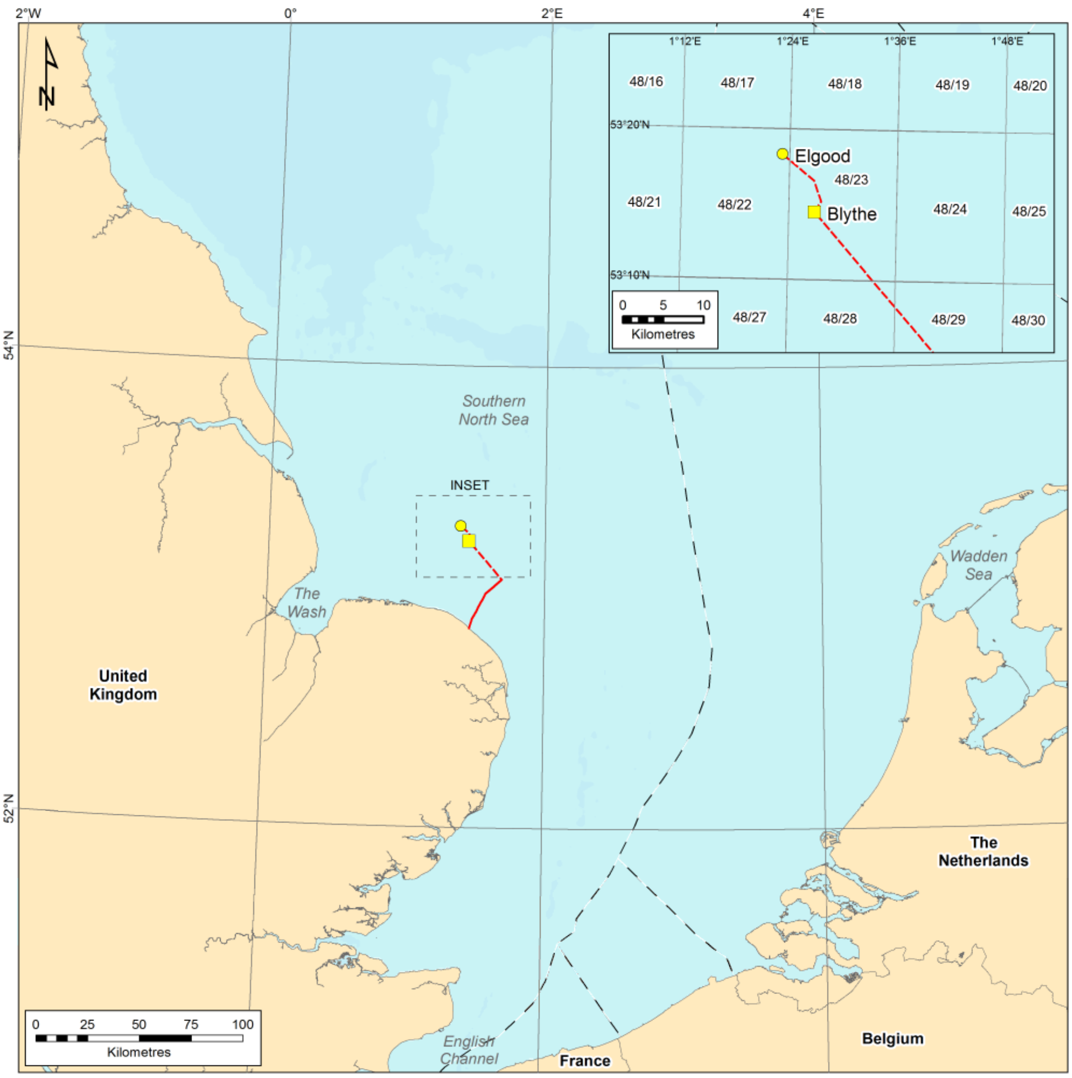
Blythe Hub Development

Environmental Impact Assessment (EIA)



D/4208/2018

ENVIRONMENTAL STATEMENT DETAILS

Section A: Administrative Information

A1 – Project Reference Number

Please confirm the unique ES identification number for the project.

Number: **D/4208/2018**

A2 - Applicant Contact Details

Company name: IOG NORTH SEA LIMITED
Contact name: Mark Routh
Contact title: Group Chief Executive

A3 - ES Contact Details (if different from above)

Company name: IOG NORTH SEA LIMITED
Contact name: Ian Pollard
Contact title: Head of HSE

A4 - ES Preparation

Please confirm the key expert staff involved in the preparation of the ES:

Name	Company	Title	Relevant Qualifications/Experience
Andrew Sutherland	Fugro GB Marine Ltd	Senior Environmental Consultant	Nine years in environmental consultancy role, in which main specialisms have been environmental impact assessment and permitting applications. MSc Ecology, BSc Zoology
Jacco Veenboer	Fugro GB Marine Ltd	Environmental Consultancy Team Leader	Eighteen years in environmental consultancy role for the offshore oil and gas industry and other marine industries. MSc Marine Resource Development and Protection, BEng Environmental Technology
Ian Stewart	Fugro GB Marine Ltd	Senior Environmental Consultant	Eleven years in environmental consultancy role, in which main specialisms have been environmental impact assessment and environmental surveys. MSc Marine Environmental Protection, BSc Ecological Science
Ian Pollard	Independent Oil & Gas	Head of HSE	Over 30 years experience of international oil and gas exploration and production, HSE management, corporate governance and risk management roles. BSc (Hons), CMIOSH

A5 - Licence Details

a) Please confirm licence(s) covering proposed activity or activities
Licence number(s): P1736 (Blythe), P2260 (Elgood)

b) Please confirm licensees and current equity

Licence Number: P1736 (Blythe) and P2260 (Elgood)	
Licensee	**Percentage Equity**
IOG NORTH SEA LIMITED	100

Section B: Project Information

B1 - Nature of Project

a) Please specify the name of the project.
Name: Blythe Hub Development

b) Please specify the name of the ES (if different from the project name).
Name: Blythe Hub Development EIA (ES Reference: D/4208/2018)

c) Please provide a brief description of the project.

Independent Oil & Gas plans to drill the Blythe and Elgood production wells, in Blocks 48/23 and 48/22, in a water depth ranging from approximately 20 – 30 m in the Southern North Sea. The objective of the development is to install a small minimum facilities platform at Blythe, and a subsea tie back at Elgood. The expected hydrocarbons are gas and condensate.

Operations are planned to commence in Q1 2019 with the installation of supporting infrastructure, followed by drilling using a jack-up in Q3 and Q4 of 2019. Additional vessels involved in the installation will include pipe lay, heavy lift and supply vessels, and tugs.

A new flowline will connect the Blythe and Elgood infrastructure to the existing Thames to Bacton pipeline PL370.

B2 - Project Location

a) Please indicate the offshore location(s) of the main project elements (for pipeline projects please provide information for both the start and end locations).

Quadrant number(s): 48

Block number(s): 22 and 23

Latitude: Longitude (W / E): 53° 14' 31.35" N, 01° 26' 51.14" E and 53° 18' 19.88" N, 01° 23' 10.31" E

Distance to nearest UK coastline (km): 35 km

Which coast? North Norfolk

Distance to nearest international median line (km): 105 km

Which line? UK/Netherlands

B3 - Previous Applications

If the project, or an element of the project, was the subject of a previous consent application supported by an ES, please provide details of the original project

Name of project: NA
Date of submission of ES: NA
Identification number of ES: NA

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INDEPENDENT
OIL & GAS PLC

Non-Technical Summary

NON-TECHNICAL SUMMARY

This environmental statement (ES) presents the findings of the environmental impact assessment (EIA) conducted by IOG North Sea Limited (IOG) for the drilling of the Blythe and Elgood production wells in Blocks 48/22 and 48/23 and the installation of supporting infrastructure to form the Blythe Hub in the Southern North Sea. The proposed Blythe Hub development is located approximately 35 km to the north of the Norfolk coast at 53° 14' 31.35" N, 01° 26' 51.14" E and 53° 18' 19.88" N, 01° 23' 10.31" E (Figure 1). The purpose of this ES is to provide an assessment of the potential environmental effects that may arise from the proposed drilling operations and to identify measures which will be put in place to minimise these effects.

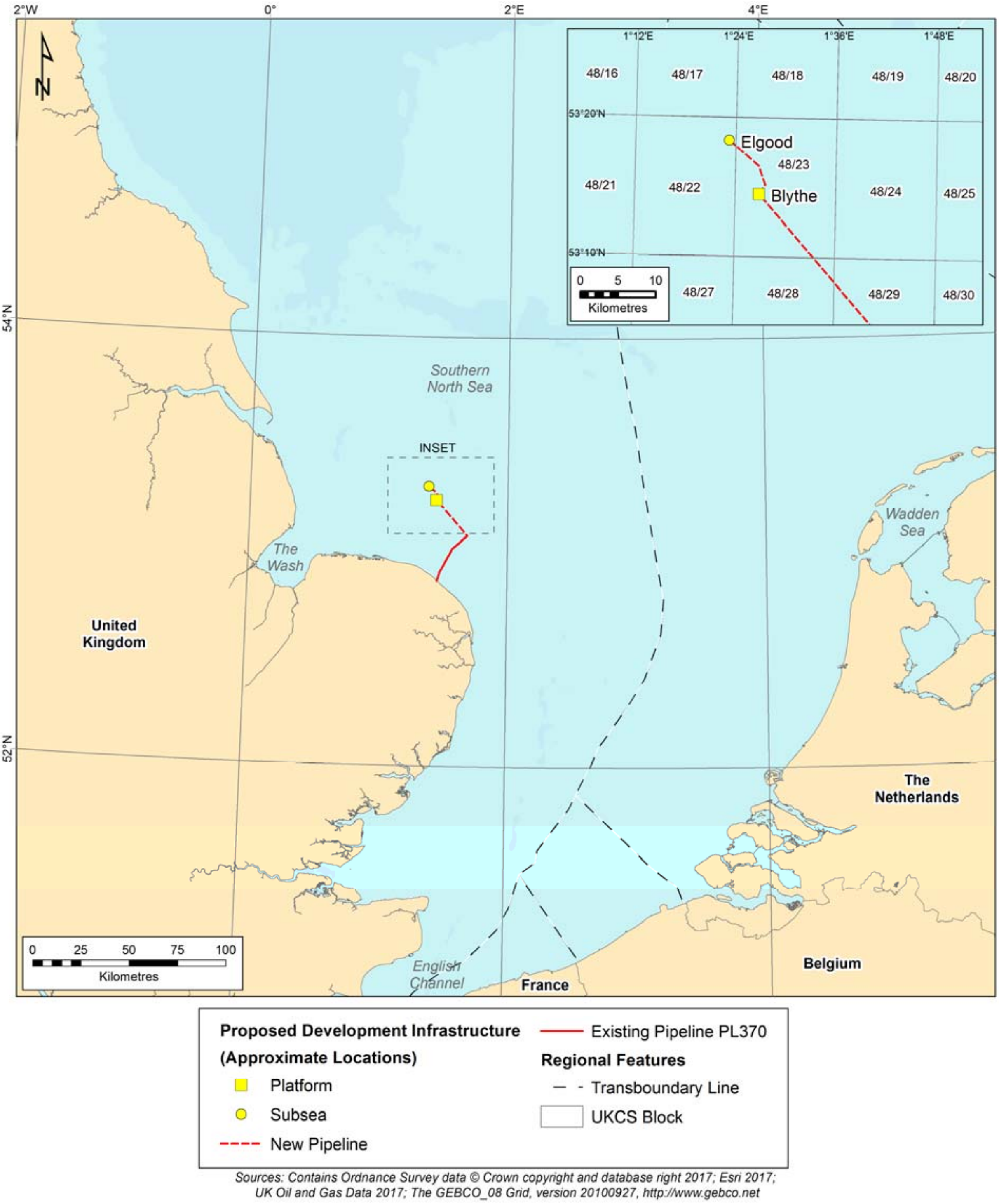

Figure 1: Location of the Blythe Hub Development

The EIA Process

Offshore drilling and production activities can involve a number of environmental interactions and impacts due, for example, to operational emissions and discharges, and general disturbance. The objective of the EIA process is to incorporate environmental considerations into the project planning and design activities, to ensure that best environmental practice is followed and, ultimately, to achieve a high standard of environmental performance. The process also allows for any potential concerns identified by stakeholders to be addressed appropriately. In addition, it ensures that the planned activities are compliant with legislative requirements.

Environmental Management

The IOG Main Board and Management Team recognise the critical importance of maintaining effective environmental management processes in the development and operation of UKCS offshore fields, and in maintaining their licence to develop the Blythe Hub.

Overall responsibility and accountability for environmental practice and compliance rests with the IOG CEO, and the Board. Leadership and commitment in all HSE aspects of IOG activities are major factors in ensuring that company values, policies and performance expectations are fulfilled.

IOG recognises the recommendations of The Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) for all operators controlling the operation of offshore installations on the UK Continental Shelf (UKCS) to have in place an EMS designed to:

- Achieve the general objectives of the OSPAR Offshore Strategy;
- Achieve the environmental goals of the prevention and elimination of pollution from offshore sources and of the protection and conservation of the maritime area against other adverse effects of offshore activities,
- Maintain continual improvement in environmental performance.

The IOG EMS:

- Is implemented at a strategic level, being driven by the CEO as an integral part of the corporate aspirations and growth of the IOG enterprise;
- Is designed to deliver and manage compliance with environmental laws and regulations on an ongoing basis, including a register of environmental legislation which describes the key requirements of each piece of legislation relevant to IOG's activities as a licence operator on the UKCS. This includes UK legislation, industry guidelines and other standards as well as EU and other international requirements such as OSPAR and MARPOL agreements. Through the use of compliance tracking and commitment registers, IOG is able to detect potential non-compliance and initiate corrective action in a timely manner;
- Delivers suitable resource management; through the office of the IOG HSE Manager, supporting line management in the discharge of their environmental responsibilities and reporting directly to the CEO on environmental matters;
- Incorporates performance metrics that are developed according to each aspect of the particular operation, and with a view to meeting the clear public reporting requirements as administered by BEIS.

The Proposed Operations

IOG plans to develop the Blythe Hub, comprising the Elgood and Blythe gas/condensate fields in the Southern North Sea. The Blythe field will comprise a single production well producing natural gas and condensate to a small unmanned platform. A single subsea well will be developed in the Elgood field which will be tied back to the Blythe platform via a subsea pipeline. Produced gas from the two fields will be exported via the existing Thames pipeline to the Bacton Terminal in north Norfolk.

IOG is currently planning to commence offshore construction and drilling activities by Q3 2019. The proposed drilling programme is expected to take approximately 180 days to complete both the Blythe and Elgood wells. An offshore production platform will then be constructed at Blythe which is designed not to require continual manning during normal production operations. The platform will be designed to provide emergency accommodation and allow for routine maintenance visits.

The Blythe and Elgood fields together are estimated to produce a combined 1.84 billion cubic metres (65 BCF) of gas and 103,342 m^3 (0.68 million barrels) of condensate over its expected 12 year life.

The Local Environment

Information about the environment at the proposed drilling location and its surroundings was collated to allow an assessment of those features that might be affected by the proposed drilling operations, or which may influence the impact of the operations. The key sensitivities of the areas are summarised below.

Physical Environment

The proposed Blythe Hub development is located in the Southern North Sea, a relatively shallow area of the North Sea where water depths across the site are typically 20 m to 30 m. North Atlantic water strongly influences the hydrography of the North Sea, with minor inflows from the English Channel and the Baltic Sea. The generalised pattern of water movement in the North Sea is anti-clockwise, with North Atlantic water moving south, balanced by a northerly outflow along the Norwegian coast. The Southern North Sea water moves in a broadly north easterly direction as part of this general circulation.

Wind direction and velocity in the proposed development area are variable throughout the year, although the most prevalent winds tend to be from the south and southwest. The windiest months are typically the winter ones, particularly December and January, whilst winds are typically lower between May and August.

Regional seabed sampling suggests that the seabed around the Blythe Hub Developement will consist of sand, coarse sand and gravels. A series of sand banks are present to the east where water depths decrease to less than 20 m.

Plankton

Plankton consists of microscopic plants (phytoplankton) and animals (zooplankton) including the larval stages of fish and many bottom living animals which drift with the ocean currents. Phytoplankton in the proposed development area has an annual seasonal growth cycle, which peaks in abundance during April. This phytoplankton bloom is closely followed by an increase in the zooplankton population as they feed on this increased food source. Zooplankton abundance is typically at its highest between May and September.

Benthos

Benthos is the term used for animals and plants associated with the seabed, although plants are generally limited by their light requirement to depths of less than 50 m. Benthos consists mainly of animals that burrow into the sediment or form tubes in it (known as infauna). Other species which live on the seabed, or attached to rocks or to other biota, are known as epifauna.

Typical epifauna fauna in the area includes dead man’s fingers, hydroids, bryozoans, anenomes and sponges. Examples of mobile epifauna in the area include seastars, crabs, flatfish and the seamouse polychaete.

The reef building worm, *Sabellaria spinulosa*, has also been found to be characteristic of coarse to medium sandy sediments in the Southern North Sea. This species can form large biogenic reefs of conservation interest.

Other potentially sensitive areas include biogenic reefs created by aggregations of the horse mussel (*Modiolus modiolus*) or the common mussel (*Mytilus edulis*) and shallow sandbanks, which are both designated as Annex I habitats under the EC Habitats Directive.

IOG has commissioned an environmental baseline survey (EBS) and habitat assessment of the Blythe Hub Development area to confirm the species and habitats present at the exact project location. However, the results of these surveys were not available in time for the preparation of this ES, so these will be discussed and used to inform future permit applications for the Blythe Hub Development, instead.

Fish and Shellfish

The Blythe Hub Development lies within or close to predicted spawning grounds for a range of species, namely cod, herring, lemon sole, mackerel, plaice, sand eels, sole and whiting. The majority of species show peak spawning activity between January and June, although several spawn over a longer period. Most fish species release large numbers of eggs directly into the water column. Their spawning grounds cover extensive areas, leaving them less vulnerable to disturbance from point sources. However, certain species relevant to this area are more restricted in their spawning preferences, e.g. herring and sand eel. The dependency of these species on specific substrates and spawning grounds makes them particularly susceptible to impacts resulting from oil and gas exploration and production. As part of any environmental survey undertaken in support of the Blythe Hub Development, investigations will be conducted to determine the suitability of the area as a herring spawning ground.

The Blythe Hub Development lies in a year-round nursery area for cod, herring, lemon sole, mackerel, plaice, sand eel and whiting.

Marine Mammals

The number and diversity of cetaceans (whales, dolphins and porpoises) decreases progressively southwards through the North Sea and the Southern North Sea supports relatively few species. The four most commonly observed species in this area are the minke whale, white beaked dolphin, Atlantic white sided dolphin and harbour porpoise. Minke whales are found in smaller numbers in the Southern North Sea and those individuals observed in the proposed development area are at the southern limit of their range. White beaked dolphins are regularly recorded in the Southern North Sea, particularly towards the coast of Norfolk, although those individuals observed in the study area are thought to be at the southern limit of their range, preferring the northern sector of the Central North Sea. Atlantic white sided dolphins have been recorded in the area, although only in low numbers. The harbour porpoise is widely distributed throughout the Southern North Sea albeit in relatively small numbers occurring throughout the year with peak sightings in the summer months.

Two species of seal, the common and grey seal, are resident in the North Sea, although densities of seals at sea vary over the year in relation to different stages in their life cycle. Common seals are concentrated in The Wash, which provides ideal breeding and haul out conditions, forming the largest single colony in the UK, with additional haul out sites located at Donna Nook on the Humber and Blakeney Point and Scroby Sands in Norfolk. Grey seals are less numerous in the area than common seals. Approximately 39% of the global grey seal population is found in the UK; however, many of these are concentrated at sites around the Hebrides and Orkney, far removed from the area of interest. However, there is a significant breeding and haul out site at Donna Nook at the mouth of the Humber estuary, to the north-west of the Blythe Hub Development. Given the shallow water and proximity to significant seal colonies in the Wash and Humber estuary, both grey and common seals may be encountered around the proposed development area.

Seabirds

Seabirds are present throughout the year in the Southern North Sea, with mostly low to moderate densities found in the proposed development area. The most abundant bird species recorded in the proposed development area are fulmar, gannet, kittiwake, guillemot and puffin. Offshore surveys suggest that the area is of particular importance for a variety of seabirds during the autumn and winter periods, with overall densities decreasing offshore during summer. Flamborough Head to the north-west of the Blythe Hub Development supports a large Kittiwake breeding colony whilst the area to the south-west of the field supports internationally important coastal seabird colonies for little, common and sandwich terns.

Conservation Areas

The nearshore and coastal habitats and species present along the coasts adjacent to the proposed development area are of notable conservation interest and are protected by a range of statutory and voluntary initiatives. There are several Special Protection Areas (SPA) designated along the coast due to the major seabird colonies or breeding and overwintering habitats for waders and wildfowl present. The closest SPA to the development area is the North Norfolk Coast SPA, located 38 km to the south-west of the proposed Blythe Hub Development location. The North Norfolk Coast SPA is designated for supporting breeding and overwintering birds.

There are also numerous Special Areas of Conservation (SAC) designated to protect important inshore and coastal habitats, such as reefs and sandbanks along with significant common seal populations. The closest SAC is The Wash and North Norfolk Coast SAC, located approximately 30 km to the south-west of the proposed Elgood development location. The SAC is designated for the presence of sandbanks which are slightly covered by seawater all the time, which provide extensive breeding and haul-out sites for harbour seal. A range of offshore SACs are located in the Southern North Sea the closest of which is the North Norfolk Sandbanks and Saturn Reef approximately 15 km east of the Blythe Hub designated for its linear ridge sandbank features. To the west, the Inner Dowsing, Race Bank and North Ridge Site of Community Importance (SCI) encompasses a wide range of sandbank types and *Sabellaria* biogenic reefs.

Fifty MCZs have been designated in English waters as part of protecting the range of marine wildlife and habitats found in UK waters with more to be designated after consultation in 2017. The nearest MCZ with coastal components is the Cromer Shoal Chalk Beds MCZ, located approximately 25 km to the south of the proposed Blythe Hub Development location along the Norfolk Coast.

Other Users of the Sea

The North Sea as a whole is a major international fishing ground. Major UK and international fishing fleets operate in the Southern North Sea, targeting a range of species, although fisheries landings are higher overall further north in the North Sea and around the Orkney and Shetland Islands. Fishing landings data from the area around the Blythe Hub Development mainly comprise shellfish species such as crabs, whelks and lobsters. Whelks make up the largest proportion of shellfish landed with the quantities caught having increased significantly since 2008. Small quantities of demersal fish are landed here such as plaice.

