pressure: The pressure exerted by overlying water.

Immiscible: Liquids which are insoluble in one another, e.g. oil and water.

Macrofauna: Referring to those animals living within sediments on the sea floor, and which are retained on a 0.5 mm mesh.

Megafauna: Large seabed animals, normally defined as those which are large enough to be seen on seabed photographs and which can be collected in trawls and dredges.

Meiofauna: Interstitial animals (i.e. microscopic and living between sediment grains) that mostly pass through a 0.5 mm mesh.

Natura 2000 sites: Natura 2000 is a European network of protected sites which represent areas of the highest value for natural habitats and rare species (See SPA and SAC).

Oil-based fluids: or oil-based mud; a drilling mud (see above) in which the main carrier phase consists of oil. Low aromatic and paraffinic oils and those mineral oil-base fluids that are neither synthetic fluids nor fluids of a class whose use is otherwise prohibited.

Passive acoustic surveys: Or passive acoustics monitoring. The use of hydrophones to detect noise and/or monitoring for the presence of marine mammals.

Pelagic: Inhabiting the water column of the sea.

Photic Zone: The layer of the ocean that is penetrated by sunlight: extends to a depth of about 200 .m

Peak pressure level is the maximum instantaneous sound pressure level attained by a signal. This metric is very commonly quoted for impulsive sounds but it does not take into account the pulse duration or bandwidth (frequency range) of a signal. Furthermore, the peak pressure is difficult to model accurately at any great distance from the source using standard broadband modelling techniques (MacGillivray and Chapman, 2005). While peak levels may be useful measures from the perspective of those involved in seismic profiling, they are not particularly meaningful as stand-alone measures of how sound is received by an animal from a detection or sensation point of view. Most biological receivers, the mammalian ear included, are best modelled as energy detectors, integrating intensity over a frequency-dependent time window of around 200 ms (Green, 1985, in Madsen *et al.*, 2006).

Pinnipeds: Of, relating to or belonging to the pinnipedia, an order of aquatic mammals including seals, sea lions and walrus.

Pockmarks: Pockmarks are small depressions in the seabed associated with areas of sediment; formed by fluid/gas escaping at the seabed.

Ramsar Sites: Ramsar sites are wetlands of international importance particularly for bird species designated under the Ramsar convention.

SAC: Special Area of Conservation. Protected sites designated under the EC Habitats Directive in order to conserve important habitats and species (excluding birds) and part of the Natura 2000 network (see above). A draft SAC (dSAC) is a site that has been formally recommended to the government, and remains as such until it has had approval to go out to formal public consultation. A possible SAC (pSAC) is a site that has had government approval to go to consultation, prior to submission to the European Commission. A candidate SAC (cSAC) is site that has been proposed as an SAC and which is awaiting approval from the European Commission. Following approval from the European Commission, the government then formally designates a site as an SAC. Regardless of where a site is on the path to approval, it retains the same legal protection afforded to fully approved SACs.

Seismic air gun: A loud sound source used in seismic sound sources and receivers on streamers towed behind a seismic survey vessel.

Seismic array: A geometric arrangement of seismic sound sources and receivers on streamers towed behind a seismic survey vessel.

Seismic survey: A technique for determining the structure of underground rock formations bysending energy waves or sound waves into the earth and recording the wave reflections. Three-dimensional seismic surveys provide enhanced data for determining well locations.

Sound pressure level, or **SPL**, is the decibel level of the mean square pressure over a fixed time period.

Sound exposure level, or **SEL**, is a measure of energy, defined as the dB level of the time integral of the squared-instantaneous sound pressure normalised to a 1 second period. This can be a very useful metric for assessing cumulative exposure because it enables sounds of differing exposures to be compared in terms of total energy. Underwater, SEL is measured in dB re 1 μPa^2-s (Southall *et al.*, 2007).

SPA: Special Protection Areas are sites designated by the Government under the European Birds Directive to protect certain rare, vulnerable and regularly occurring migratory bird species. Along with SACs, SPAs form part of Natura 2000 (see above).

Streamer: A flexible clear plastic tube containing groups of hydrophones used for marine seismic surveys.

Water column: The open water of the ocean between the surface and the floor.

Wetlands: A lowland area, such as a marsh, or swamp saturated with water.

Zonation: Distribution of plants or animals arranged along an environmental gradient such as water depth.