There are few active mariculture sites situated along the Humber and Norfolk coasts adjacent to the Blythe Hub Development as the coastline generally does not provide appropriate conditions for cultivation. However, there are a few sites in the Humber and more extensively the Wash which culture shellfish, mostly mussels and some pacific oysters.

The Blythe Hub Development is situated within an area of intensive pre-existing offshore gas developments and as such is surrounded by a range of surface and subsurface infrastructure. The Shell gas pipeline running from the Shearwater field to the Bacton gas terminal passes through the edge of the Blythe field outline. The Perenco Waveney field production platform is situated approximately 7.4 km north west of the proposed Elgood development location, and is connected in turn to the Lancelot field complex, approximately 11 km north of the proposed Elgood development location.

A range of other industries make use of the Southern North Sea area where the proposed Blythe Hub development will be located. The Blythe Hub infrastructure will be adjacent to the Dudgeon Offshore Wind Farm, whilst approximately 60 km to the south-east is the next tranche of the proposed East Anglia Array Offshore Wind Farm.

Several marine aggregate production areas are also present to the north of the proposed development area the closest of which is sited approximately 10 km away.

The Southern North Sea region supports more intense shipping activity in general compared to the central and northern North Sea, with some major ports such as Rotterdam located in the region. A high number of cargo vessels and ferries pass through the general area along with offshore vessels supporting the numerous gas developments present. Block 48/22 (Elgood) has been classed as having very high shipping density, and Block 48/23 (Blythe) as having high shipping density.

Assessment of Potential Impacts

In order to determine which activities associated with the proposed drilling and installation operations at the Blythe Hub could have on the environment which could potentially be considered as significant, IOG has undertaken the following scoping activities:

- An Environmental Issues Identification (ENVID) workshop by members of the project team and independent environmental consultants;
- A consultation meeting was held with the main consenting regulator for the UK oil and gas industry, the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED);
- An Early Consultation Document (ECD) setting out the project and main environmental receptors to be assessed was circulated to a range of statutory and non-statutory consultees and their comments were invited in order to help shape the EIA.

The scoping process identified the following activities which may result in impacts and therefore required further consideration:

- Physical presence of the drilling rig, subsea infrastructure and protective materials impacting on the seabed environment and other users of the sea such as fisheries and shipping;
- Marine discharges from the deposition of drill cuttings, associated muds and excess cement directly on to the seabed and use and discharge of chemicals and discharge of produced water during production operations potentially impacting on the seabed environment;
- Underwater noise from the rig, platform piling operations and support vessels impacting on marine mammals and fish;
- Atmospheric emissions from fuel use and flaring;
- Accidental events comprising hydrocarbon spills and vessel/rig collisions.

Each concern is fully addressed in the individual impact sections of the ES, including any residual, cumulative and transboundary impacts to the environment. They also describe any mitigation measures in place to manage and reduce these impacts to an acceptable level, where required. The impact sections are summarised below.

Physical Presence

The placement of the development infrastructure on the seabed is anticipated to lead to the loss of the underlying seabed communities (benthos) in an area of up to 0.1414 km^2, due to the placement of the jack-up drilling rig and subsequent placement of the Blythe platform on the seabed, the subsea wellhead structure at Elgood and the installation of pipelines. The direct physical disturbance of the seabed will result in the loss of the benthic communities. Benthic communities of the types affected are common and widespread throughout the Southern North Sea. No potential Annex 1 habitats or protected areas are directly affected by the installation.

The Blythe Hub Development is located approximately 35 km from the nearest shoreline. During drilling operations, the maximum elevation of the platform legs of the jack-up rig will be approximately 82 m, resulting in a geometric horizon of 37 km for a person standing on the shore. The maximum elevation of the Blythe platform will be 38.6 m above the lowest astronomical tide (LAT), resulting in a geometric horizon of approximately 27 km, meaning the platform will not be visible from the shore at sea level. The jack-up drilling rig may be just visible on clear days during the drilling operations (82.5 days at Blythe and 85.5 days at Elgood), but will be imperceptible to the human eye, under most conditions. The Blythe platform itself will not be visible from the shore at sea level.

The Blythe Hub Development lies within ICES rectangle 35F1 which is 3,712 km^2 in area. Fishing will be excluded from an area totalling 1.57 km^2, representing approximately 0.04% of 35F1. Inter-annual variation for the shellfisheries varies between 17% (2009 to 2010) and a maximum of 46% (2011 to 2012). The proportion of fishing ground lost is significantly smaller (425 times) than the smallest inter-annual variation between 2008 and 2013.

The recently installed Dudgeon OWF has diverted the majority of larger vessel traffic to the south and west of the OWF extent, and therefore away from Blythe and Elgood. The implementation of the 500 m statutory safety zone around Blythe and Elgood will therefore only have a minor effect on shipping in the area.

Marine Discharges

The drilling discharges from the proposed drilling operations at the Blythe and Elgood wells have the potential to cause moderate effects in the immediate vicinity of the well location. As a general rule, effects of drilling fluids and cuttings discharges on the benthic environment are related to the total quantity discharged and the energy regime encountered at the discharge site, particularly the currents close to the seabed itself. Based on these factors, the discharge of drill cuttings, drilling fluids (mud) and cement at the Blythe and Elgood wells have the potential to cause a localised impact to the benthic environment, primarily through direct physical changes to the seabed.

Based on these factors, the discharge of cuttings and drilling fluids at the Blythe and Elgood well locations have the potential to cause a temporary localised impact to the benthic environment, primarily through direct physical changes to the seabed. This effect is expected to be chiefly limited to within 50 m of the well location. Recovery of the benthos is expected to begin soon after discharges cease. The areas of the seabed directly affected by drilling discharges are not protected, or potential Annex 1 habitat, and are typical and widespread in the Southern North Sea.

All chemicals used will be approved by Cefas, and will be in accordance with UK chemicals regulations. Wherever practicable and technically feasible, chemicals without substitution warnings will be prioritised over those that do have warnings.

Bearing these factors in mind, the magnitude of environmental effects is considered to be minor and thus not significant.

Noise Generation and Wildlife Disturbance

Man-made underwater noise has the potential to impact marine animals. During the operations at the Blythe Hub Development, the loudest anticipated sound source will be piling noise generated during platform installation. Once the platform is in place, underwater noise generation will be minimal and will be mainly limited to vessels and helicopters visiting the platform.

Although it is unlikely that the proposed piling operations will cause injury, they may evoke a certain level of behavioural responses from any whales, dolphins and seals in the vicinity of such operations. It is estimated that some avoidance behaviour may be expected within 9 km from the platform and more subtle effects may be noticed up to a distance of 29 km from the platform piling operations. Given the intermittent nature and short overall duration of the piling operations (i.e. 4 days), the impact on cetaceans is expected to be limited to some potential avoidance responses for individual animals in the immediate vicinity of the platform (i.e. within 9 kilometres), with whales and dolphins returning to the area within a few days after piling operations have ceased. Seals are expected to return within a few hours after the piling operations have finished. Therefore, the impact of piling operations on whales, dolphins and seals is considered to be not significant.

The effect of piling operations on fish is strongly related to their life cycle stage. Adult and juvenile fish are rarely affected by piling operations because they are able to detect and physically avoid the area. Given the limited spatial extent of the anticipated impact and the limited (4 day) period over which the piling will take place, the proposed piling operations is not anticipated to cause any significant impacts on fish.

With regard to potential transboundary effects, the location of the Blythe Hub is 105 km east of the UK/Netherlands transboundary line. At this distance any underwater sound will have attenuated to a low level therefore no observable effects are expected to occur.

Atmospheric Impacts

Generation of power onboard the jack-up drilling rig, all support vessels and aircraft will result in the emissions of various combustion gases. These emissions will contribute to local and global environmental effects. During the production phase, emissions will be minimal, as the power required onboard the Blythe platform will be mainly supplied by wind/solar energy.

At a local level, such impacts are mitigated by health and safety measures in place to control emissions onboard the vessels, as well as by the dispersive nature of the offshore environment (i.e. the wind and weather conditions).

Emissions will also contribute to global environmental issues such as climate change. The most commonly used general indicator of atmospheric emissions is the global warming potential (GWP), expressed in tonnes of carbon dioxide (CO_2) equivalents. The GWP can be used to estimate the potential future impacts of gaseous emissions upon the climate system.

Whilst on location at the Blythe and Elgood wells the jack-up drilling rig is estimated to generate a GWP of 8,757 tonnes CO_2 equivalents. Compared to the combined emissions produced by all offshore oil and gas activities taking place on the UKCS, these emissions are very small (<0. 06%). In this context, the atmospheric emissions generated during the Blythe and Elgood wells are considered to be not significant.

Accidental Events

The risk of a large-scale hydrocarbon spill occurring during drilling operations at the proposed Blythe and Elgood production wells is very low.

Oil spill modelling indicates that, under the majority of scenarios assessed, any hydrocarbon release would most likely move to the north or east of the development site, however, there is potential for interaction with the Norfolk coastline, at certain times of the year, with very small amounts of hydrocarbons to have the potential to beach on the Norfolk coastline.

These modelling results assume no intervention in the slick. In practice oil spill response resources would be mobilised immediately if a spill occurred. It would be a priority to ensure no spilled oil would impact the coastline, including the protected areas that exist along the Norfolk coastline, and, therefore, all appropriate oil spill response techniques would be employed in the event of a spillage moving towards the shore.

Throughout the proposed operations, the focus will be on the prevention of oil spills. Stringent safety and operational procedures will be adhered to throughout the operations. A blow-out preventer (BOP) will be put in place, in order to prevent the uncontrolled release of hydrocarbons from the well.

In the unlikely event of a well control incident, the BOP will be closed to prevent hydrocarbons from flowing to the surface. If all attempts to close the BOP fail, attempts would be made to temporarily seal the well using a capping device, while operations to drill a relief well and permanently abandon the well would commence as soon as possible.

A detailed operation specific Oil Pollution Emergency Plan (OPEP) will be in place to ensure that immediate and appropriate action is taken in the event of any hydrocarbon spillage, minimising any impact to the marine environment. A robust operations and maintenance programme will be produced thereby ensuring any potential defects with the pipeline are identified before a failure occurs.

Overall Conclusion

The only potential significant impact identified in the environmental impact assessment is that of a large scale condensate or diesel spill. However, the probability of such a spill is very low and mitigation and management procedures will be in place to prevent this from happening, as well as adequate resources to deal with any such spill should it occur. All other impacts identified in the ES are expected to only have localised impacts with good recovery potential over time.

Overall, it is concluded that the environmental impacts of the proposed Blythe Hub development will not incur any significant long lasting environmental effects.

INDEPENDENT OIL & GAS PLC

Section 1

Introduction

1. INTRODUCTION

This Environmental Statement (ES) presents the findings of the Environmental Impact Assessment (EIA) conducted by IOG North Sea Limited (IOG) for the proposed Blythe Hub Development comprising the Blythe and Elgood gas fields in the Southern North Sea. The Blythe and Elgood fields are situated within United Kingdom Continental Shelf (UKCS) Blocks 48/23 and 48/22, in the Southern North Sea (Figure 1.1). The nearest landfall to the development area is the north Norfolk coast, approximately 35 km to the south-west of the Blythe field. At its nearest point, the UK/Netherlands median line is situated approximately 105 km east of the development area.

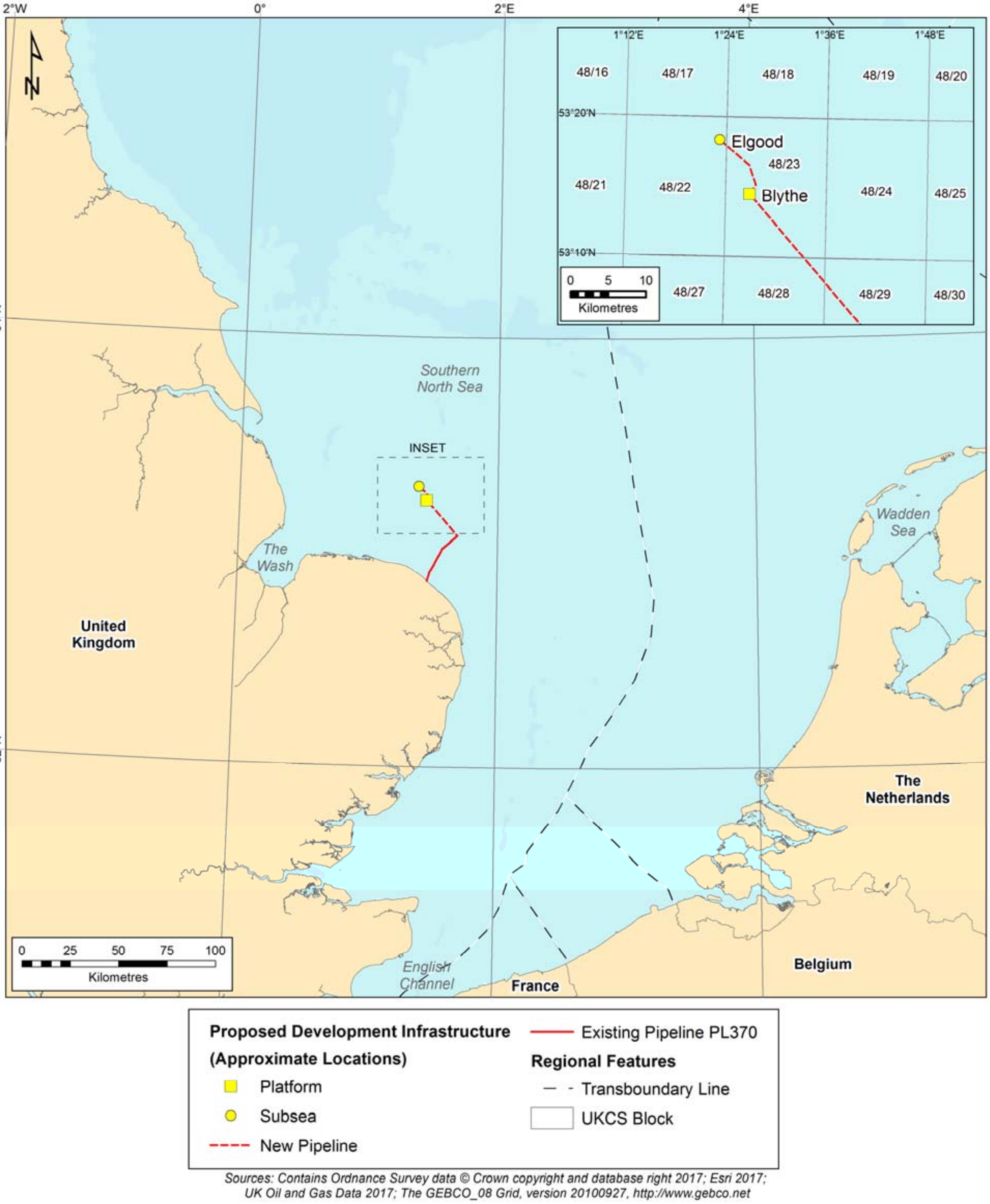

Figure 1.1: Location of the Blythe Hub Development Fields

The purpose of this ES is to provide an assessment of the potential environmental effects that may arise from the proposed Blythe Hub Development and to identify the measures which will be put in place to minimise these effects.

This ES has been produced in accordance with the Offshore Petroleum Pipeline (Assessment of Environmental Effects) Regulations 1999 and associated guidelines. It also addresses the relevant requirements associated with the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 and the Offshore Chemicals Regulations 2002.

The introductory sections below explain the background and purpose of the development, the scope of the ES and describe the EIA process. The underlying regulatory and IOG's own environmental requirements are also outlined.

1.1 Project Background

The Blythe Field was discovered by Burmah Oil in 1966 (Well 48/22-1). The discovery was appraised in the following year by Well 48/22-2, also drilled by Burmah Oil. Subsequent Wells 48/23-3 and 48/23a-4 were drilled by Arco between 1987 and 1990, which both tested up to 424,753 m^3/day (15 MMscfd). The Elgood Field, some 10 km north-west of Blythe was discovered by Enterprise in 1990 (Well 48/22-4). It tested the Leman Sandstone Formation twice with the highest flow rate being 498,377 m^3/day (17.6 MMscfd). IOG, a wholly owned subsidiary of Independent Oil and Gas plc, became operator and 100% owner of the Blythe and Elgood fields in 2016.

IOG plans to develop the Blythe Hub as part of a larger plan that includes developing two new UK gas hubs in the Southern North Sea based around re-use of the previously decommissioned Thames to Bacton pipeline. Apart from the Blythe Hub Development, it is anticipated that three fields known as the Vulcan Satellites will also produce into this pipeline.

This ES has been prepared in support of the Blythe Hub Field Development Plan (FDP) which has been submitted by IOG to the Oil & Gas Authority (OGA) for approval. The Vulcan Satellites development is the subject of a separate FDP which has been submitted by IOG to the OGA, and will accordingly be the subject of a separate ES.

Figure 1.1 shows the locations of the Blythe Hub (which is the subject of this ES), relative to the Thames pipeline which is tied back to the gas reception facilities at Bacton Norfolk.

The nearest landfall to the development area is the north Norfolk coast, approximately 35 km to the south-west of the Blythe Hub development. At its nearest point, the UK/Netherlands median line is situated approximately 105 km east of the Blythe Hub Development.

IOG proposes to develop the Blythe field via a single production well. A single subsea well will also be developed in the Elgood field which will be tied back to Blythe via an 8" subsea flowline and controlled from Blythe by an umbilical.

Produced gas from the two fields will be comingled at Blythe and exported via the existing Thames pipeline to the Bacton Terminal in north Norfolk.

An offshore production platform will be constructed at Blythe which is designed so as not to require continual manning during normal production operations. The platform will be designed to provide emergency accommodation and allow for routine maintenance visits.

The Blythe and Elgood fields together are estimated to produce a combined 1.84 billion cubic metres (65 BCF) of gas and 103,342 m^3 (0.68 million barrels) of condensate over its expected 12 year life.

IOG is currently planning to commence offshore construction and drilling activities by Q3 2019.

1.2 Scope of the Environmental Statement

This Environmental Statement (ES) considers the environmental implications of the proposed Blythe Hub Development, which includes the Elgood field. The scope of the ES encompasses all new infrastructure, flowlines and associated activities, up to their connection points with the existing Thames export line, and includes all installation and connection methods involved.

The environmental implications of recommissioning the existing Thames export line and any modifications required at the Bacton Terminal fall outside the scope of this ES. The proposed Vulcan Satellites Hub mentioned above in Section 1.1 will be covered in a separate ES.

1.3 Legislative Framework

The proposed field development operations lie outside UK territorial waters (greater than 12 nm from land). Therefore, the majority of the activities undertaken will be governed under current legislation regarding offshore oil and gas activities. The main legislation applicable to the proposed field development operations is summarised in Appendix A Summary of Legislation together with the relevant consents, authorisations and exemptions that are required. An overview of the pertinent and impending legislative requirements is given below.

1.3.1 The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended)

These regulations implement the requirements of EC Directive 85/337/EEC in the UK for offshore oil and gas operations. They require that an Environmental Impact Assessment (EIA) be undertaken for a variety of offshore developments and that a public consultation document (the Environmental Statement) be submitted to the Offshore Petroleum Regulator for Decommissioning and Environment (OPRED) and made available to any interested party for comment prior to approval by the Secretary of State (SoS). OPRED has prepared guidance notes on the regulations which detail the information the Environmental Statement must contain. Essentially, the document must describe the proposed development and identify any impacts it is likely to have on the receiving environment together with any measure to reduce the significance of any impact. No consent in respect of an activity will be granted until the Secretary of State is satisfied with the environmental information provided and that there will be no significant effect on the environment.

These regulations were amended in 2007, to implement the requirements of Council Directive 2003/35/EC providing for public participation. This Directive implements the second part of the Aarhus Convention. The Directive requires an increase in the level of public participation in the process by which regulators consider environmental implications for offshore activities.

1.3.2 The Offshore Chemicals Regulations 2002 (as amended)

The Offshore Chemicals Regulations 2002 were developed in response to the Harmonised Mandatory Control System (HMCS) for the use and discharge of offshore chemicals, first introduced by the Convention for the Protection of the Marine Environment of the Northeast Atlantic (the OSPAR Convention) in 2000.

The regulations stipulate that operators have to apply for a permit to use and discharge chemicals offshore. This permit must be in place before commencement of operations. The chemical permit applications are Subsidiary Application Templates (SATs), embedded within Master Application Templates (MATs) and submitted electronically.

An application for the grant of a permit from OPRED is made via an electronic submission using the online OPRED UK Oil portal, and contains:

- A description of the offshore source on or from which the offshore chemical is to be used or discharged, and the location of the offshore source in the relevant area;
- A description of the proposed technology and other techniques for preventing or, where this is not possible, reducing the use or discharge of the offshore chemical from the offshore source;
- A description of the measures planned to monitor the use or discharge of chemicals;
- An assessment of the risk of damage to the environment from the use and discharge of the offshore chemicals proposed.

Chemical permits last for the duration of the activity and require reporting of actual chemical use and discharge when the activity is complete. These regulations were amended in 2011, making it an offence to unintentionally release a chemical offshore. The updated regulations clarify the legal distinction between accidental “releases” and operational “discharges” and increase the powers of OPRED inspectors to investigate non-compliances/risk of significant pollution from chemical discharge.

1.3.3 The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended)

These regulations, generally referred to as the Oil Pollution Prevention and Control (OPPC) Regulations, introduced a permitting system for oil discharges to sea.

In 2011, amendments were made to the OPPC Regulations to align them with amendments to the Offshore Chemical Regulations (Section 1.3.2). The amendments made it unlawful to unintentionally release oil into the offshore environment. All oil discharges must be in accordance with the terms and conditions of an OPPC permit.

The OPPC Regulations also amend the Offshore Chemicals Regulations 2002 to increase the powers of OPRED inspectors to investigate non-compliances and risk of significant pollution from chemical discharges, including the issue of prohibition or enforcement notices. Operators are required to report all unpermitted oil discharges, regardless of size, to the HM Coastguard, OPRED and other relevant authorities.

Under the amendments, the OPPC regulations now also apply to offshore pipeline operations.

1.3.4 The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended)

These regulations, as amended in 2007, seek to ensure that oil and gas activities on the UKCS are carried out in a manner that is consistent with the requirements of the European Union (EU) Habitats Directive. These Regulations are designed to ensure that the integrity of neither a Special Area of Conservation (SAC) nor a Special Protection Area (SPA) is significantly affected by activities occurring either within or outside those sites. Any plan or project which either alone or in combination with other plans or projects would be likely to have a significant effect on a site must be subject to an appropriate assessment of its implications for a site’s conservation objectives. Such a plan or project may only be agreed after ascertaining that it will not adversely affect the integrity of a SAC or SPA unless there are imperative reasons of overriding public interest for carrying out a plan or project.

1.3.5 The Offshore Marine Conservation (Natural Habitats &c) Regulations 2007 (as amended)

These Regulations, as amended in 2010, implement the EU Habitats Directive and Birds Directive in the UKCS outside the 12 nm zone. The Regulations make provision for the selection, registration, notification and management of European Offshore Marine Sites. Competent authorities are required to ensure that steps are taken to avoid the disturbance of species and deterioration of habitat in respect of the offshore marine sites and that any significant effects are considered before authorisation of certain plans or projects. Provisions are also in place for issuing of licences for certain activities and for undertaking monitoring and surveillance of offshore marine sites.

These Regulations also make it an offence to deliberately disturb wild animals of a European Protected Species (EPS), in such a way as to significantly affect the ability of any significant group of animals to survive or breed, or the local distribution or abundance of that species. If appropriate, a Wildlife Disturbance Licence may be required.

1.3.6 Petroleum Act 1998 (as amended)

The Petroleum Act 1998 establishes the regulatory regime applying to oil and gas exploration and production in the UK (other than onshore in Northern Ireland). The Petroleum Act (as amended) vests all rights to the nation’s petroleum resources in the Crown, but allows licences to be granted that confer exclusive rights to ‘search and bore for and get’ petroleum on the UKCS. The vast majority of offshore energy activities relating to oil and gas exploration and production are controlled under the Petroleum Act 1998 (as amended) and the Energy Act 2008 (as amended), or are exempted under the Marine Licensing (Exempted Activities) Order 2011 (as amended).

1.3.7 The Energy Act 2008 (as amended)

The Act, as amended in 2016, make provisions for the decommissioning of offshore oil and gas installations. Part III of the Energy Act 2008 amends Part 4 of the Petroleum Act 1998 and contains provisions to enable the Secretary of State to make all relevant parties liable for the decommissioning of an installation or pipeline; provide powers to require decommissioning security at any time during the life of the installation and powers to protect the funds put aside for decommissioning in case of insolvency of the relevant party.

1.3.8 Marine and Coastal Access Act 2009

The Act provides a legal mechanism for improved management and protection of the marine and coastal environment, with particular relevance to biodiversity and nature conservation. This legislation makes provision for the designation of Marine Conservation Zones (MCZs) in the territorial waters adjacent to England and Wales and UK offshore waters.

Operators will need to apply for a marine licence to undertake certain licensable marine activities as per Part 4 of the regulations.

1.3.9 National Marine Plan

The UK government introduced a number of measures via the Marine and Coastal Access Act 2009 (MCAA) to deliver its vision of "clean, healthy, safe, productive and biologically diverse oceans and seas" for the whole of the UK. These measures included the introduction of a marine planning system, establishing the Secretary of State as the marine planning authority for the English Inshore and English Offshore marine planning regions with the power to delegate certain marine planning functions. The Secretary of State delegated these functions to the Marine Management Organisation (MMO) in April 2010. The aim of the Marine Plan is to help ensure the sustainable development of the marine areas through informing and guiding regulation, management, use and protection of the marine plan areas. There are 11 marine plan areas in England, each of which have an individual marine plan detailing the long-term view of activities within each area. Each marine plan sets out priorities, directions and guidance for sustainable future development within the plan area. Any licence application within a marine plan area must demonstrate that the marine plan has been considered and explain how the activity will contribute to achieving the objectives set out in the marine plan.

1.3.10 The Merchant Shipping (Oil Pollution Preparedness, Response and Cooperation Convention) Regulations 1998

These regulations require that all operators have a formally approved OPEP in place for each offshore operation, or agreed grouping of facilities. The regulations also stipulate legal oil spill reporting requirements.

These Regulations, which came into force on 19 July 2015, together with the Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 and the Offshore Petroleum Licensing (Offshore Safety Directive) Regulations 2015, implement the European Union Directive 2013/30/EU on the safety of offshore oil and gas operations (OSD).

1.3.11 The Offshore Installations (Offshore Safety Directive (Safety Cases etc.) Regulations 2015

The Offshore Installation (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 came into force on the 19 July 2015 replacing the 2005 Safety Case Regulations. The 2015 Regulations apply to all oil and gas operations in UK waters and implement the EC Directive on safety of offshore oil and gas operations 2013/30/EU. The EU has put in place a set of rules to help prevent accidents, as well as respond promptly and efficiency should one occur. The 2015 Regulations provide for the preparation of safety cases for offshore installations and the notification of specified activities to the competent authority.

1.4 Environmental Management

1.4.1 Policy and Governance

The IOG Main Board and Management Team recognise the critical importance of maintaining effective environmental management processes in the development and operation of UKCS offshore fields, and in maintaining their licence to develop the Blythe Hub.

Overall responsibility and accountability for environmental practice and compliance rests with the IOG CEO, and the Board. Leadership and commitment in all HSE aspects of IOG activities are major factors in ensuring that company values, policies and performance expectations are fulfilled.

Each IOG line manager is responsible for ensuring that IOG policies and expectations are adhered to in the conduct of all activities within their respective areas of responsibility, and individuals engaged by IOG are personally responsible for their conduct in respect of environmental care and compliance.

Professional advice and guidance on environmental matters is provided to IOG by their appointed HSE Manager, whom reports directly on such matters to the CEO, and whom also ensures that specialist environmental support is provided as required, including the use of specialist external environmental services.

The IOG Board have oversight of the IOG environmental policies and the Board expresses expectations through the office of the CEO. Any significant environmental incident is reported to the Board, and the environmental risk profile of the company forms part of the corporate risk management obligations undertaken by the Board.

1.4.2 Environmental Management System (EMS)

IOG recognises the recommendations of The Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) for all operators controlling the operation of offshore installations on the UK Continental Shelf (UKCS) to have in place an EMS designed to:

- Achieve the general objectives of the OSPAR Offshore Strategy;
- Achieve the environmental goals of the prevention and elimination of pollution from offshore sources and of the protection and conservation of the maritime area against other adverse effects of offshore activities,
- Maintain continual improvement in environmental performance.

The IOG EMS:

- Is implemented at a strategic level, being driven by the CEO as an integral part of the corporate aspirations and growth of the IOG enterprise;
- Is designed to deliver and manage compliance with environmental laws and regulations on an ongoing basis, including a register of environmental legislation which describes the key requirements of each piece of legislation relevant to IOG's activities as a licence operator on the UKCS. This includes UK legislation, industry guidelines and other standards as well as EU and other international requirements such as OSPAR and MARPOL agreements. Through the use of compliance tracking and commitment registers, IOG is able to detect potential non-compliance and initiate corrective action in a timely manner;
- Delivers suitable resource management; through the office of the IOG HSE Manager, supporting line management in the discharge of their environmental responsibilities and reporting directly to the CEO on environmental matters;
- Incorporates performance metrics that are developed according to each aspect of the particular operation, and with a view to meeting the clear public reporting requirements as administered by BEIS.

1.4.3 Offshore Operations

The offshore installations that are to be established as part of the Blythe Hub Development are to be operated by an Installation Operator Duty Holder, appointed by IOG within the terms of the Offshore Installations (Offshore Safety Directive) (Safety Case etc) Regulations 2015 (OSDSCR).

IOG also intends to appoint a Well Operator within the terms of OSDSCR for the drilling of the Blythe Hub Development Wells, and a Pipeline Operator within the terms of the Pipelines Safety Regulations 1996 to operate pipelines.

IOG recognises its obligations under Regulation 5 of the OSDSCR Regulations, to ensure the capability of the Duty Holder(s) and to take all reasonable steps to ensure that they satisfactorily meet their obligations.

A particular and key requirement of duty holders appointed by IOG to undertake offshore operations, is that the duty holders have an EMS in accordance with the BEIS Guidance to OSPAR 2003/5.

1.4.4 Emergency Response

IOG recognises that it has ultimate responsibility to ensure an effective response to offshore emergencies, and in particular a responsibility to minimise the risk and impact of any environmental aspects.

IOG intends to utilise the shore-based Emergency Response facilities (i.e. Emergency Response Centre, and associated personnel and technical resources) established and maintained by its appointed duty holders, for the purposes of response. Such arrangements will be documented in emergency response plans and within the OPEP submissions that are required to be approved by BEIS prior to undertaking prescribed offshore activities.

The Offshore Pollution Liability Association Limited (OPOL), provides a voluntary industry mutual agreement that requires each operator to accept strict liability for pollution damage and reimbursement of third parties (including public authorities) for clean-up and compensation costs. Parties to the agreement jointly agree that in the event of a default by one of the parties, each will contribute proportionally to meet claims.

IOG is registered with the OPOL, and will retain membership and registration in respect to the Blythe Hub Development.

As a party to the OPOL agreement, IOG has therefore agreed to accept strict liability for pollution damage and the cost of remedial measures, and has established financial responsibility in order to meet claims arising under OPOL.

1.5 Environmental Assessment Process

Offshore drilling, development and production activities can involve several environmental interactions and impacts due, for example, to operational emissions and discharges and general disturbance. The objective of the environmental assessment process is to incorporate environmental considerations into the project planning and design activities, to ensure that best environmental practice is followed and, ultimately, to achieve a high standard of environmental performance. The process also provides for the potential concerns of stakeholders to be identified and addressed, as far as possible, at an early stage. In addition, it also ensures that the planned activities are compliant with legislative requirements and IOG's procedures.

1.5.1 Scoping and Consultation

Informal consultation has been undertaken by means of a scoping meeting between IOG and OPRED (which took place on 5 October 2017). During this meeting OPRED was informed about the project and shown an Early Consultation Document (ECD) which outlined the proposed development and summarised the perceived environmental sensitivities. In total, the ECD was distributed to 41 statutory and non-statutory stakeholders who were invited to comment on the proposals. Details of the informal consultation process and the comments received from consultees are outlined in ES Section 4. The formal statutory consultation process takes place following submission of the environmental statement, which is subject to public review.

1.5.2 Information Gathering

Information was gathered on the natural and the socio-economic environment in the vicinity of the proposed wells, and potential sensitivities identified. Information was also gathered on the proposed operations, including the alternative options considered.

1.5.3 Commissioning Specialist Studies

Specialist studies have been commissioned where insufficient information was available with which to assess the environmental impacts of the project. These studies include an Environmental Baseline Survey (EBS), which will also include a herring spawning survey and a habitat assessment.

1.5.4 Identification and Assessment of Potential Environmental Impacts

A core element of the EIA process is the identification of all environmental effects associated with proposed project activities which may have a 'potentially significant' impact. This process is called 'scoping'. An environmental effect can be any change to the environment or its use. Effects can be positive or negative and can result directly or indirectly from project activities or events. A systematic approach was used to ensure that all aspects of the project were considered in the same way.

The first step was to determine all stages in the project process, to ensure that all activities were fully considered. Those aspects of the project that have the potential to interact with the environment in a significant way were then identified. The complete life cycle of the proposed drilling operations was reviewed for potential environmental impacts with the intention of eliminating or reducing the cause. Central to this process was an Environmental Issues Identification (ENVID) workshop attended by key members of the project team. This workshop was carried out to evaluate the project for potential environmental interactions and to identify key issues for further consideration.

A series of matrices were prepared at the ENVID workshop that identified the interactions associated with the proposed development. These interactions were then assessed for their significance in order to determine the key environmental issues associated with each stage of the project. Details of this procedure and the key issues identified are presented in ES Section 4.

The environmental assessment process then involves a detailed evaluation of each of the interactions that are of concern. The concerns include both the key issues identified by the screening process and the concerns raised by stakeholders during informal consultation. Each concern is dealt with in the same manner, which involves describing IOG's understanding of the concern, describing and quantifying the effects from the proposed project, recognising any gaps in understanding and explaining how these are dealt with, and defining measures that have been taken to mitigate the impact.

1.5.5 Development of Mitigation Measures

Identifying and assessing impacts and mitigating their significance is an iterative process conducted throughout the project. Mitigation measures were explored throughout the assessment process in order to eliminate or reduce the significance of the identified environmental impacts. Mitigation measures adopted are described in each of the individual impacts sections (Section 5 to 9) and summarised in Section 10.

1.5.6 Reporting of the Outcome of the Process by Means of the Publicly Reviewed Environmental Statement

This ES reports the findings of the EIA process and explains how the conclusions have been reached. The intention has been to present the information in such a way to allow readers to form their own opinions on the acceptability of the residual levels of impact associated with the project. The statement covers:

- The reasons for developing the Blythe and Elgood fields and the nature and role of the EIA process (Section 1);
- A description of the option selection process and final proposed operations (Section 2);
- A description of the environment in the vicinity of the proposed operations (Section 3);
- The methods used to identify the environmental concerns associated with the programme (Section 4);
- A detailed assessment of each concern, including any potential cumulative and transboundary impacts, and mitigation measures (Sections 5 to 9);
- Conclusions (Section 10).

In addition, the whole ES is summarised in the non-technical summary at the front of the report.

INDEPENDENT OIL & GAS PLC

Section 2

Option Selection and Project Description

2 OPTION SELECTION AND PROJECT DESCRIPTION

This section contains a detailed description of the activities involved with the proposed drilling, completion and development operations at the Blythe Hub Development comprising the Blythe and Elgood fields. This section also describes the alternative project options considered when developing the current preferred project design, and justifications for the options selected.

2.1. Development Justification

Developing the Blythe Hub Development will support the objectives of the UK's current energy policy, as set out in the Oil & Gas Authority (OGA) document The Maximising Economic Recovery Strategy for the UK (OGA, 2016). The strategy's oil and gas objectives aim to ensure the UK secures a resilient and diverse energy supply, in both the domestic and international markets, and maximises the economic recovery of our existing reserves as part of the wider energy strategy. Developing these gas fields also supports the objective of transitioning to cleaner forms of fossil fuels. Whilst not developing the Blythe and Elgood fields would avoid any potential for environmental impact, it would prevent the production of natural gas from these fields that would help to meet the UK's energy needs, and would not provide any economic benefit.

2.2. Option Selection

Various options for the field development were evaluated in terms of technical feasibility, environmental impact, health and safety, reputation and cost. The environmental assessment process (ES Section 1.4) was initiated early in the planning stage to support the option selection process. The following options were considered by the project team in planning the development:

- Number of wells in each reservoir;
- Well design;
- Type of surface production facilities to be used;
- Pipeline options;
- Pipeline installation and protection methods;
- Corrosion and Hydrate Prevention;
- Mobile drilling rig selection;
- Selection of drilling fluids;
- Fate of drill cuttings;
- Chemical use and discharges;
- Decommissioning.

2.2.1 Number of Wells in Each Reservoir

Historic well test data was used to develop reservoir and well performance models to determine the optimal number of wells for each reservoir and the associated infrastructure required. Options were prioritised to maximise the field productivity, minimise the initial development expense and the environmental footprint, and to ensure the sustainability of the development. The reservoir and well performance modelling indicated that early stage production would be viable with one well in the Blythe field (BL_H2V2) and one in the Elgood field (EL_H1).

2.2.2 Well Design

A slim hole casing design is planned for both the Blythe and Elgood wells. Use of a slim hole design is considered to be advantageous in this instance for the following reasons:

- Other slim hole wells have been successfully drilled and operated in nearby formations;
- Significant time and cost savings when compared to alternative conventional casing design schemes;
- Significantly less cuttings produced than for standard well bore diameters.

2.2.3 Surface Infrastructure

The decision to install a platform at Blythe was to support the potential for future expansion at the hub. The design basis for the platform is premised on an existing successfully operated design in the Southern North Sea which allows standardised construction and operation across all planned developments. All processing will take place at the Bacton Terminal, and therefore there will be no requirement for processing facilities on the platform.

The selected platform structure is based on a four-legged jacket with skirt piles supporting minimal topsides which will provide wet gas metering for all fluids and emergency overnight accommodation.

2.2.4 Pipeline Options

The Blythe Hub export system is premised exclusively upon re-using the existing decommissioned 24" pipeline (PL370) between Perenco's Thames field and the Bacton Terminal. It was determined that recommissioning the existing Thames export line would have the lowest environmental impact, and will be the most cost-effective option.

Flow assurance modelling was used to determine the appropriate pipeline diameters for the in-field lines to tie-in to PL370. The Blythe to PL370 will be a 10" pipeline, and the Elgood to Blythe will be an 8" pipeline.

2.2.5 Pipeline Installation and Protection

In line with industry best practice on the UKCS, with regard to other users of the sea, safety and environmental factors, in-field pipelines will be reel-laid, trenched and buried. Mattresses will be used at the tie-in points at the base of the platform and at the tie-in with PL370, and at all pipeline and cable crossing points. Rock dump will not be used for pipeline protection.

2.2.6 Corrosion and Hydrate Prevention

Corrosion and hydrate prevention chemicals will be delivered to the wells and pipeline by the existing Perenco-operated Bacton to Lancelot 3" Monoethylene Glycol (MEG) line (PL877). The option to deliver chemicals by vessel and bunker on the platform was considered, but dismissed as impractical.

2.2.7 Drilling Rig Selection

The shallow water at both the Blythe and Elgood fields determined that a jack up drilling rig is the most appropriate method for drilling the wells.

2.2.8 Drilling Fluids and Chemicals

The main options in the selection of drilling muds are water-base muds (WBM) and synthetic oil-base muds (OBM). Where technically possible, IOG has selected WBM for the Blythe Hub Development. For both the Blythe and Elgood wells, seawater and viscous sweeps will be used for the 36" section, and WBM will be used for the 17 ½" section. However, the characteristics of the geology determined the selection of low toxicity oil based mud (LTOBM) for the lower sections of both wells.

All chemicals used will be approved by Cefas, and will be in accordance with UK chemicals regulations. Wherever practicable and technically feasible, chemicals without substitution warnings will be prioritised over those that do have warnings. The fate of cuttings, drilling fluids and other chemicals used will be determined according to the UK regulatory regime.

2.2.9 Decommissioning

The well design and platform selection take in to consideration decommissioning requirements in line with current guidance.

2.3. Project Overview

The concept for the Blythe area is to create a hub which will support the future development for a number of small fields. This hub would provide utility support and an export route for the production. IOG proposes to develop the Blythe field via a single production well, which will produce to a minimum facilities platform. The Elgood field will be developed via a single subsea well, which will be tied back to the Blythe Hub via an 8" flowline. The produced gas and condensate from both fields will be exported via a pipeline to the Bacton Terminal in north Norfolk.

First gas is anticipated from the Blythe field in Q4 2019, and from Elgood in Q1 2020. It is expected that over the commercial life of the field, multiple additional single well field developments will be appraised and may be tied back to the Blythe Hub infrastructure in the future.

The design basis of the field development plan is to minimise offshore facilities by using onshore separation, processing and compression, and to re-use existing infrastructure, where technically and economically viable. This will enable production to commence immediately after the Blythe well is completed.

2.3.1 Blythe Field Infrastructure

In order to support the Blythe Hub production concept, the Blythe facility will comprise the installation of a newly built lattice jacket. Water depth at the platform location is approximately 20 m below Lowest Astronomical Tide (LAT). Although normally unmanned, the platform will include temporary living quarters and support systems for up to 12 personnel for emergency use. The following facilities will be provided at Blythe:

- Hydraulically operated wellhead tree valves;
- Electrically powered continuously variable, remotely controlled choke valve;
- 4 well slots with 1 gas production wellhead;
- J-tube for Elgood umbilical;
- 10" diameter export riser;
- Wet gas multiphase flow meters for each well;
- Minimum 5 tonne rated crane;
- Injection for hydrate and corrosion inhibition;
- Emergency accommodation for 12 persons;
- Helideck access with an integrated firefighting system;
- Boat access/walk to work system;
- Evacuation systems;
- Remote control system by satellite link to the onshore control centre in Great Yarmouth.

The jacket substructure will be constructed with 4-legs and a skirt pile frame with a bottle-elevation profile. Each pile cluster has a footprint of approximately 16 m^2, measuring 64 m^2 in total. The jacket will support a topsides structure comprising a cellar, mezzanine and weather decks (Figure 2.1). The top deck will measure 22 m x 22 m. The helideck will be supported from the weather deck. The topsides rise to 38.6 m above LAT at their heighest elevation. Control of the platform will be by satellite from IOG's onshore location in Great Yarmouth.

A new 10" flowline of approximately 24.5 km will then be installed, buried and tied into the existing Thames to Bacton 24" pipeline.

Once all the platform and pipeline installation works are complete, a jack-up drilling rig will be used to drill and complete one production well through the Blythe platform. This will allow production to commence immediately afterwards, with first gas anticipated during Q4 2019.

There will be no flaring on the platform, with all produced hydrocarbons being exported to the Bacton Terminal. All processing will be carried out onshore at the Bacton Terminal. Corrosion and hydrate prevention chemicals will be provided for both wells.

The Blythe installation will be unmanned during normal production operations. The platform will be visited periodically during daytime, as required for routine maintenance and replenishment of consumables and will only ever be manned overnight in an emergency situation.

The installation will not support well interventions; any necessary intervention operations will be undertaken from a separate dedicated well intervention vessel or mobile drilling rig.

The installation of the Blythe platform is anticipated to take approximately 30 days, including topsides hook up work. Drilling is scheduled to commence immediately after the platform installation is complete.

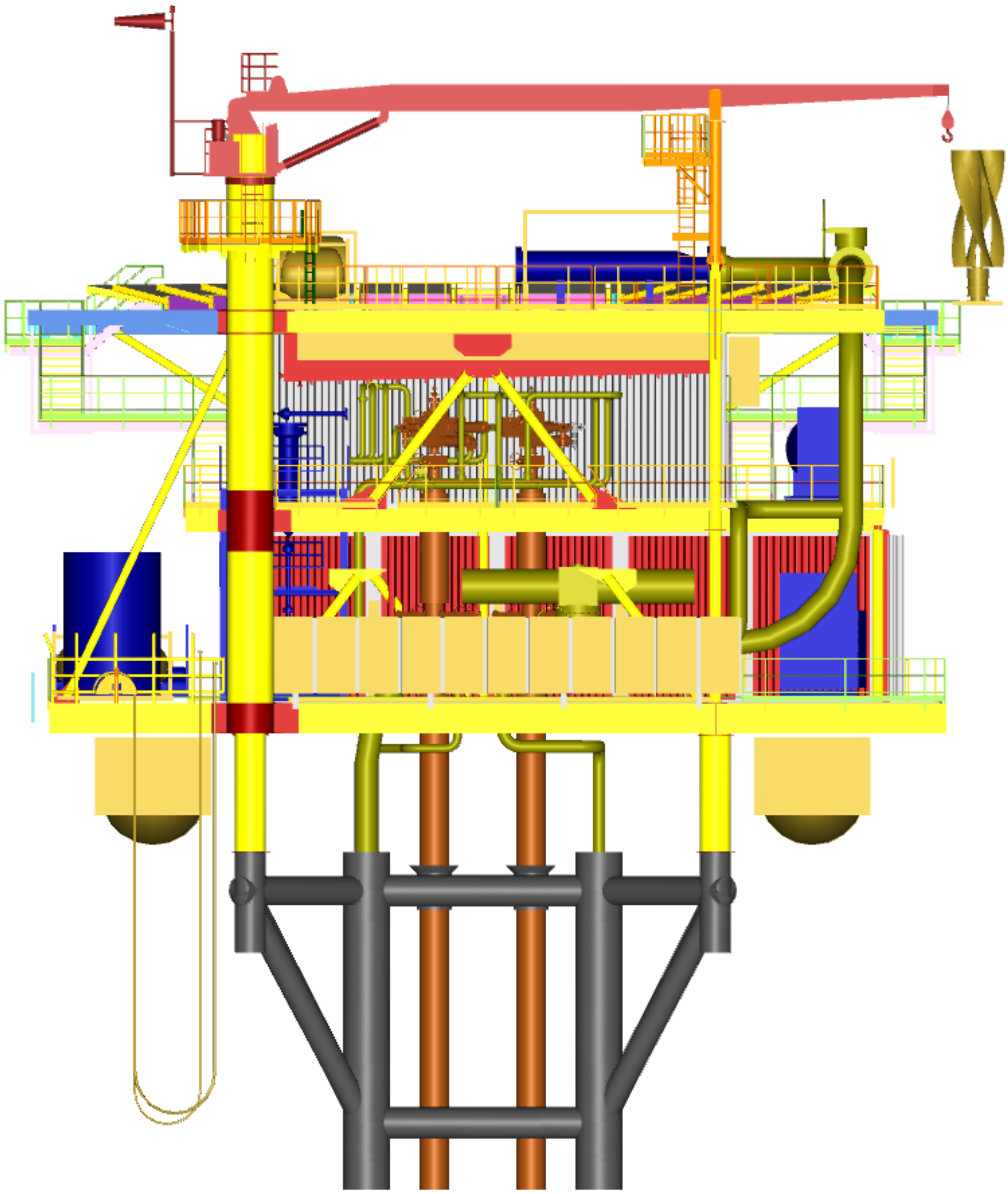

Figure 2.1: Elevation of the Blythe platform.

2.3.2 Elgood Field Infrastructure

The Elgood field will comprise of a single subsea production well, which will be tied back to the Blythe Hub via an 8" subsea pipeline. The subsea tree will lie at approximately 22 m below the sea level at the LAT. An umbilical from the Blythe platform will provide control of the Elgood subsea tree and delivery of corrosion and hydrate inhibitors. The subsea tree will be protected from dropped objects and resist snagging of fishing trawling gear by installation of a fishing-friendly structure. The pipeline will be routed to avoid the Dudgeon Offshore Wind Farm, which is situated between the Elgood and Blythe infrastructure.

2.3.3 Thames to Bacton Pipeline

It is proposed that the Blythe Hub is tied into the re-commissioned Thames to Bacton 24" pipeline (PL370) via a 10" buried export pipeline, and a clamp-on T-piece connection. The Thames to Bacton pipeline is currently decommissioned and will be fully evaluated to confirm its structural integrity and suitability for use as part of the Blythe Hub development before it will be re-commissioned.

2.3.4 Bacton Terminal

Reservoir fluids will be processed and fiscally metered for sale at the onshore Bacton terminal, operated by Perenco. As explained in Section 1.2, any modifications required at the Bacton Terminal fall outside the scope of this ES.

2.3.5 Drilling Rig

Due to the shallow water in both the Blythe and Elgood fields the wells will be drilled from a conventional jack up drilling rig. The drilling rig will be towed in to location and the legs lowered on to the seabed. At present, no specific drilling rig has been contracted, therefore a 116-C class jack up drilling rig has been used as proxy for the purposes of the assessment, as commonly used in the Southern North Sea for this type of operation. A 116-C jack up drilling rig could have a fuel capacity of up to 1000 tonnes and a fuel consumption of up to 15 tonnes per day.

Each spud can of the drilling rig has a footprint of approximately 154.4 m^2, totalling around 463.2 m^2. Before drilling operations, stabilisation and scour protection will be provided by rock dump, with approximately 1,000 tonnes per leg. Assuming that the stabilising material is deposited within 5 m of each spud can, the rock dump should cover an area of around 1,359.5 m^2. The drilling rig will be moved on to location by three tugs.

2.3.6 Other Vessels and Helicopters

It is anticipated that during drilling and installation operations, 3 supply vessels per week will visit the site, to deliver fuel, chemicals, water, and other supplies and equipment. In addition, 5 helicopter round trips per week from Norwich Heliport to the development location per week could be completed for crew changes or other purposes.

2.3.7 Estimated Construction Phase Fuel Consumption

Estimates of the fuel consumption for the major construction activities for the Blythe Field are provided in Table 2.1, and estimates for the Elgood field are provided in Table 2.2.

Table 2.1: Breakdown of Estimated Fuel Consumption of Construction Activities at the Blythe Field

Activity	Vessel	Fuel Type	Consumption [m^3/day]	Duration [days]	Total Fuel Consumption [m^3]
Mobilisation and demobilisation of drilling rig	Anchor handling tug × 3	Diesel	3 × 50	4	600
Drilling operations on location	116-C Class Jack-up	Diesel	15	82.5	1,238
Supply shipping (5 round trips per week, 12 hr round trips)	Supply vessels	Diesel	10	23	230
Safety vessel mob and demob	Emergency Response & Rescue Vessel	Diesel	8	2	16
Safety vessel on location	Emergency Response & Rescue Vessel	Diesel	4	82.5	330
Mobilisation and demobilisation of jacket and topsides	Tug x 2	Diesel	2 × 10	1	20
Mobilisation and demobilisation of jacket and topsides to field location	Heavy lift barge	Diesel	50	2	100
Installation of jacket and topsides	Heavy lift barge	Diesel	20	5	100
Mobilisation and demobilisation of pipelay vessel	Pipelay vessel	Diesel	8	2	16
Installation of export line and umbilicals	Pipelay vessel	Diesel	15	10	150
Mobilisation and demobilisation of Diving Support Vessel (DSV)	DSV	Diesel	22	4	88
Installation of manifolds	DSV	Diesel	18	10	180
				Total	**3,068**
Activity	**Vessel**	**Fuel Type**	**Consumption [l/hr]**	**Duration [hrs]**	**Total Fuel Consumption [m^3]**
Personnel transport (5 round trips per week)	Helicopter	Aviation fuel	603	59	28

Note:
Consumption rates taken from Guidelines for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures (Institute of Petroleum, 2000)

Table 2.2: Breakdown of Estimated Fuel Consumption of Construction Activities at the Elgood Field

Activity	Vessel	Fuel Type	Consumption rate [m^3/day]	Duration [days]	Total Fuel Consumption [m^3]
Mobilisation and demobilisation of drilling rig	Anchor handling tug × 3	Diesel	3 × 50	4	600
Drilling operations on location	116-C Class Jack-up	Diesel	15	85.5	1,283
Supply Shipping (5 round trips per week, 12 hr round trips)	Supply vessels	Diesel	10	20.5	205
Safety vessel Mobilisation and demobilisation	Emergency Response & Rescue Vessel	Diesel	8	2	16
Safety vessel on location	Emergency Response & Rescue Vessel	Diesel	4	85.5	342
Mobilisation and demobilisation of pipelay vessel	Pipelay vessel	Diesel	8	2	16
Installation of pipelines and umbilicals	Pipelay vessel	Diesel	15	5	75
Mobilisation and demobilisation of Diving Support Vessel (DSV)	DSV	Diesel	22	4	88
Hook-up, testing and commissioning	DSV	Diesel	18	5	90
				Total Diesel Consumption	**2,715**
Activity	**Vessel**	**Fuel Type**	**Consumption [l/hr]**	**Duration [hrs]**	**Total Fuel Consumption [m^3]**
Personnel transport (5 round trips per week)	Helicopter	Aviation fuel	603	62	30

Note:
Consumption rates taken from Guidelines for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures (Institute of Petroleum, 2000)

2.4. Drilling and Completion Operations

The Blythe and Elgood fields will be developed by drilling single horizontal wells into each reservoir. To prevent water breakthrough from the underlying aquifer, a suitable distance will be maintained above the free water level (FWL), currently planned to be approximately 26.4 m (80 ft). The drilling and completion operations are planned to be undertaken as a single campaign. Both wells will be completed with a 4½" production tubing.

2.4.1 Drilling Schedule

The Blythe jacket and topsides will be installed during Q2 2019. Drilling activity would commence immediately after the installation activities are complete and the Jack-up can be cantilevered over the platform. Once the Blythe well is completed and put on production the drill rig will be mobilised to either the Vulcan Satellites or Elgood.

The proposed drilling programme is expected to take 82.5 days to complete the BL_H2V2 well and 85.5 days to complete the EL_H1 well. A schedule of the proposed drilling and completion operations is provided in Table 2.3.

Table 2.3: Schedule of the Proposed Drilling Operations for the Blythe Well

Well	Description of Drilling and Completion Operation	Days	Cumulative Time (Days)
BL_H2V2	Mobilisation	2.00	2.00
	Prepare to spud	1.00	3.00
	Drill 36" section	1.00	4.00
	Run and cement 30" conductor	1.75	5.75
	Drill 17½ " section	4.25	10.00
	Run and cement 13⅜" casing	1.50	11.50
	Install wellhead and 13⅝" BOP	2.25	13.75
	Drill 12¼" section	16.00	29.75
	Run and cement 9⅝" casing	2.25	32.00
	Drill 8½" section	8.50	40.50
	Run and cement 7" liner	3.00	43.50
	Drill 6" section	10.75	54.25
	Run and cement 4½" liner	3.25	57.50
	Well bore clean-up	2.50	60.00
	Completion and run production tree	15.00	75.00
	Rig down and demob	7.50	82.50

Table 2.4: Schedule of the Proposed Drilling Operations for the Elgood Well

Well	Description of Drilling and Completion Operation	Days	Cumulative Time (Days)
EL_H1	Mobilisation	2.00	2.00
	Prepare to spud	2.00	4.00
	Drill 36" section	1.00	5.00
	Run and cement 30" conductor	1.75	6.75
	Drill 17½" section	4.25	11.00
	Run and cement 13⅜" casing	1.50	12.50
	Install wellhead and 13⅝" BOP	2.25	14.75
	Drill 12¼" section	11.25	26.00
	Run and cement 9⅝" casing	2.50	28.50
	Drill 8½" section	10.75	39.25
	Run and cement 7" liner	3.25	42.50
	Drill 6" section	12.25	54.75
	Run and cement 4½" liner	3.50	58.25
	Well bore clean-up	2.75	61.00
	Completion and run production tree	18.50	79.50
	Rig down and demob	6.00	85.50

2.4.2 Drilling, Cementing and Completion Chemicals Management

During the proposed drilling operations, a variety of chemicals will be used to facilitate the drilling process and the safe completion of the well including drilling fluids and cementing chemicals. Contingency chemicals will also be present on the rig in case they are required for any unexpected situations encountered during drilling. In addition, a number of chemicals will be used on the drilling rig for maintenance, such as detergents to wash the rig floors and lubricants for certain equipment and machinery.

All chemicals used will be approved by Cefas, and will be in accordance with UK chemicals regulations. Wherever practicable and technically feasible, chemicals without substitution warnings will be prioritised over those that do have warnings.

2.4.3 Drilling Muds

Seawater and high viscosity sweeps will be used to drill the 36" section. WBM will be used for the 17½" sections. The WBM will be made from a base fluid which may be seawater or brine. These WBM systems incorporate natural clays in the course of the drilling operation and any chemicals that are added to WBM are generally of low environmental risk and many are classified as Pose Little or No Risk (to the environment) (PLONOR).

LTOBM will be used to drill the lower sections of the well and are composed of oil in the continuous phase, where they will be formulated with mineral oil, or low-toxicity linear olefins and paraffins, and water in the dispersed phase in conjunction with certain chemical additives such as emulsifiers and wetting agents. LTOBM offers a number of advantages over drilling with WBM such as offering faster drilling rates, increased stability in water-sensitive rock formations (e.g. clays and shales) and greater effectiveness at drilling deep, high-temperature wells. In addition, LTOBM is used in a closed system and therefore muds can be recycled throughout the drilling programme consequently smaller quantities are required compared to WBM.

2.4.4 Cuttings and Mud Discharges

Cuttings and viscous sweeps and WBM from the 36" section will be discharged at the seabed, as is normal practice on the UKCS. Cuttings and drilling fluids from the 17½" section will be returned to the rig via the conductor, and pass through a mud recovery system to recover as much of the drilling mud as possible. Once reconditioned, this mud will be used again, thereby minimising the amount of drilling mud required. Cuttings from the 17½" section will be discharged at the sea surface. It is anticipated that the cuttings and any residual WBM will be dispersed naturally by the strong tidal currents, and that there will be no requirement for mechanical cuttings relocation or dredging.

Cuttings and drilling fluids from the lower well sections and will be circulated back to the drilling rig via the annulus (the space between the drill stem and the wall of the bore hole) and the conductor. The mud and cuttings from these sections will also pass through the mud recovery system to recover as much of the drilling mud as possible.

LTOBM contains a number of chemical additives, as well as the oil-base, that may have an impact on the marine environment and may be listed as candidates for substitution. As such, the discharge of LTOBM is prohibited in UK waters and spent LTOBM and cuttings will be shipped to shore for treatment and disposal and will not be discharged into the marine environment during the course of the operations. Table 2.5 and Table 2.6 provide the estimated cuttings generation and associated mud use for each well. Prohibited discharges are classified as Zero Discharge, Skip and Ship (ZSS).

Table 2.5: Estimated Cuttings Generation and Discharges for BL_H2V2

Section	Mud System	Discharge Point	Section Length [m]	Cuttings Volume [m³]	Cuttings Generated [Tonnes]	WBM Discharged [Tonnes]
36"	Seawater and viscous sweeps	Seabed	78	154	400	310
17½"	WBM	Rig/sea surface	622	145	376	1,250
12¼"	LTOBM	Skip and ship	1,760	147	383	NA
8½"	LTOBM	Skip and ship	648	25	64	NA
6"	LTOBM	Skip and ship	656	13	34	NA
		Total	**3,764**	**484**	**1,257**	**1,560**

Table 2.6: Estimated Cuttings Generation and Discharges for EL_H1

Section	Mud System	Discharge Point	Section Length [m]	Cuttings Volume [m³]	Cuttings Generated [Tonnes]	WBM Discharged [Tonnes]
36"	Seawater and viscous sweeps	Seabed	78	154	400	310
17½"	WBM	Rig/sea surface	622	145	376	1,250
12¼"	LTOBM	Skip and ship	2,301	193	500	NA
8½"	LTOBM	Skip and ship	960	39	101	NA
6"	LTOBM	Skip and ship	422	9	22	NA
		Total	**4,383**	**540**	**1,399**	**1,560**

2.4.5 Cement Discharges

The casings used to prevent the well from collapsing will be cemented into place by pumping cement down the casing string, out through a hole in the bottom and back up to the surface through the annulus. For the conductor (30") and surface casing (13 ⅜") it is critical to get cement back to seabed to ensure the structural integrity of the well and therefore there is the possibility that cement will be discharged to the sea.

For the 30" conductor, the cement will be pumped down the drill string and up the conductor annulus to the seabed. Rather than mixing a large batch of cement for this job it will be mixed on demand and when cement is observed at seabed by the Remotely Operated Vehicle (ROV) mixing and pumping will be terminated to minimise the volume discharged. The worst case estimated cement discharge for this section is 31 m^3 or 60 tonnes. This is based on the entire excess reaching seabed, in the event that the hole is in gauge (so estimated excess proves to have been unnecessary) and the ROV was unable to see the cement returns due to poor visibility or poor weather preventing ROV launch.

The 13 ⅜" casing will also be cemented in place but in this case any excess cement returns will be returned to the rig before being discharged overboard in the same manner as drill cuttings. The estimated worst case for cement discharge from this section is 20 m^3 or 31 tonnes.

Subsequent casing strings will not be cemented in place, so it is highly unlikely that cement will return to the rig, however, in the event that it does, it will be captured in the skip and ship system and returned to shore for processing due to the presence of oil based mud in the well at this time.

A small volume of cement will also be discharged following each cement job during the process of cleaning the cement pump and mixing tank. The volume of cement being discharged at this time will be very small and is unlikely to exceed 2 m^3.

Any cementing chemicals which will be required as part of the proposed operations will be included in a supporting Chemical Permit (CP) Subsidiary Application Template (SAT) application submitted to BEIS. IOG anticipates that up to 10% of any cement will be discharged to sea as a result of tank and pipework cleaning and flushing. Additional cementing chemicals may be required to deal with any unplanned events and, therefore, a number of contingency chemicals will be stored on the drilling rig to manage any such eventualities to allow the operations to be completed. A similar level of discharge is anticipated for these chemicals (10%).

In the event that cement is mixed and there is a requirement for an emergency discharge of a larger volume of slurry due to an issue arising downhole then IOG will contact BEIS to discuss the best practicable environmental option for the disposal of the chemicals involved.

2.4.6 Well Completion

The wells will be completed as gas production wells. The wells will be completed with a 4½**"** tubing. After pressure testing to confirm integrity, the liner will be perforated.

If the proposed drilling operations are unsuccessful and no natural gas is found, the contingency option will be to suspend or abandon the wells, following the Oil and Gas UK Suspension and Abandonment of Wells Guidelines (OGUK, 2015).

2.5. Subsea Installation

2.5.1 Installation Vessels

Specific vessels have not yet been contracted, so the following vessels will be used as proxies in the relevant impact assessment chapters.

2.5.2 Blythe Platform Installation

The jacket will be transported and installed by the heavy lift vessel. The jacket will be skirt piled to the seabed, with two piles per leg. Each pile will have a diameter of 91.4 cm (36"). The piles will be driven by a subsea hydraulic hammer. Hammer energy is likely to be between 1,800 kNm or 2,300 kNm. Piling is expected to take one day per leg.

2.5.3 Elgood Infrastructure Installation

The installation of the wellhead, subsea production tree and fishing friendly protection structure will be conducted from the drilling rig. Well completion and installation of the subsea tree will take 18.5 days. This is included in the total duration provided for the Elgood drilling programme in Table 2.4. The fishing friendly structure will be clamped on to the tree, and therefore no piling will be necessary.

2.5.4 Pipeline Installation and Protection

The 8" flowline from Elgood to Blythe, the 10" pipeline from Blythe to the Thames export line, and chemical flowlines will be mechanically trenched and buried by a subsea trenching vehicle. Both lines are expected to be reel laid into position. The control umbilical from Blythe to Elgood will be installed into a separate trench with a suitable subsea cable plough. Details of the footprint of pipeline installation methods is provided in Table 2.7.

Table 2.7: Footprint of Trenching Activities

Pipeline	Length [km]	Installation Method	Trench Width [m]	Area Disturbed [km^2]	Track/Skid Width [m]	Area Compacted [km^2]	Total Area Affected [km^2]
Blythe to Thames 10" Export	24.5	Trenching vehicle	1.07	0.026	2	0.049	0.075
Elgood to Blythe 8" Flow Line	9.3	Trenching vehicle	1.07	0.010	2	0.019	0.029
Blythe to Elgood Umbilical	9.3	Subsea cable plough	0.25	0.002	3	0.028	0.030
						Total	**0.134**

The new Blythe manifold connection will be constructed into the pipeline within the Block 48/29. The precise final location is subject to a detailed survey. The water depth at the expected tie in point is approximately 32 m below LAT.

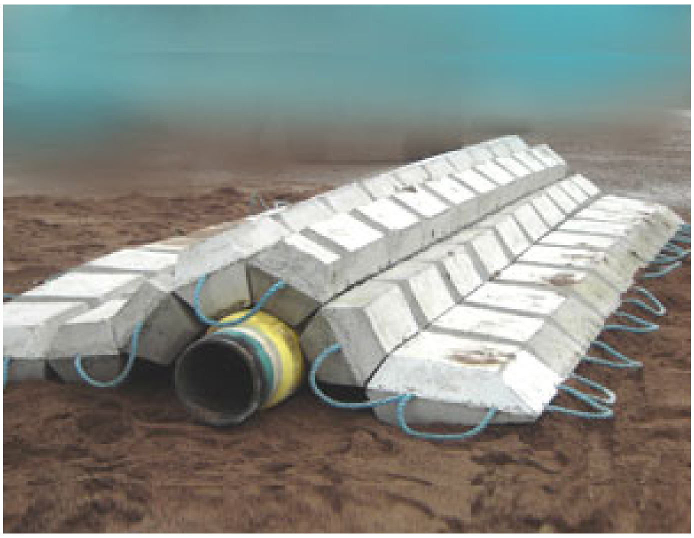

Figure 2.2: Concrete mattress of the type to be used for pipeline protection

Dropped object protection for exposed sections of pipeline and umbilical at connection points, tie-in points and crossing points will be provided by 6 × 4 m concrete mattresses similar to that shown in Figure 2.2. Five mattresses will be laid for each pipeline crossing. The umbilical connection at Elgood will lie on the seabed surface with a 100 m length laid in a shepherd’s crook arrangement. Up to 25 mattresses will be used to provide protection for this section of umbilical.

Table 2.8: Areas Seabed Covered by Mattresses

Location	Pipeline	Number of Mattresses	Area Covered [m^2]
Tie-in point at PL370	10" Blythe export	5	120
Crossing PL253	10" Blythe export	5	120
Crossing PL632	10" Blythe export	5	120
Crossing PL996	10" Blythe export	5	120
Crossing Stratos Cable	10" Blythe export	2	48
Crossing PL1570, PL876, PL877 (Assumed same trench)	10" Blythe export	5	120
Connection at Blythe platform	10" Blythe export	5	120
Connection at Blythe platform	3" MEG line	5	120
Connection at Blythe platform	8" Elgood line	5	120
Connection at Elgood	8" Elgood line	5	120
Connection at Blythe platform	Umbilical	3	72
Connection at Elgood	Umbilical	25	600
		Total	**1,800**

2.5.5 Surrounding Pipelines and Cables

The Blythe to Thames export line will cross six other existing active gas export or chemical lines (Figure 2.3).

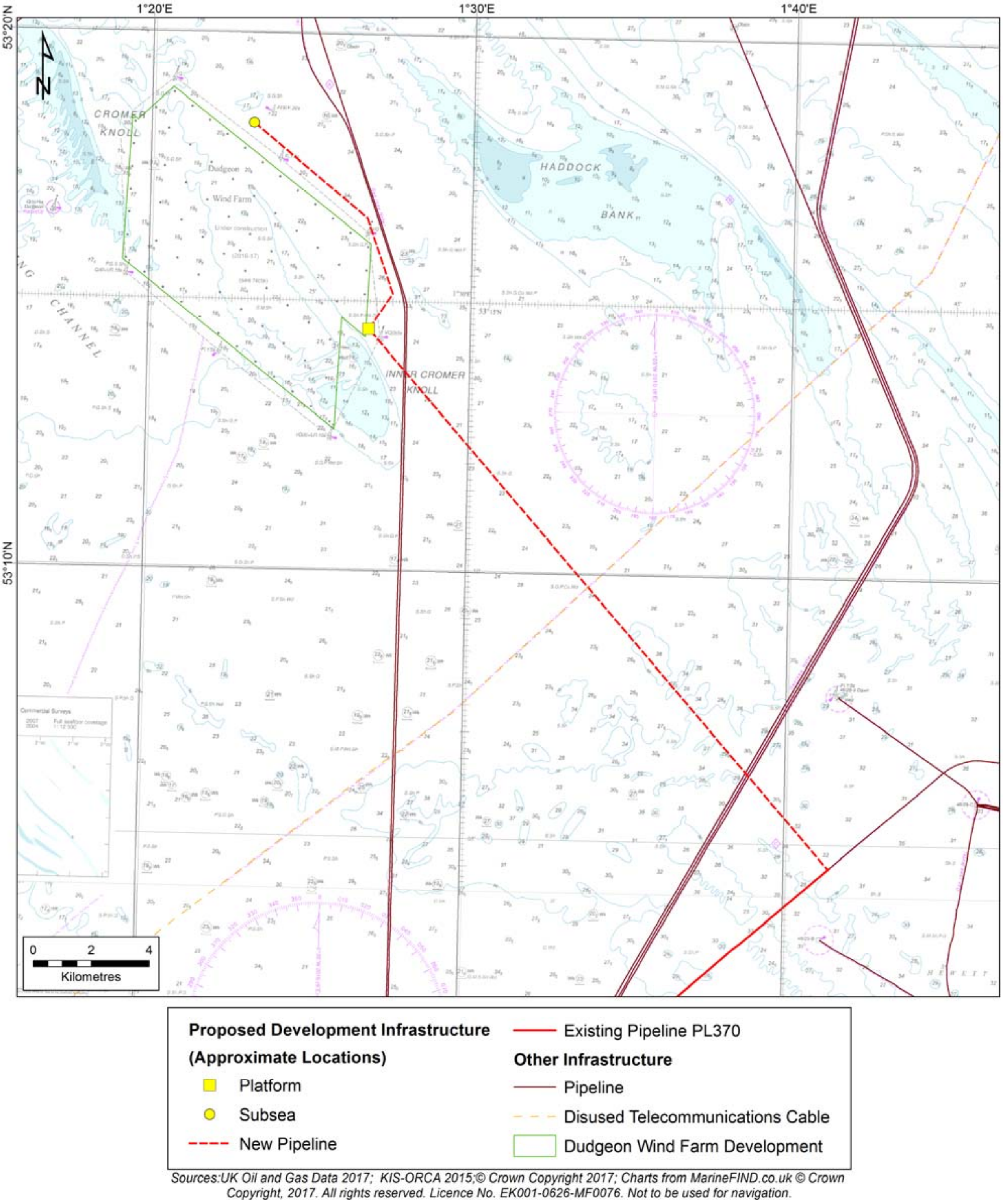

Figure 2.3: Pipeline crossings for the Elgood and Blythe export lines

Table 2.9 provides details of the oil and gas pipelines that the 10" export pipeline from the Blythe platform will cross.

Table 2.9: Details of Pipelines Crossed by the Blythe Export Line

Pipeline	Ref	Fluid	Diameter	Status	Operator
Esmond to Bacton Gas Export Line	PL253	Gas/Condensate	24"	Active	Perenco
Clipper PT to Bacton Gas Line	PL632	Gas	24"	Active	Shell
Bacton to Clipper PT Glycol Line	PL996	Chemical	3.5"	Active	Shell
Shearwater to Bacton (SEAL) Gas Line	PL1570	Gas	34"	Active	Shell
Lancelot to Bacton Gas Export	PL876	Gas	20"	Active	Perenco
Bacton to Lancelot MEG Line	PL877	Chemical	3"	Active	Perenco

The 8" flowline from the Elgood well to the Blythe platform will run parallel three existing pipelines, PL1570, PL876 and PL877 around the eastern corner of the Dudgeon OWF, separated by approximately 325 m.

Corrosion inhibitor and hydrate prevention chemicals will be provided via the Bacton to Lancelot 3" MEG line and stored on the platform, therefore the chemical line tie-in may need to cross the export lines.

Table 2.10 provides details of the subsea cables that the 10" export pipeline from the Blythe platform will cross.

Table 2.10: Details of Cables Crossed by the Blythe Export Line

Cable	Type	Status	Operator
STRATOS	Telecoms	Active	BT/BAE

The final specification of installations and construction methodology for crossing points will be determined once full pipeline surveys have been completed.

2.5.6 Pipeline Hydro-testing and Flushing

Once the Blythe export line has been successfully tied in, it will be pressure tested. Water remaining in the pipeline after testing will be deposited into the PL370 export pipeline to Bacton.

2.6. Production Operations

The production rate will be initially capped at 1,699,009 m^3/day (60 MMcfd). Table 2.11 presents the range of production estimates for the Blythe and Elgood fields over the 12 year life of the fields.

Table 2.11: Production Estimates for the Blythe and Elgood Fields Combined

	Gas		Condensate	
Case	**[Millions m^3]**	**[Bcf]**	**[m^3]**	**Bbls [Millions]**
High	2,506	88.5	143,089	0.90
Medium	1,841	65.0	103,342	0.65
Low	1,220	43.1	63,595	0.40

2.6.1 Platform Operations

Once the well is commissioned and brought into production the platform will begin normal unattended operations. The platform will only ever be manned overnight in an emergency situation and for periodic day visits as required for routine maintenance and replenishing consumables. Accommodation on board is provided for emergency use only with access by both helicopter and boat landing.

The well will be configured for remote start up. This operation will be auto controlled by a valve arrangement. All utilities, power and controls for Elgood will be provided via an umbilical connection from the Blythe platform.

Facilities for a temporary pig launcher will be installed on the Blythe platform upstream of the riser for dewatering purposes post construction of the pipeline. A pigging philosophy will be developed as part of Front End Engineering and Design (FEED) to address operational needs.

Wet gas type allocation metering will be provided on the Blythe platform prior to export, with fiscal metering provided at the Bacton terminal.

A High Integrity Pressure Protection System (HIPPS) will be provided on the Blythe platform in order to protect the safe operating pressure of the topsides and export pipeline.

2.6.2 Power Requirements

Power requirements are anticipated to be in the region of 30 kW to 35 kW. Power generation for the Blythe platform will be provided by a combined part renewable energy system (wind and solar energy) and a part traditional diesel engine system for when renewable energy is not in full supply. Therefore, combustion emissions from the platform will be minimal and well below the 20 MW(th) threshold for the EU Greenhouse Emissions Trading Scheme (ETS).

2.6.3 Produced Water

Produced water is not expected for the first six years. When water breakthrough occurs it will be exported along with all other reservoir fluids to the Bacton Terminal for processing and appropriate disposal.

2.6.4 Pipeline and Production Chemicals

Corrosion inhibitors and hydrate inhibitors will be supplied to the Blythe and Elgood wells via the Bacton to Lancelot 3" MEG line and stored on the platform. Any chemicals used will be approved by Cefas, and will be in accordance with UK chemicals regulations. Wherever practicable and technically feasible, chemicals without substitution warnings will be prioritised over those that do have warnings.

2.7. Project Schedule

Facilities development operations at Blythe are currently planned to take place during Q1 and Q2 2019, and development at Elgood planned between Q2 and Q3 2019. Drilling operations are expected to last for 82.5 to 85.5 days per well, and are planned in Q3 2019 for Blythe and in Q4 2019 for Elgood. A schedule of the proposed operations is provided in Table 2.12.

Table 2.12: Schedule of Offshore Activities

Field	Activity	2018				2019				2020			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Blythe	**Delete row**												
	Site surveys	■											
	Facilities installation					■	■						
	Drilling							■					
	First Gas								■				
Elgood	**Delete row**												
	Site surveys	■											
	Facilities installation						■	■					
	Drilling								■				
	First Gas									■			

2.8. Decommissioning

Cessation of production estimated at circa 2031, depending on production and economic limits. In the UK, decommissioning is controlled through the Petroleum Act 1998, as amended by the Energy Act 1998. The UK's international obligations on decommissioning are governed principally by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention).

The infrastructure associated with the development will be decommissioned when operations are no longer economically viable. The lifespan of the Blythe Hub Development is expected to be approximately 12 years. Within this time frame there may be changes to statutory decommissioning requirements as well as advances in technology and knowledge. IOG will therefore aim to utilise best recognised environmental practice during all decommissioning operations in line with legislation and guidance at the time.

The main considerations of the decommissioning process will be navigational safety, the prevention of marine pollution and prevention of damage to the marine environment. The ultimate intention is to leave the seabed development area in the condition that it will pose no harm to the marine environment.

It is proposed to completely remove the wellhead platform from the seabed, following the cessation of economic production. Under the current legislation, it is planned to flush and leave the buried pipelines in situ. A decommissioning review will be conducted every three years throughout the life of the field. This will ensure that the financial provisions are made to meet the projected decommissioning costs.

Prior to the decommissioning process, re-use and recycling alternatives will be considered where feasible. In advance of the decommissioning process, an inventory of all project equipment will be made and an examination for further reuse will be carried out. Pre-decommissioning surveys will be carried out to establish the environmental baseline before decommissioning. Precise decommissioning methodology will depend upon operating conditions. Discussion on what may be required in an individual case will be held with the BEIS Offshore Decommissioning Unit before commencing.

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Section 3

The Local Environment

3 THE LOCAL ENVIRONMENT

3.1. Introduction

The Blythe Hub Development is situated within UKCS Blocks 48/22 and 48/23 in the Southern North Sea (Figure 3.1). The nearest landfall to the development area is the north Norfolk coast, approximately 35 km to the south-west of the Blythe field. At its nearest point, the UK/Netherlands median line is situated approximately 105 km east of the development area.

Information about the environment at the proposed development location and its surroundings has been collated to allow an assessment of those features that might be affected by the proposed Blythe Hub Development, or may influence the behaviour of potential contaminants.

The results of the scoping process (ES Section 4), and the subsequent assessment of all impacts deemed potentially significant, indicate that the majority of these will occur in the immediate vicinity of the development location. Any environmental receptors than may be impacted upon are described on a local scale. Other activities or events, such as underwater noise generation or large oil spills, could potentially affect a wider area. In these instances, the environmental sensitivities that may be affected are described on a broader scale.

3.2. Physical Environment

3.2.1 Hydrography

Water Masses and Currents

Inputs of North Atlantic water strongly influence the hydrography of the North Sea, with minor inflows from the English Channel and the Baltic Sea (DTI, 2002). The generalised pattern of water movement in the North Sea is anti-clockwise, with North Atlantic water moving south, balanced by a northerly outflow along the Norwegian coast. The Southern North Sea water moves in a broadly north easterly direction as part of this general circulation (DTI, 2002). The major water movements within the Southern North Sea are illustrated in Figure 3.1, and the characteristics of the main water masses are shown in Table 3.1.

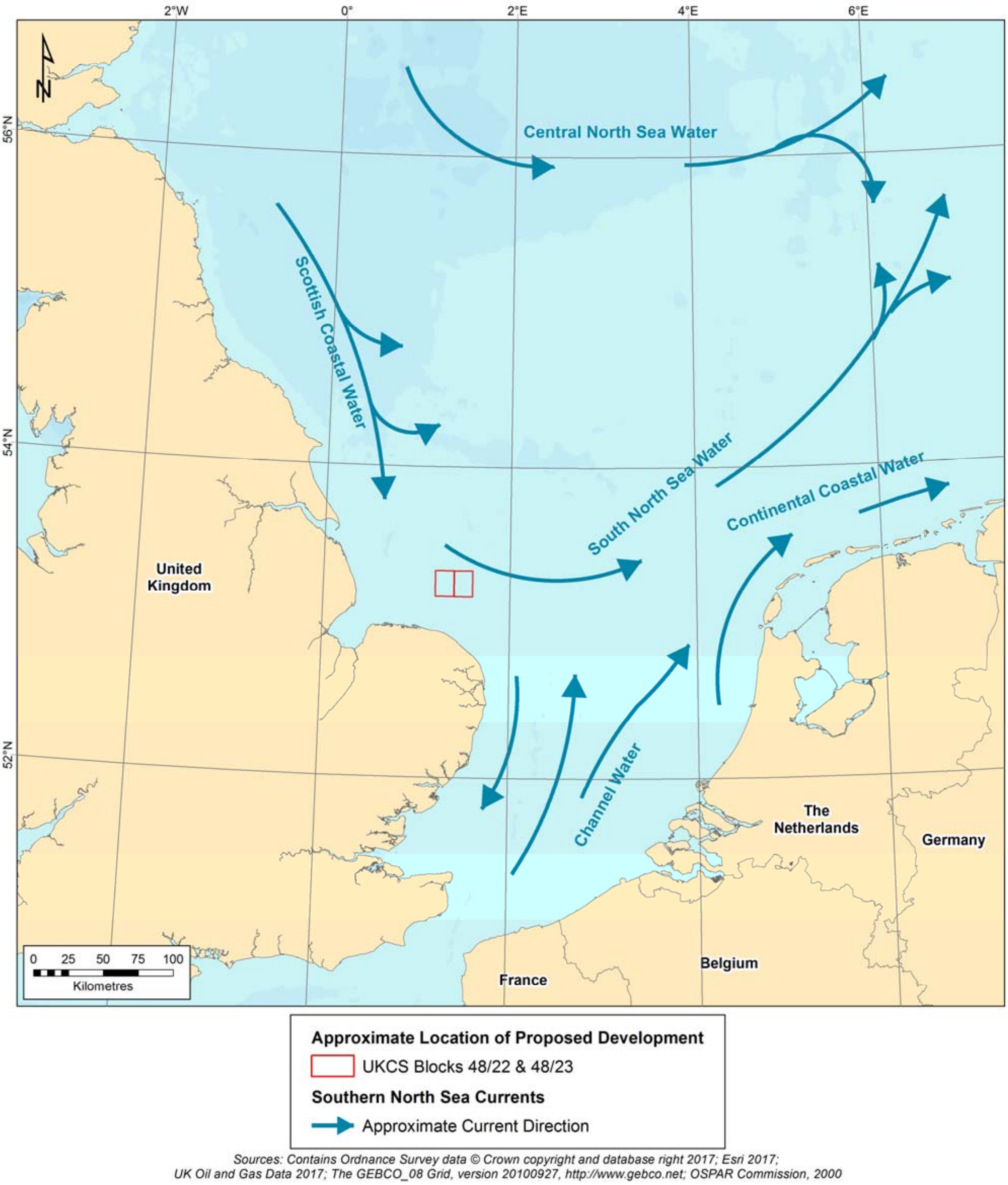


Figure 3.1: Ocean currents in the Southern North Sea (OSPAR Commission, 2000)

Table 3.1: Typical Temperature and Salinities of Water Masses in the North Sea (OSPAR Commission, 2000)

Water Mass	Temperature [°C]	Salinity [‰]
Scottish coastal water	5 to 15	33 to 34.5
Southern North Sea water	4 to 14	34 to 34.75
Channel water	6 to 18	>35
Continental coastal water	0 to 20	31 to 34

Considerable seasonal and annual variability of water inflow to the North Sea may be influenced by short to medium term weather conditions (OSPAR Commission, 2010; DTI, 2002). This can be responsible for large-scale differences in the salinity of the North Sea from year to year, as well as having implications for the circulation of nutrients and contaminants and for the supply of oceanic planktonic species and fish larvae (DTI, 2002).

Unlike the northern and central regions of the North Sea, the shallow parts of the Southern North Sea do not show stratification in the summer months. Instead, the water column in the Southern North Sea remains well mixed throughout the year due to strong tidal action (OSPAR Commission, 2000; DTI, 2001). Frontal areas mark the boundary between different water masses, including mixed and stratified areas, and are numerous in the Southern North Sea. Thermal fronts marking the transition zones between mixed and stratified water occur from the area off Flamborough Head to the Frisian Islands, off the Dutch, German and Danish coast (DTI, 2002).

Tidal waters in the proposed development area flood to the south and ebb to the north (BGS, 1995). Tidal stream data charted from the tidal diamond in location 53°19.0'N 1°25.4'E, located between the Elgood and Blythe fields, show maximum surface current speeds of 0.88 ms^{-1} during spring tides and 0.46 ms^{-1} during neap tides. The overall residual current is 0.049 ms^{-1}, flowing north-east (Hydrographer of the Navy, 2008).

Tidal range tends to increase from north to south throughout the study area, with water building up along the coast owing to the rotation of the earth. The mean spring tidal range at the Blythe Hub Development is approximately 4.5 m to 5.0 m (BGS, 1995). Low atmospheric pressure may raise the water level in this region, with dramatic effects, especially when associated with northerly winds. Tidal ranges may be up to 30 % greater during gales (BGS, 1995).

<u>Waves</u>

Wave climate is influenced by wind speed, wind duration and fetch (the distance over which the wind blows uninterrupted over the sea), which are in turn dependent on season and location. From October to March the North Sea south of 55°N, which includes the proposed development area, experiences significant wave heights of 4 m for <15% of the time (DTI, 2002).

Around the proposed development area, significant wave height, exceeded for 10% of the year, ranges from 2.0 m to 2.5 m (BGS, 1995). Fifty year maximum wave heights in the North Sea are estimated to range from around 32 m in the north to 12 m in the Channel (DTI, 2002).

3.2.2 Meteorology

<u>Wind</u>

Wind direction and velocity in the proposed development area are variable throughout the year, although the most prevalent winds tend to be from the south and south-west (DTI, 2002). Seasonal wind roses indicate that westerly winds are the most common, particularly from July to September, with winds from the west and south-west dominating. The windiest months recorded in the proposed development area are December and January when winds of 14 ms^{-1} to 16.5 ms^{-1} (Beaufort force 7) or more blow for 6 to 10 days a month. May through to August tend to be the least windy months with only 1 to 3 days reaching wind speeds of 14 ms^{-1} to 16.5 ms^{-1} (BGS, 1995 and HSE, 2001).

During the summer, there are occasional thundery squalls with wind speeds greater than 14 ms^{-1}, generally occurring near the coastline. Squalls associated with cold fronts can occur during any season, and showers of hail, sleet or snow that are common in winter and spring often give rise to sudden changes in wind speed and direction.

<u>Precipitation</u>

Mean annual rainfall is relatively low over much of the Southern North Sea when compared to the Atlantic seaboard and Norwegian coastal waters. Rainfall in the development area is estimated to be between 200 mm and 400 mm per annum (OSPAR Commission, 2000).

3.2.3 Seabed Characteristics

<u>Bathymetry and Seabed Features</u>

Water depths in the Southern North Sea are relatively shallow compared with the central and northern areas. The proposed development area is situated in the shallow, coastal waters of the Southern North Sea at water depths ranging from approximately 20 m to 30 m (UK Oil and Gas Data, 2017). A series of sand banks are present to the east where water depths decrease to less than 20 m.

Regional seabed sampling suggests that the seabed encountered around interest will consist of sand, coarse sand and gravels (DTI, 2002). The hydrodynamic regime in this area of the Southern North Sea has generated large expanses of sandbanks, some of which are slightly covered by seawater at all times resulting in a complex seabed topography. Two large areas of sandbanks of note are the Norfolk Banks and Sand Hills. The Sand Hills are a group of parallel ridges, some of which are covered in sand waves so may in part be 'active' (BGS, 2001). The Norfolk Banks sandbanks are the most extensive example of the offshore linear ridge sandbank type in UK waters and rest on a relatively flat sea bed at 20 m to 30 m depth (JNCC, 2017). The largest of the Norfolk Banks sandbanks is over 50 km long, 1.7 km wide and rises 38 m above the seafloor, although some banks are known to be even higher at over 42 m. The banks closest to shore tend to have sand waves on their flanks and are more active than the offshore banks, possibly due to the greater tidal current velocities closer to the coast (BGS, 2001).

Geology and Seabed Sediments

East of the Norfolk coast, the underlying offshore geology is composed of an upper cretaceous fine-grained limestone, which overlays a lower Cretaceous layer of mainly sandstones and mudstones (BGS, 1995).

The area surrounding the proposed development is one of complex seabed sediment distribution with Holocene sediments generally forming a veneer less than 1 m thick (BGS, 1995). The seabed sediments in the development area consist of sand, gravelly sand, and sandy gravel (BGS, 1995; Jones *et al*, 2004).

3.3. Biological Environment

3.3.1 Plankton

Plankton consists of microscopic plants (phytoplankton) and animals (zooplankton) including the larval stages of fish and many bottom living animals which drift with the ocean currents. The abundance of plankton is strongly influenced by factors such as water depth, tidal mixing and temperature stratification which determine the vertical stability of the water column; whilst the distribution of species is affected by salinity, temperature, water flow and the presence of local benthic communities (Edwards & John, 1995).

During spring, an increase in day length and temperature results in the rapid growth of the phytoplankton population. Phytoplankton assemblages in the proposed development area are expected to be characterised mostly by the dinoflagellate genera *Ceratia* and the diatoms *Chaetocera*, *Hyalochaete*, *Thalassiosira* and *Phaeoceros* (DECC, 2009; Johns & Reid, 2001). Although the size and timing of this bloom varies from year to year, in the relatively warm well mixed waters of the Southern North Sea it generally peaks in April. This phytoplankton bloom is closely followed by an increase in the zooplankton population as they feed on this increased food source.

Zooplankton abundance is typically at its highest between May and September, providing an important source of food for a range of fish species (Johns & Reid, 2001). Zooplankton communities in the Southern North Sea are dominated by copepod crustaceans such as *Calanus* and the larvae of echinoderms (Johns & Reid, 2001; DECC, 2009). Secondary phytoplankton and zooplankton blooms occur in autumn, although these are less pronounced (DTI, 2001).

3.3.2 Benthos

Benthos is the term used for animals and plants associated with the seabed, although plants are generally limited by their light requirement to depths of less than 50 m. Benthos consists mainly of animals that burrow into the sediment or form tubes in it (known as infauna). Other species which live on the seabed, or attached to rocks or to other biota, are known as epifauna. In general, the main influences on benthic communities are water depth and sediment type.

Locations to the north, east and south of the development area were sampled as part of the 1986 North Sea Benthos Survey (ICES, 2017). The results of this survey show the polychaetes *Ophelia borealis* and *Scoloplos armiger* to be abundant in the sample stations to the north and east of the development area (ICES, 2017.) In the sample station to the south of the development area, the amphipod crustacean *Bathyporeis elegans*, bivalve mollusc *Fabulina fabula* and the sea urchin *Echinocardium cordatum* were abundant (ICES, 2017).

Following the North Sea Benthos Survey in 1986, the benthic infauna in the Southern North Sea were categorised by Künitzer *et al* (1992) who recorded that fine sand sediments in a depth range of 30 m to 70 m in the region tended to be characterised by species of polychaetes such as *Ophelia borealis* and *Nephtys longosetosa*. The same study identified that the seabed was found to consist of coarser sediment at depths of <30 m and was typically dominated by the polychaete *Nephtys caeca*, the burrowing sea urchin *Echinocardium cordatum* and the amphipod crustacean *Urothoe poseidonis*.

Epibenthic trawl studies in the area have shown that the starfish *Astropecten irregularis*, brittle star *Ophiura ophiura*, hermit crab *Pagurus bernhardus* and decapod *Liocarcinus holsatus* are typical of the larger and more widely dispersed animals to be found in the Southern North Sea (Callaway *et al*, 2002; Jennings *et al*, 1999). *Asterias rubens* is found throughout the North Sea, but the largest numbers have been found in the Southern North Sea (Dyer *et al*, 1983). Additionally, the sea urchin *Psammechinus miliaris* is very common throughout the area in water less than 100 m (Cranmer, 1985; Jennings *et al*, 1999). A habitat investigation survey undertaken by Fugro in 2008 observed that the benthic fauna within the development area was typical of mixed sediment habitats in the Southern North Sea. Identified fauna from the survey included dead man's fingers (*Alcyonium digitatum*), hydroids, bryozoans (*Flustra foliacea*), anenomes and sponges (Fugro, 2008). Examples of mobile epifauna identified within the survey area included seastars (*Asterias rubens*), crabs, flatfish and a seamouse polychaete (*Aphrodite aculeata*) (Fugro, 2008).

The reef building worm, *Sabellaria spinulosa*, has also been found to be characteristic of coarse to medium sandy sediments in the Southern North Sea (Rees *et al*, 2007). This species can form large biogenic reefs of conservation interest. Favourable conditions for *Sabellaria* include areas of silty sand sediment with a high abundance of coarse material (e.g. cobbles/shells) for attachment. *Sabellaria* are often found on areas of raised topography where suspended sand supply may be high for feeding and tube formation (i.e. the edges of sandbanks and where there are sand waves) (Foster-Smith & White, 2001; Holt *et al*, 1998). The sandy sediments and high energy currents of the Southern North Sea provide suitable conditions for the formation of extensive biogenic reefs, created by *Sabellaria*.

Reefs can persist for many years and consequently have an important physical influence on the environment. They provide a diverse 3-dimensional biogenic habitat (i.e. crevices, surfaces, hard substrata and sediments) for attachment, colonisation and establishment of many associated species in areas where they would not otherwise be found (Foster-Smith & Hendrick, 2003). For these reasons, biogenic reefs have a very rich associated flora and fauna, which is often much richer and more diverse than in surrounding areas, and may play an important role in the functioning of the wider local ecosystem.

Other potentially sensitive areas include biogenic reefs created by aggregations of the horse mussel (*Modiolus modiolus*) or the common mussel (*Mytilus edulis*) and shallow sandbanks, which are both designated as Annex I habitats under the EC Habitats Directive.

IOG has commissioned an environmental baseline survey (EBS) and habitat assessment of the Blythe Hub Development area to confirm the species and habitats present at the exact project location. However, the results of these surveys were not available in time for the preparation of this ES, so these will be discussed and used to inform future permit applications for the Blythe Hub Development, instead.

3.3.3 Fish and Shellfish

Distribution of Adults

The proposed development area will, at times, contain fish stocks of both commercial and non-commercial importance. Adult fish populations are highly dynamic and it is difficult to define fixed patterns of their presence and distribution. However, fisheries landings data suggest that adult populations of cod, whiting, plaice, sole, lemon sole, herring, and sand eel are found in this area of the Southern North Sea. Commercially important shellfish populations of lobsters, edible crabs, whelks, and scallops are also present within the general area (Scottish Government, 2016). Fishing effort and landings are discussed separately in Section 3.5.1.

Spawning and Nursery Grounds

Extensive survey programmes have been used to predict the broad distribution of spawning grounds for a range of commercially important fish and shellfish species in UK waters (Coull *et al*, 1998). For many of these species, this has been supplemented by more recent data collation and review by CEFAS (Ellis *et al*, 2012) and Marine Scotland (Aires *et al*, 2014), the latter with specific reference to the distribution of juvenile individuals.

The Blythe Hub Development lie within or close to predicted spawning grounds for a range of species; cod, herring, lemon sole, mackerel, plaice, sand eels, sole and whiting (Coull *et al*, 1998; Ellis *et al*, 2012). The majority of species show peak spawning activity between January and June, although several spawn over a longer period (Table 3.2).

Table 3.2: Fish Spawning and Nursery Grounds in the Vicinity of Blythe Hub Development (Coull *et al*, 1998; CEFAS, 2001; DTI, 2002; Ellis *et al*, 2012)

	Fish Spawning and Nursery Grounds											
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Cod	S/N	**S**/N	**S**/N	S/N	N	N	N	N	N	N	N	N
	Cod occur throughout the northern and central areas of the North Sea. Cod spawn all over the North Sea, although there are several areas where spawning is concentrated, particularly in the northern North Sea, the central North Sea around the Dogger Bank and in the Southern North Sea and German Bight.											
Herring	N	N	N	N	N	N	N	S/N	S/N	S/N	N	N
	Herring are found throughout the shelf waters and spawn in relatively shallow, well oxygenated, water in areas of coarse sediment. Sub-populations of North Sea herring spawn at different times of year in localised areas. In the Central and Southern North Sea off the north-east English coast, spawning takes place from August to October.											
Lemon sole	N	N	N	S/N	S/N	S/N	S/N	S/N	S/N	N	N	N
	Although the centre of distribution of lemon sole is in the coastal waters of northern Scotland and the Orkney and Shetland Islands, they are also found off the north-east coast of England and throughout the central and Southern North Sea. Little is known about the spawning habits of lemon sole.											
Mackerel	N	N	N	N	**S**/N	**S**/N	**S**/N	S/N	N	N	N	N
	Two main stocks of mackerel occur in the north-east Atlantic, the western stock and the North Sea stock. The North Sea stock has been at a very low level for years due to high fishing pressure and poor recruitment. North Sea mackerel overwinter in the deep water to the east and north of the Shetland Islands. In spring, they migrate south to spawn in the North Sea between May and August.											
Plaice	**S**/N	**S**/N	S/N	N	N	N	N	N	N	N	N	S/N
	Plaice are a coastal species and can be found at highest abundance in the southern part of the North Sea. Plaice spawn throughout the shallower parts of the Southern North Sea. Peak spawning occurs in early January in the eastern part of the English Channel and February in the southern Bight, German Bight and off Flamborough Head.											
Sand eel	S/N	S/N	N	N	N	N	N	N	N	N	S/N	S/N
	Sandeels are a shoaling species which lie buried in the sand at night and hunt during the day. Spawning occurs throughout the southern and Central North Sea, but especially near sandy sediments off the coast of north-east England. Spawning usually takes place between November and February.											
Sole	N	N	S/N	**S**/N	S/N	N	N	N	N	N	N	N
	Sole is a southern species that is close to the northern limits of its distribution in the North Sea. They spawn during April and May in shallow inshore areas and close to sandbanks. Nursery grounds are situated in shallow waters along the English and continental European coasts at depths of between 5 and 10 m.											
Whiting	N	S/N	S/N	S/N	S/N	S/N	N	N	N	N	N	N
	Although it is one of the most abundant species in the North Sea, information on whiting spawning is limited. Spawning areas are located in the central and Southern North Sea and off the coast of Scotland, although other areas may be important. Juveniles can be found throughout the North Sea, particularly off the north-east coast of England.											
S	Spawning ground (Peak spawning shown in **bold**)					N	Nursery area			S/N	Spawning and Nursery	

Most fish species release large numbers of eggs directly into the water column. Their spawning grounds cover extensive areas, leaving them less vulnerable to disturbance from point sources. However, certain species relevant to this area are more restricted in their spawning preferences, e.g. herring and sand eel. The dependency of these species on specific substrates and spawning grounds makes them particularly susceptible to impacts resulting from oil and gas exploration and production.

Herring spawning takes place in relatively shallow water, at depths of approximately 15 m to 40 m. Shoals congregate on persistent spawning grounds where all members of the shoal spawn simultaneously. Herring are demersal spawners, depositing their sticky eggs on coarse sand, gravel and shells, resulting in an 'egg carpet' of between four and nine layers thick (DTI, 2002). In this part of the Southern North Sea, spawning takes place between August and October (Ellis *et al*, 2012). Each female will produce a single batch of eggs every year, with the eggs taking between one and three weeks to hatch. As part of any environmental survey undertaken in support of the Blythe Hub Development, investigations will be conducted to determine the suitability of the area as a herring spawning ground.

Sand eels deposit their eggs on the sandy sediments with which they remain in close association. This dependence on sandy sediments means that the distribution of juvenile and adult sand eels is restricted by the patchy distribution of their preferred habitat. Sand eels spawn between November and February (Ellis *et al*, 2012).

The Blythe Hub Development lies in a year-round nursery area for cod, herring, lemon sole, mackerel, plaice, sand eel and whiting (Figure 3.2). Apart from sand eels, these areas form part of large continuous swathes of habitat over which nursery grounds are found. As stated above, Marine Scotland have recently published a report which provides modelled spatial representations of the predicted distribution of 0 age group fish (fish in the first year of their life) aggregations. These modelled representations are not provided in Figure 3.2. Although not all North Sea species were included in the study, a review of the associated report indicates that there is a low probability of the development area being utilised as a nursery area by whiting (Aires *et al*, 2014).

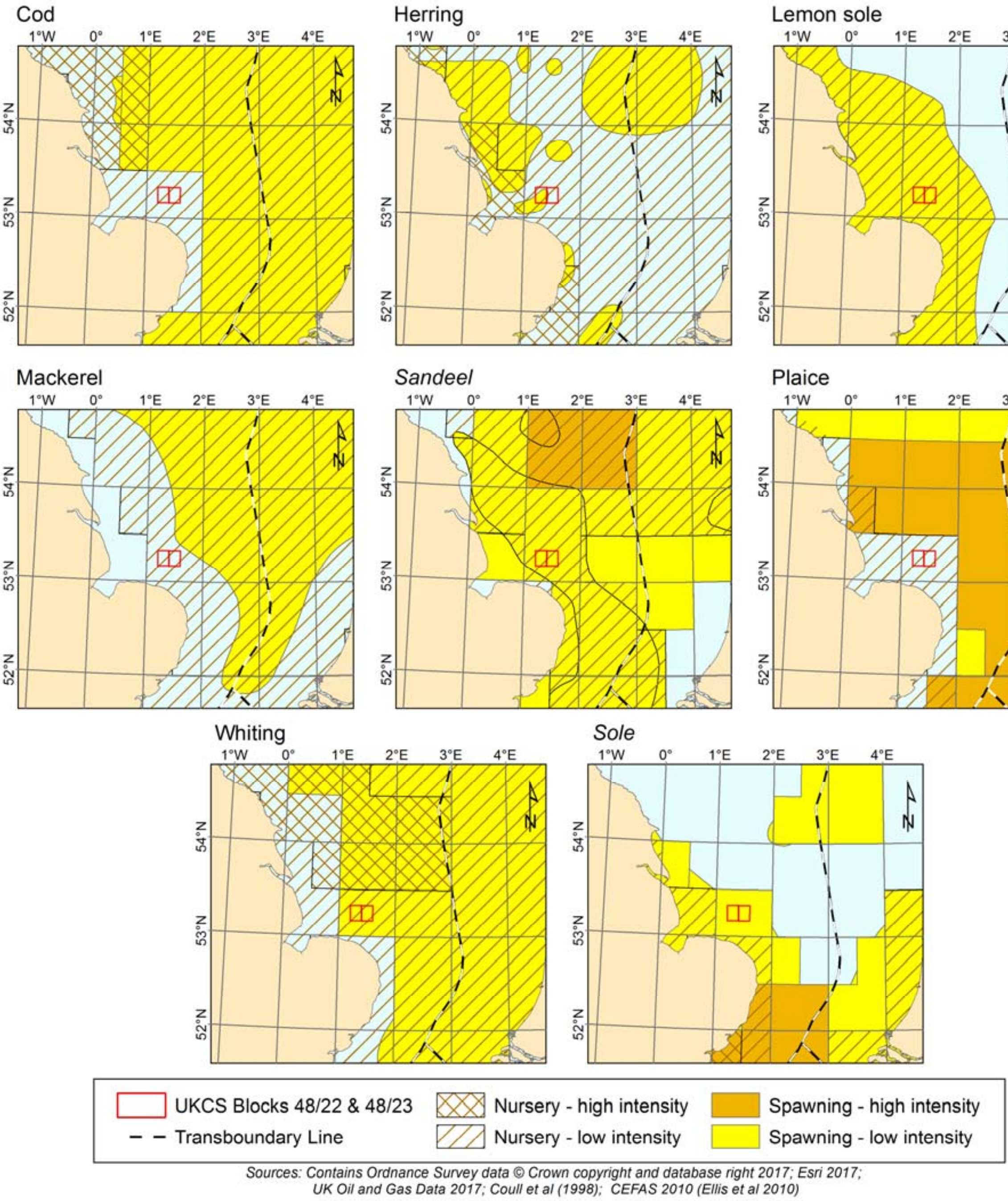


Figure 3.2: Commercially important fish spawning and nursery grounds

3.3.4 Marine Mammals

Whales, Dolphins and Porpoises

The Blythe Hub Development is located in the shallow waters of the Southern North Sea near the Norfolk coast. The number and diversity of cetaceans (whales, dolphins and porpoises) decreases progressively southwards through the North Sea and the Southern North Sea supports relatively few species (Sea Watch Foundation, 2017). The four most commonly observed species in this area are the minke whale, white beaked dolphin, Atlantic white sided dolphin and harbour porpoise (Reid *et al*, 2003).

Minke whales occur frequently throughout the northern and central North Sea, but are found in smaller numbers in the Southern North Sea (Reid *et al*, 2003). Those individuals observed in the proposed development area are at the southern limit of their range (Reid *et al*, 2003). Minke whale are generally present in the Southern North Sea between July and October (Evans, 1995). Minke whale are usually seen singly or in pairs, although they can aggregate in groups of 10 to 15 individuals when feeding (Reid *et al*, 2003). Minke whales occur both on the continental shelf and in offshore waters, where they feed on a variety of schooling fish and crustaceans. Favoured feeding locations tend to include areas of upwelling and strong currents, where prey resources are increased and feeding effort reduced (Reid *et al*, 2003).

White beaked dolphins are present in the North Sea all year round, although sightings tend to peak between June and October (Hammond *et al*, 2002; Northridge *et al*, 1995; Reid *et al*, 2003). White beaked dolphins are largely found in waters less than 100 m. Individuals are regularly recorded in the Southern North Sea, particularly towards the coast of Norfolk, although those individuals observed in the study are thought to be at the southern limit of their range, preferring the northern sector of the central North Sea (Reid *et al*, 2003). White-beaked dolphins are generally observed in small groups of less than ten individuals and feed on a range of prey species including herring, cod, haddock, whiting and hake (Northridge *et al*, 1995; Reid *et al*, 2003).

Atlantic white sided dolphins have been recorded in the area, although in low numbers (BODC, 1998). This species is generally concentrated to the north and north-west of Britain, but they do seem to enter the North Sea in summer (Reid *et al*, 2003). Atlantic white sided dolphin is a deep-water species, generally recorded more than 10 km from the coast (Sea Watch Foundation, 2017). However, this species has been sighted north-east of Flamborough Head between July and September, and near Dogger Bank between July and November (Sea Watch Foundation, 2017).

The harbour porpoise is the most abundant cetacean in the North Sea, with the highest densities recorded in water depths less than 100 m. In the Southern North Sea, the harbour porpoise is widely distributed in relatively small numbers. The harbour porpoise occurs throughout the year, although are sighted most frequently in the Southern North Sea during the summer months, between July and October, with a peak in September (Evans, 1995; BODC, 1998; Sea Watch Foundation, 2017). Typically, harbour porpoise occur in small groups of one to three animals. Their diet comprises a wide variety of small fish, e.g. pollock, whiting, cod, sand eels, herring and sole, dependent on the time of year and location. Sandbanks typically provide habitats for sandeels, other fish and invertebrate communities, and support rich feeding grounds for seabird and marine mammals. As such, harbour porpoises are commonly found in association with areas of shallow sandbanks, which form important nurseries and feeding grounds for a number of commonly occurring prey species such as sand eels.

Seals

Two species of seal, the common and grey seal, are resident in the North Sea, although densities of seals at sea vary over the year in relation to different stages in their life cycle.

The common seal is one of the most widely distributed seal species within the east Atlantic, and the UK is home to approximately 30% (approximately 40,414) of the European population of common seals (SCOS, 2015). Common seal haul out, breeding and moulting sites are typically situated in sheltered estuaries and on sandbanks but they also utilise rocky areas. Common seals are concentrated in The Wash, which provides ideal breeding and haul out conditions, forming the largest single colony in the UK (Duck, 1995; JNCC, 2017). Additional haul out sites are located at Donna Nook on the Humber and Blakeney Point and Scroby Sands in Norfolk (Duck, 1995). Common seals spend a high proportion of time ashore during the pupping and moulting seasons from approximately June to September (Hammond *et al*, 2001). Recent satellite telemetry studies have found the foraging behaviour of the common seal to be very variable. Although the majority of foraging trips along the east coast of the UK remain within a 60 km radius of haul out sites, longer trips have also been recorded (Hammond *et al*, 2002; SCOS, 2005).

Grey seals are less numerous in the area than common seals. Approximately 39% of the global grey seal population is found in the UK; however, many of these are concentrated at sites around the Hebrides and Orkney, far removed from the area of interest (SCOS, 2015). Grey seals utilise outlying islands and remote coastlines as moulting, pupping and general haul-out sites. There are few sites of significance for grey seals along the east coast of the UK adjacent to the proposed development area. However, there is a significant breeding and haul out site at Donna Nook at the mouth of the Humber estuary, to the north-west of the Blythe Hub Development (JNCC, 2017). Although grey seals have been seen to forage up to several hundred kilometres from haul out sites, their movements are generally restricted to within 40 km of land (McConnell *et al*, 1999; SCOS, 2009). Grey seal densities at sea are lowest during the moulting (February to March) and pupping seasons (October to late November) (Hammond *et al*, 2001). Given the shallow water and proximity to significant seal colonies in the Wash and Humber estuary, both grey and common seals may be encountered around the proposed development area.

3.3.5 Seabirds

Abundance and Distribution

Seabirds found in offshore areas around the UK include members of several families, most notably the petrels and shearwaters, gannets, gulls, skuas and auks. These birds breed on the coasts of the UK, but frequently feed far offshore. In winter, they become less attached to their nesting sites and travel considerable distances in search of food. Seabirds are present throughout the year in the Southern North Sea, with mostly low to moderate densities found in the proposed development area. However, some species, e.g. guillemot, occur in high densities in the proposed development area at certain times of the year. Offshore surveys suggest that the area is of particular importance for a variety of seabirds during the autumn and winter periods, with overall densities decreasing offshore during summer.

During the breeding season, generally between March and June, large numbers of seabirds congregate in coastal breeding colonies. Most seabird species prefer isolated sea cliffs as a breeding habitat. Such habitats are relatively infrequent along the coastline adjacent to the proposed development area. However, Flamborough Head to the north-west of the Blythe Hub Development supports a large Kittiwake breeding colony (JNCC, 2017). The area to the south-west of the field also supports some internationally important coastal seabird colonies for little, common and sandwich terns, with nearshore waters in the Wash, Humber estuary and adjacent coastlines heavily utilised by tern species (Tasker, 1995; Defra, 2017).

Seabirds tend to exhibit a more inshore distribution during the breeding season as they are constrained by the location of their colonies. However, juvenile seabirds are not restricted in their distribution during this period and may be more widely dispersed offshore (DTI, 2002). Once breeding is complete, seabirds disperse into areas further offshore, although the extent to which they disperse varies between species.

Seabird abundance tends to decrease with increasing distance from shore, and their distribution becomes increasing patchy in relation to a number of oceanographic features. The availability and distribution of prey, however, is considered to be the most important factor driving seabird distribution and abundance, particularly around colonies during the breeding season. The various seabird families also differ in the total amount of time they spend at sea, the distances they travel and how they behave when at sea, both during and outside the breeding season.

Overall, the most abundant bird species recorded in the proposed development area are fulmar, gannet, kittiwake, guillemot and puffin. Lower densities of a number of other species also occur at certain times of the year (BODC, 1998; Wakefield *et al*. 2017). Some seabirds are present in the area all year round (Table 3.3).

Table 3.3: Density of Seabirds in the Vicinity of the Blythe Hub Development (BODC, 1998; Wakefield *et al*. 2017)

	Seabird Presence											
	J	F	M	A	M	J	J	A	S	O	N	D
Red-throated diver		L			L							L
	This diver is entirely coastal in its distribution, preferring shallow inshore waters with sandy bays. Outside the breeding season, it is numerous along the east coast of England and Scotland.											
Black-throated diver						M						
	Black-throated divers are coastal in distribution, preferring shallow inshore waters with sandy bays. Outside the breeding season, it is numerous along the east coast of England and Scotland.											
Fulmar		L	L	L	M			M	L	L		L
	Wintering densities are relatively low throughout the North Sea, due to the widespread dispersion of birds. Numbers increase in the central and Southern North Sea during the breeding season, leading to a peak in September.											
Manx shearwater								L	L			
	Manx shearwaters are also recorded less frequently than fulmars in the North Sea. They breed in small numbers in Orkney and Shetland, and are present in low numbers in the northern North Sea between May and October.											
Gannet					L	L		L	L	L	L	L
	The Southern North Sea holds relatively high gannet densities during the winter months, when dispersion from breeding sites is highest. During pre-breeding and breeding seasons, gannets are concentrated inshore around breeding colonies.											
Red breasted merganser			L								L	
	This diving duck starts to flock on the coast from July, reaching a peak in December. Although a coastal species, the red-breasted merganser is occasionally recorded offshore in the Southern North Sea.											
Pomarine skua					L			L	L			
	The Pomarine skua is recorded offshore throughout the North Sea. This skua is an occasional passage migrant, passing through in both spring to breeding in the high Arctic and again in autumn to winter off the coast of west Africa.											
Arctic skua					M			L	L			
	Approximately 3,200 pairs of arctic skuas breed around the North Sea, mainly in Orkney and Shetland. They are recorded offshore throughout the North Sea April to December, dispersing widely in the Atlantic following breeding.											
Great skua								L	L			
	The great skua is recorded offshore throughout the North Sea. Pairs of great skuas breed around the North Sea, although mainly in Orkney and Shetland, where distribution is centred during the breeding season.											
Little gull								M		H		M
	Little gulls are distributed throughout the North Sea at all times of year, however, they are concentrated mainly in inshore and southern areas during spring and autumn.											
Black-headed gull								L				
	Black-headed gulls have been recorded in the North Sea at all times of year. Despite large coastal breeding populations, very few of these gulls are observed offshore.											
Common gull		L	L		L				L			L
	Common gulls are distributed throughout the North Sea at all times of year. However, there distribution is predominantly southern and inshore. Their numbers peak in the North Sea in winter.											
Lesser black-backed gull		L			L			L	L			
	Although lesser black-backed gulls are distributed throughout the North Sea at all times of year, they are principally summer visitors, travelling through to breeding colonies around the North Sea.											
Herring gull		L	L					L	L			L
	Herring gulls breed on nearly all North Sea coasts, with the exception of the Wash. Densities in offshore Southern North Sea are highest from November to March, and very low from April to October. These gulls are relatively sedentary.											
Great black-backed gull		L						L	L	L		L
	The great black-backed gull breeds on northern coasts. Although distributed throughout the North Sea, numbers are highest off the north-eastern coast of England. The highest densities are recorded at sea between September and April.											

	Seabird Presence											
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Kittiwake	L	M	M	L	M	L	L	M	L	M	L	M
	Kittiwakes are widely dispersed in the North Sea during winter. Densities increase inshore around breeding colonies in spring and summer. However, large numbers are still present offshore at this time, due to movement of juvenile birds.											
Sandwich tern					L							
	A summer visitor, Sandwich terns migrate through the offshore North Sea in the same way as Arctic terns. This species breeds around the southern and eastern North Sea.											
Arctic tern								L				
	Arctic terns are summer visitors to the North Sea, normally recorded between April and October. They migrate northwards through the offshore North Sea in April and May, with return passage from July to September.											
Guillemot	L	H	L	L	M			M	L	VH		H
	Between March and June, most guillemots are found close to their colonies. The birds move offshore in July, concentrating in the central northern North Sea. The birds move gradually south, becoming more widespread by winter.											
Razorbill		M	M		L				L	M		M
	Razorbills follow a broadly similar seasonal distribution pattern to guillemots, although their concentrations are generally more northerly. Razorbills from more southern colonies are relatively sedentary.											
Puffin		L		L	L			L	L			L
	Information on the life history of puffins is limited. Departure from colonies commences in July with movement south and east from the northerly colonies. Winter puffin distribution in the North Sea is widespread with low densities.											

	None	L	Low	M	Moderate	H	High	VH	Very high

<u>Vulnerability to Pollution</u>

Seabirds are particularly vulnerable to oil pollution at the sea surface which can cause a range of physical and physiological effects. The vulnerability of bird species to oil pollution is dependent on several factors and varies considerably throughout the year. The Joint Nature Conservation Committee (JNCC) has produced a Seabird Oil Sensitivity Index (SOSI) which identifies areas at sea where seabirds are likely to be most sensitive to oil pollution. The SOSI uses seabird survey data collected between 1995 and 2015, in addition to individual species sensitivity index values, combined at each location to create a single measure of seabird sensitivity to oil pollution (JNCC, 2016).

Birds are particularly susceptible to oil pollution on the sea surface. Following contact with oil, they risk loss of buoyancy and insulation, and an array of physiological effects through ingestion of oil when preening. The aerial habits of the fulmar and gulls, together with their large populations and widespread distribution, reduce vulnerability of these species. Gannets, skuas and auk species are considered to be most vulnerable to oil pollution due to a combination of heavy reliance on the marine environment, low breeding output with a long period of immaturity before breeding, and the regional presence of a large percentage of the biogeographical population (DTI, 2001).

Monthly vulnerability for the area around the Blythe Hub Development is presented in Table 3.4 and Figure 3.3. The vulnerability of birds in the vicinity of the proposed development area decreases slightly during the breeding season, generally between March and June, when large numbers of birds congregate in coastal breeding colonies (RSPB, 2017; Table 3.4). Seabird vulnerability in the area is high or very high for much of the second half of the year, possibly in association with the movement away from colonies after breeding. The vulnerability is increased by the large numbers of auks, primarily guillemots, but also puffins and razorbills, found at sea during this time (BODC, 1998; DTI 2001). Congregating into large groups referred to as ‘rafts’, these birds undergo a full moult at sea, rendering them flightless and leaving them highly susceptible to surface pollution (RSPB, 2017).

Both the density and diversity of bird species sighted in the vicinity of the proposed development area increases during the winter months. Vulnerability remains very high during this time, due to the presence of these overwintering and migratory species. The area is important for auk species, which remain vulnerable to surface pollution while at sea, as they swim on the surface prior to diving for prey (Mitchell *et al*, 2004). Gannets, which feed by plunging into the sea, are also present is small numbers (BODC, 1998). Spreading out from inland breeding sites, several species of gull have been observed in high numbers around the blocks from October through to March. However, these birds are much less reliant on the sea as either their habitat or source of food, eating insects, worms, rubbish and other birds (RSPB, 2017).

Overall, the Block average for Blocks 48/22 and 48/23 shows a high vulnerability to oil and surface pollutants, following the breeding season and throughout the winter (JNCC, 2016).

Table 3.4: Seabird Vulnerability to Surface Pollution in the Vicinity of Blocks 48/22 and 48/23 (JNCC, 2016)

UKCS Block	Seabird Vulnerability											
	J	F	M	A	M	J	J	A	S	O	N	D
48/16	3	4	3	3*	5	5	5	4	5	4	2	3
48/17	3	3	3	3*	5	5	5	3	4	2	1	3
48/18	1	2	3	3*	5	5	5	3	3	1*	1	1
48/19	1	1	3	3*	3	5	5	3	3	1*	1	1
48/21	4	4	3	1*	5	5	5	4	4	4	2	3
48/22	4	3	3	ND	5	5	5	3	3	2	2	2
48/23	2	2	3	ND	5	5	5	3	4	2*	2	2
48/24	1	2	2	ND	4	5	5	3	3	2*	2	2
48/26	4	3	2	1*	5	5	5	3	3	3	2	3
48/27	4	3	3	ND	5	5	5	3	4	1	2	2
48/28	2	2	3	ND	5	5	5	3	4	2*	2	2
48/29	1	1	3	ND	4	5	5	4	5	3*	3	2

1 Extremely high; 2 Very high; 3 High; 4 Medium; 5 Low; ND No data

* Indicates blocks for which no data was available, and therefore score has been calculated using that of an adjacent month or block

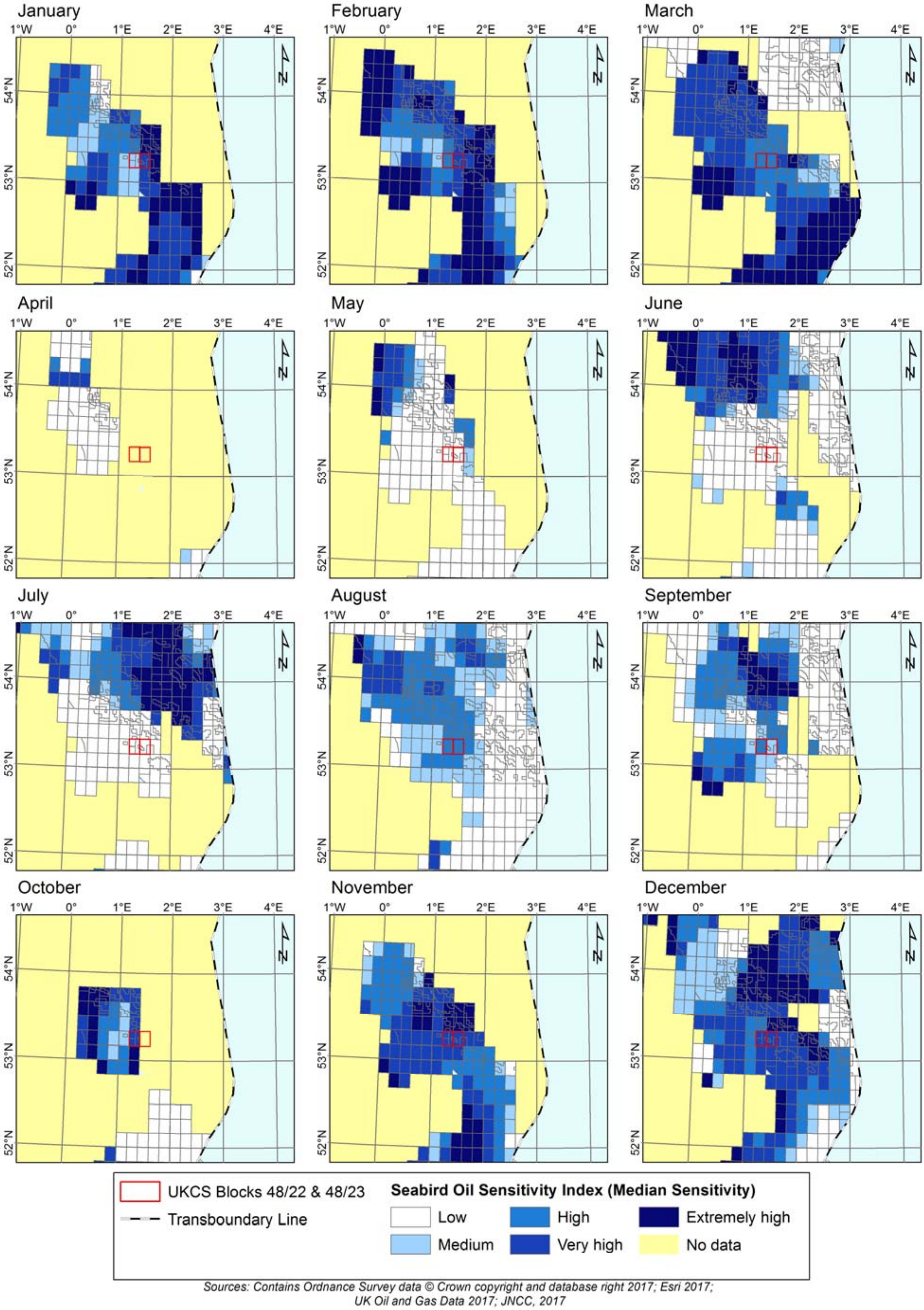


Figure 3.3: Seabird vulnerability to surface pollution

Waders and Wildfowl

Estuarine areas, including the Humber, the Wash, and the north Norfolk Marshes, are particularly important for breeding waders, with a higher species diversity than elsewhere in the UK. In addition to coastal breeding species, internationally important numbers of migrant and wintering waterfowl use this coastline. The Humber Estuary, the Wash and the north Norfolk coast are of major international importance for their waterfowl populations (Stroud & Craddock, 1995). The shelduck is the most abundant duck in the region, while the knot and the dunlin are the most abundant wader species in the region. This region also lies on the major migratory flyway of the east Atlantic, as many birds move between wintering areas on the African and Mediterranean coasts to Arctic breeding grounds (Stroud & Craddock, 1995).

3.4. Conservation Areas

3.4.1 Nearshore and Coastal Conservation Features

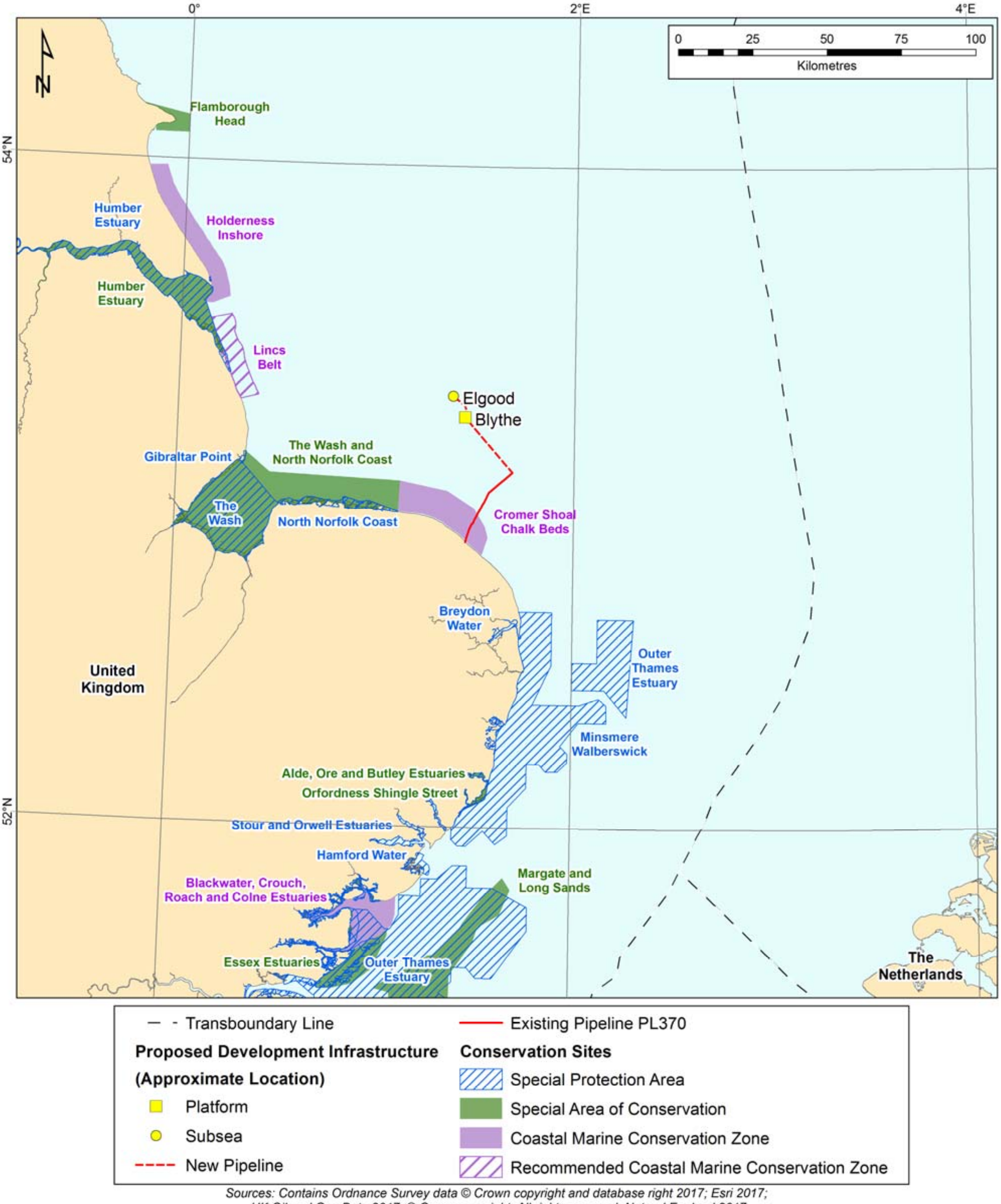
The nearshore and coastal habitats and species present along the coasts adjacent to the proposed development area are of notable conservation interest and are protected by a range of statutory and voluntary initiatives. At an international level, there are several Special Protection Areas (SPA) designated along the coast due to the major seabird colonies or breeding and overwintering habitats for waders and wildfowl present. The closest SPA to the development area is the North Norfolk Coast SPA, located 38 km to the south-west of the proposed Blythe Hub Development location. The North Norfolk Coast SPA is designated for supporting breeding and overwintering birds (JNCC, 2017).

The Wash SPA is also located approximately 68 km to the south-west of the proposed Elgood development area. In addition, the Greater Wash proposed SPA, which is currently under consultation, may extend to within 40 km of the proposed Elgood development location. This area is proposed as an SPA to protect important areas of sea used by rare waterbirds, specifically common scoter and red-throated diver, during the non-breeding period, and for foraging by tern species in the breeding season (Defra, 2017). Many of the sites of ornithological importance are conferred further protection as Important Bird Areas or Ramsar sites (RSIS, 2017).

There are also numerous Special Areas of Conservation (SAC) designated to protect important inshore and coastal habitats, such as reefs and sandbanks along with significant common seal populations. The closest SAC is The Wash and North Norfolk Coast SAC, located approximately 30 km to the south-west of the proposed Elgood development location. The SAC is designated for the presence of sandbanks which are slightly covered by seawater all the time, which provide extensive breeding and haul-out sites for harbour seal (JNCC, 2017).

Many of the internationally protected sites also encompass smaller nationally designated protected areas such as Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR) and voluntary sites managed by organisations such as the RSPB.

Under the Marine and Coastal Access Act (MCAA) 2009, powers have been provided to the UK government to designate new marine protected areas, known as Marine Conservation Zones (MCZ) in England and Wales, to create an ecologically coherent network of conservation sites. Fifty MCZs have been designated in English waters as part of protecting the range of marine wildlife and habitats found in UK waters with more to be designated after consultation in 2017. The nearest MCZ with coastal components is the Cromer Shoal Chalk Beds MCZ, located approximately 25 km to the south of the proposed Blythe Hub Development location along the Norfolk Coast (Figure 3.4). This site is designated for its chalk reef habitats and the diversity of invertebrate and vertebrate species they support (Wildlife Trusts, 2017).



JNCC, 2017

Figure 3.4: Conservation areas with coastal components

3.4.2 Offshore Conservation Features

Offshore SACs are designated to protect fully marine habitats situated beyond the 12 nm limit of UK territorial waters. The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended) apply the requirements of the European Habitats Directive and Wild Birds Directive to oil and gas activities on the entire United Kingdom Continental Shelf, including within the 12 nm territorial limit. Annex I of the Habitats Directive lists three habitat types that are most likely to occur in offshore waters and be eligible for designation as offshore Special Areas of Conservation (SAC):

- Submarine structures made by leaking gases (pockmarks);
- Reefs (bedrock, stony or biogenic);
- Sandbanks that are slightly covered by water all the time.

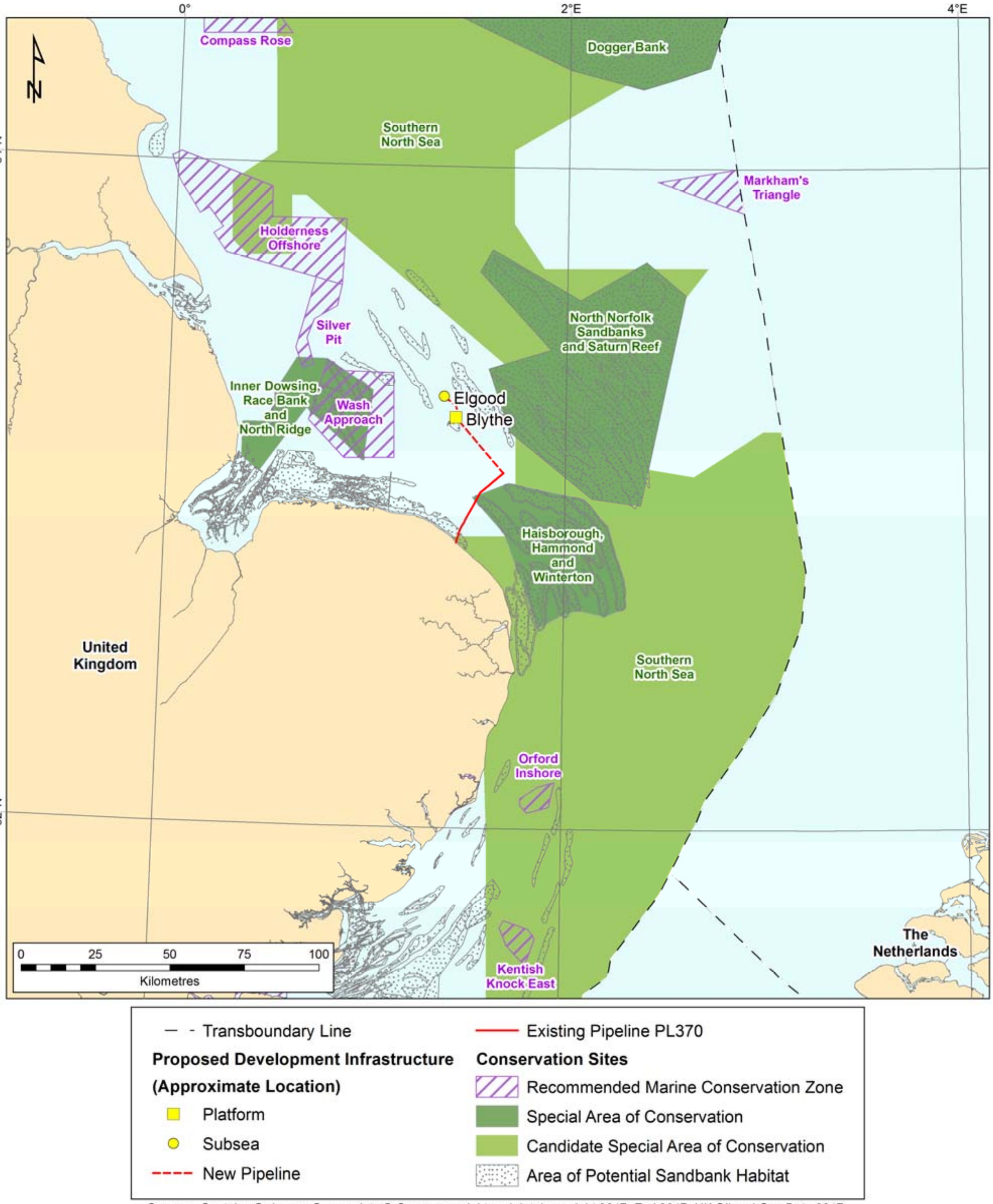
As a result, the proposed development area is surrounded by a range of offshore protected areas designated at European level for these important habitats. The closest offshore SAC to the development area is the North Norfolk Sandbanks and Saturn Reef SAC (Figure 3.5). The proposed Blythe Hub Development is located approximately 15 km to the west of the SAC's boundary (JNCC, 2017). The North Norfolk Sandbanks are the most extensive example of the offshore linear ridge sandbank type in UK waters (Graham *et al*, 2001). They support communities of invertebrates which are typical of sandy sediments in the Southern North Sea such as polychaete worms, isopods, crabs and starfish (JNCC, 2017). The Saturn *Sabellaria spinulosa* biogenic reef is formed from the tubes of thousands of individual *Sabellaria* worms which have consolidated together to form a solid reef like structure raised above the seabed. The reef supports a range of polychaete worms and molluscs as well as epifaunal species such as small crabs and squat lobsters which are not normally present in areas of sandy sediments (JNCC, 2017).

Furthermore, the Inner Dowsing, Race Bank and North Ridge Site of Community Importance (SCI) is located approximately 23 km to the west of the proposed Elgood development location, and encompasses a wide range of sandbank types and *Sabellaria* biogenic reefs supporting a variety of bryozoans, hydroids, sponges and anemones (JNCC, 2017). The Haisborough, Hammond and Winterton SCI, 20 km to the south-east of the Blythe Hub Development, is also designated to protect a series of long standing shallow sandbanks supporting a range of invertebrate species in sheltered areas, along with some *Sabellaria* reefs (JNCC, 2017).

In addition to these protected areas, the JNCC has identified areas where Annex I habitats may be present. Of the three habitat types most likely to occur in UK offshore waters (reefs, sandbanks and pockmarks), sandbanks and reefs are most common in the Southern North Sea. There are no identified potential pockmark areas in the vicinity of the proposed development area. However, there are areas of potential Annex I reefs, the closest of which lies 15 km to the south of the proposed Blythe Hub Development location (Figure 3.5). Potential areas of sandbanks which are slightly covered by seawater all the time are also present in the proposed development area (Figure 3.5).

As well as seabed features, the Habitats Directive also lists qualifying marine species (Annex II species) for which SACs should be developed. The Annex II species present in UK offshore waters are grey and common seals as well as the harbour porpoise and bottlenose dolphin. JNCC and national conservation agencies are continuously investigating the potential for designating additional sites in waters away from the coast for these species. One candidate SAC has been identified in the Southern North Sea. The Southern North Sea candidate SAC (cSAC) is located approximately 19 km to the east of the proposed Blythe Hub Development area. The Southern North Sea cSAC is proposed for the protection of harbour porpoise, and is considered to be one of the best areas in the United Kingdom for this species (JNCC, 2017).

Fourteen of the MCZ designated around England are partly or entirely located in offshore waters. None of these are currently located in the vicinity of the proposed development area. However, further offshore MCZs will be implemented as part of the third tranche of MCZ designation in 2017, helping to completing the network of protected sites in UK waters. During the original research process for identification of MCZ, the Wash Approach offshore area, 16 km west of the proposed Elgood development location, was recommended for inclusion (Figure 3.5). This site overlaps with the Inner Dowsing, Race Bank and North Ridge SCI. It was recommended for a series of sandbanks interspersed with cobbles, sand and gravel with *Sabellaria* reefs. A range of attached invertebrate species are found on these habitats, creating year round harbour porpoise, grey seal and common seal feeding areas (Wildlife Trusts, 2017).



Sources: Contains Ordnance Survey data © Crown copyright and database right 2017; Esri 2017; UK Oil and Gas Data 2017; © Crown copyright. All rights reserved. Natural England 2017; Crown Copyright. Contains data from JNCC, Defra, NRW, NE, SNH, DAERA

JNCC, 2017

Figure 3.5: Offshore conservation areas

3.5. Other Users of the Sea

3.5.1 Commercial Fisheries

The North Sea as a whole is a major international fishing ground. Major UK and international fishing fleets operate in the Southern North Sea, targeting a range of species, although fisheries landings are higher overall further north in the North Sea and around the Orkney and Shetland Islands (MMO, 2015, Scottish Government, 2016). For fisheries statistics purposes, the north-east Atlantic is divided into rectangles by the International Council for the Exploration of the Sea (ICES). The Blythe Hub Development lies within ICES rectangle 35F1.

Table 3.5 indicates that between 2008 and 2013, the majority of landings from ICES rectangle 35F1 were shellfish species with some demersal fish species. Shellfish landings largely comprise whelks, crabs and lobsters. Whelks make up the largest proportion of shellfish recorded with the qualities landed, having increased significantly between 2008 and 2013 (Scottish Government, 2016). Figure 3.6 below shoes the seasonal distribution of catches in ICES Rectangle 35F1. Landings from ICES rectangle 35F1 are made throughout the year with notable increases in landings through the spring into the summer before a rapid decline in landings from mid-summer and through to the winter months (Scottish Government, 2016).

Table 3.5: Landings (Tonnes) for ICES rectangle 35F1 Between 2008 and 2013

Year	Demersal	Pelagic	Shellfish	Total
2008	14	0	442	**456**
2009	8	2	317	**327**
2010	2	0	384	**386**
2011	4	0	472	**476**
2012	8	1	878	**887**
2013	25	0	1392	**1,417**
Total	**61**	**3**	**3,885**	**3,949**

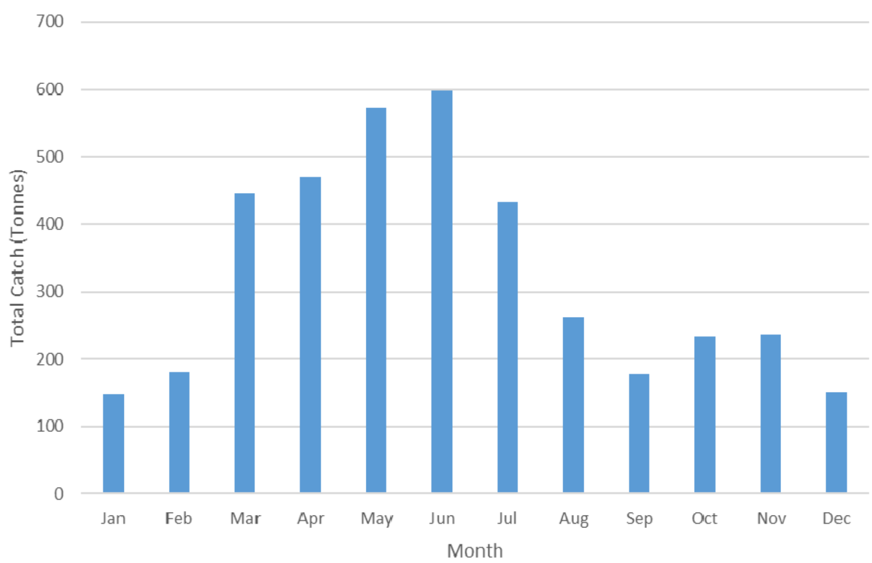


Figure 3.6: Monthly distributions of catches in ICES rectangle 35F1 (2008-2013)

<u>Shellfish Fisheries</u>

Shellfish fisheries can be broadly divided into offshore and onshore components. Static gears such as creels and pots are used in inshore areas to catch crabs and lobsters while the offshore component targets *Nephrops* and scallops using trawls. Waters off the coast of Humberside to the west and Norfolk to the south of the proposed development area make up some of the most important shellfish areas in the UK. Landings data from around the proposed development area are consistent with this pattern; recent landings data showing that shellfish dominate the local catches in terms of quantity and value. Landings data indicate that crabs, whelks, lobsters and scallops are the main species caught from this area. The quantity of whelks landed from this particular area has increased by a factor of almost ten between 2008 and 2013 indicating an increasing abundance or fishing effort of this particular species in the area. Landings of crabs and lobsters have remained broadly similar over the same period of time.

Demersal Fisheries

Demersal fisheries target species which live on or near the seabed and generally feed on bottom-living organisms and other fish. Although these fisheries may be directed towards a particular species or species group, demersal fish are often caught together and comprise a mixed fishery. One of the most important fisheries in North Sea is the mixed demersal fishery that targets cod, haddock and whiting. However, a combination of poor stock recruitment and over-exploitation has led to a significant decline in the mixed demersal fishery in this area. Landing data suggest that demersal species are not caught in significant quantities from this area, and quantities landed are much lower than those of crabs and other shellfish (Scottish Government, 2016). Static gill and trammel nets are used to catch both cod family species (gadoids) and flatfish such as plaice. Beam and otter trawlers are also used to target flatfish during the summer months (Walmsley & Pawson, 2007).

Pelagic Fisheries

Pelagic fisheries target species which live in the water column. Pelagic fisheries in the North Sea are generally more active in deeper waters, predominantly targeting herring and mackerel. This is reflected in the available landings data which show very low levels of pelagic species, chiefly mackerel. Herring forms the basis of the fishery in the Southern North Sea in general, mainly caught by trawlers. Few, if any pelagic species are landed from ICES rectangle 35F1 (Scottish Government, 2016).

3.5.2 Shipping and Other Vessel Traffic

The Southern North Sea region supports more intense shipping activity in general compared to the central and northern North Sea, with some major ports such as Rotterdam located in the region. A high number of cargo vessels and ferries pass through the general area along with offshore vessels supporting the numerous gas developments present (DTI, 2001). Block 48/22 (Elgood) has been classed as having very high shipping density, and Block 48/23 (Blythe) as having high shipping density (OGA, 2017a).

A navigational risk assessment undertaken for Dudgeon Offshore Wind Farm, which is in close proximity to the proposed development area, indicates that up to 50 vessels per day pass within a 10 nm buffer zone of the wind farm boundary, equating to 18,250 vessels annually (Anatec, 2013). The majority of these vessels pass through the Outer Dowsing Channel, located to the south of the proposed development area. Cargo vessels and tankers were most frequently recorded within the Dudgeon Offshore Wind Farm 10 nm buffer zone, with a smaller proportion made up of passenger vessels and oil and gas support vessels (Anatec, 2013).

In 2013, an average of 3.5 fishing vessels were recorded in the vicinity of the proposed development area, within a 10 nm buffer zone of Dudgeon Offshore Wind Farm (Anatec, 2013). However, it is considered that many of the fishing vessels tracked during the 2013 survey period were French registered, and steaming between ports/fishing grounds (based on vessel track and speed) as opposed to being engaged in fishing in the area (Anatec, 2013).

3.5.3 Oil and Gas Infrastructure

The Blythe Hub Development is situated within an area of intensive pre-existing offshore gas developments and as such is surrounded by a range of surface and subsurface infrastructure (Figure 3.7). The Shell gas flowline and associated umbilical running from the Shearwater field to the Bacton gas terminal pass through the edge of the Blythe field outline (UK Oil and Gas Data, 2017). The Perenco Waveney field production platform is situated approximately 7.4 km north-west of the proposed Elgood development location, and is connected in turn to the Lancelot field complex, approximately 11 km north of the proposed Elgood development location (UK Oil and Gas Data, 2017).

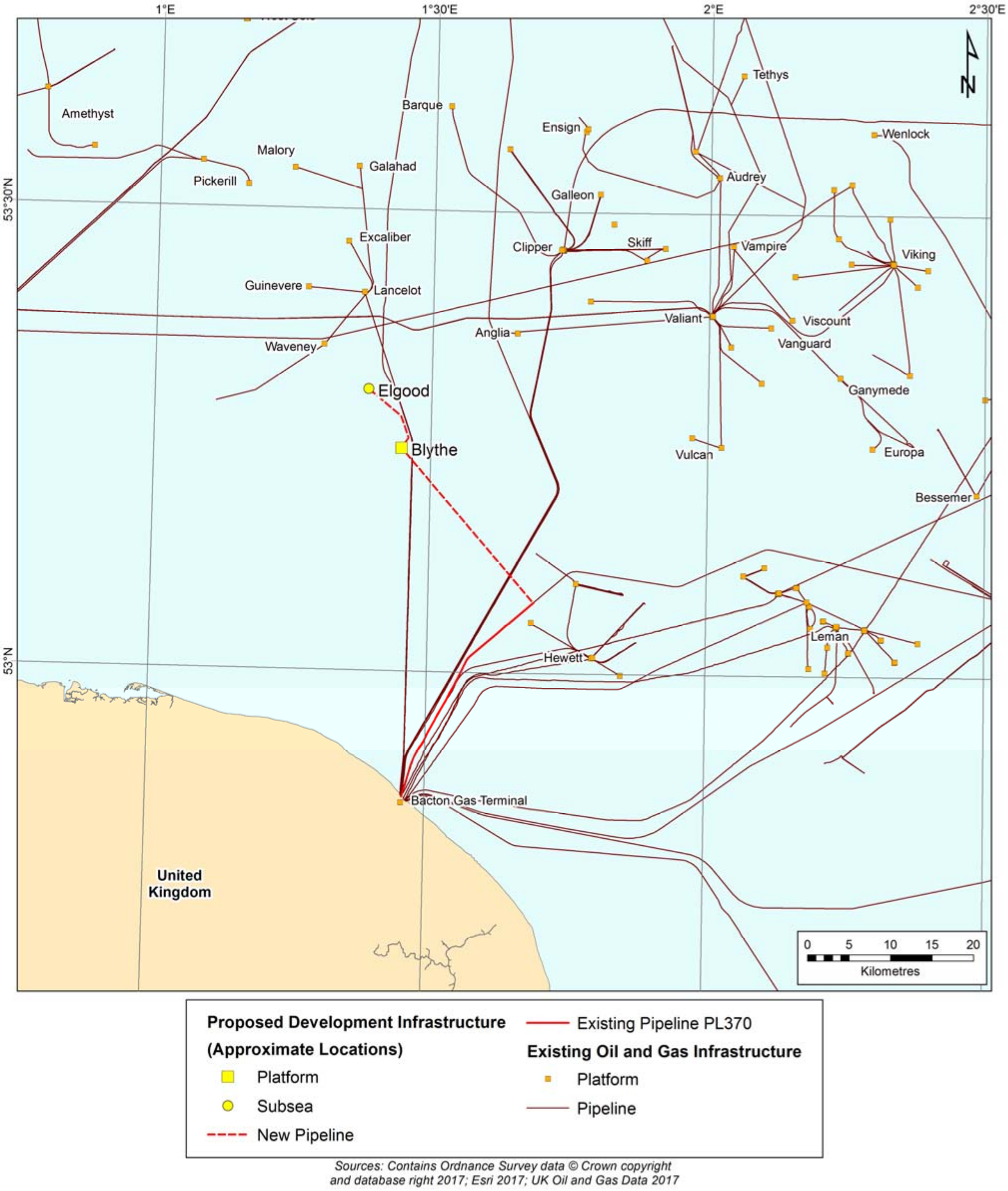


Figure 3.7: Oil and gas infrastructure in the vicinity of the Blythe Hub Development

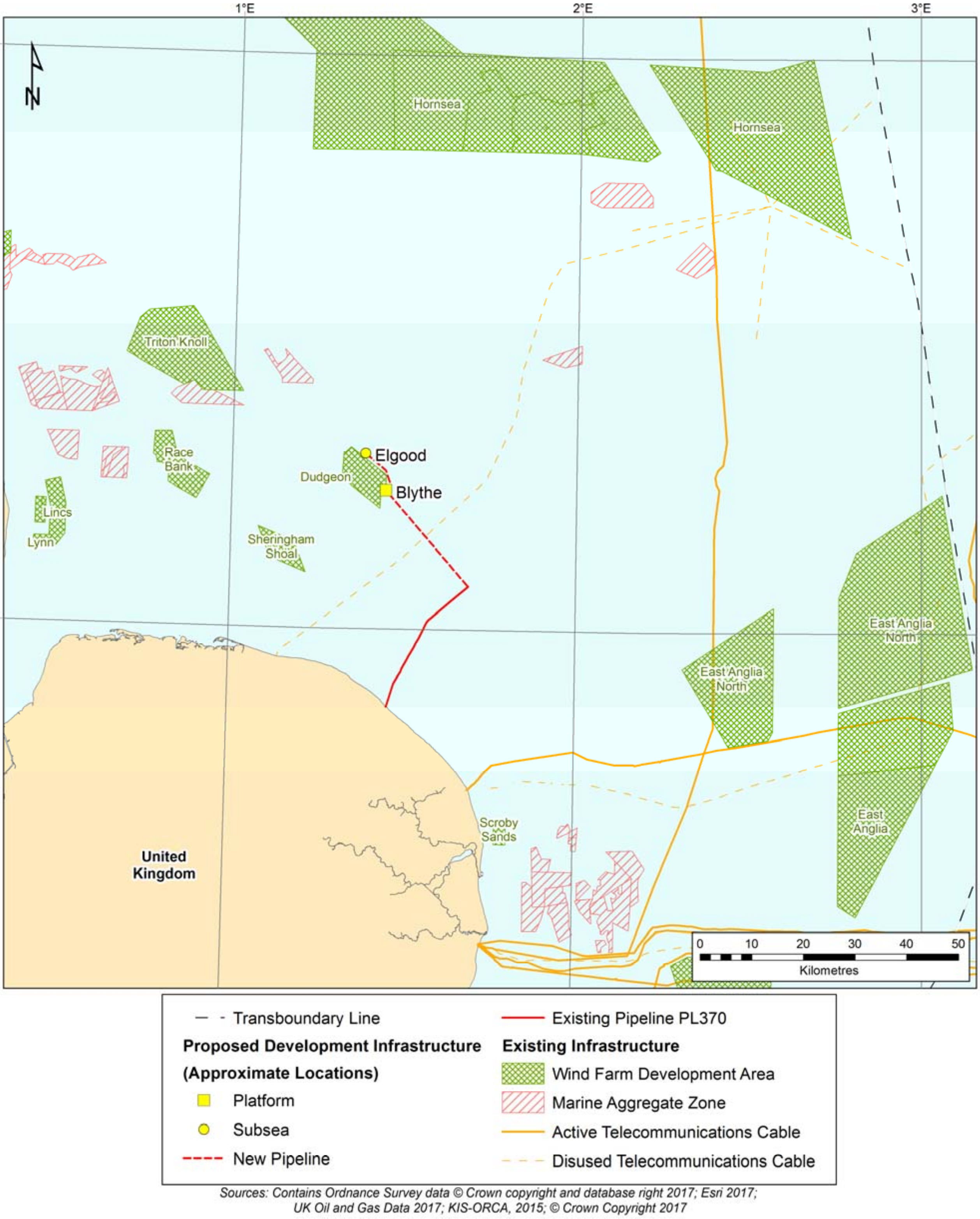
3.5.4 Offshore Wind, Aggregates and Submarine Cables

This area of the Southern North Sea provides good conditions for offshore wind farm development and has been subject to a range of licensing rounds for offshore wind. There are a number of wind farms development sites at various stages of planning or operation immediately around the proposed development area (Figure 3.8). The proposed Elgood development is located adjacent to the Dudgeon wind farm development at the western edge of the wind farms lease area, which is operational; whilst the proposed Blythe Hub Development location is in close proximity to the eastern edge of the Dudgeon lease area (Crown Estate, 2017).

Approximately 60 km to the south-east of the proposed Blythe Hub Development location is the next tranche of the proposed East Anglia Array Offshore Wind Farm. This development is still in the early planning phase, with a formal planning application not anticipated until Q2 2018 (National Infrastructure Planning, 2017; Vattenfall 2017).

Several marine aggregate production areas are also present to the north of the proposed development area. Approximately 10 km to the north-west of the proposed Blythe Hub Development, there is a licensed site for aggregate extraction which is operated by DEME Building Materials (Crown Estate, 2017). To the north-west of the proposed Elgood development area, there is a further licensed site for aggregate extraction.

There are no active cables running through the proposed development area (Crown Estate, 2017; KIS-ORCA, 2017).



KIS-ORCA 2017

Figure 3.8: Distribution of offshore wind developments, aggregate zones and cables around the Blythe Hub Development

3.5.5 Mariculture

There are few active mariculture sites situated along the Humber and Norfolk coasts adjacent to the Blythe Hub Development as the coastline generally does not provide appropriate conditions for cultivation. However, there are a few sites in the Humber and more extensively the Wash which culture shellfish, mostly mussels and some pacific oysters (DTI, 2002; UKMMAS, 2010).

3.5.6 Wrecks and Archaeological Sites

There are no protected wrecks designated around the proposed development area (Historic England, 2017). There may be additional uncharted wrecks located within the area. A study by Wessex Archaeology in support of the development of the Dudgeon offshore wind farm identified several potential wreck sites at the eastern edge of the windfarm lease area however none of the wrecks identified were designated (Wessex Archaeology, 2009). Furthermore, submerged remains of ancient human settlements have been uncovered from around the Leman Bank to the east of the proposed Blythe Hub Development location (Fleming, 2002).

3.5.7 Ministry of Defence

Block 48/22 is situated in a Ministry of Defence (MoD) training range, according to the licensing restrictions released as part of information provided for the 29th Licensing Round (OGA, 2017b).

3.6. Summary of Key Offshore Sensitivities

Table 3.6 provides a summary of the key environmental sensitivities identified throughout this chapter for the proposed development.

Table 3.6: Seasonal Variation of Key Environmental Sensitivities

	Environmental sensitivity											
	J	F	M	A	M	J	J	A	S	O	N	D
Plankton	L	H	H	H	L	L	L	L	L	L	L	L
	Phytoplankton productivity in the Southern North Sea is highest in the spring and autumn with a major peak starting in March and a lesser peak in August. Zooplankton productivity follows a similar pattern, but the blooms follow approximately one month later.											
Benthos	L	L	L	L	L	M	H	H	H	H	M	M
	Life cycles of organisms within the seabed communities are not well understood. Based on the characteristic species, a spawning period for those with a planktotrophic life phase and larger macrofaunal species is thought to be between July and October, with possible winter recruitment sensitivity in November or December.											
Fish and shellfish	M	H	H	H	H	H	L	L	L	L	L	L
	The proposed development area lies within or close to known spawning grounds for herring, lemon sole, sole, sand eels, plaice, cod, mackerel and whiting. The proposed development area is located in a year round nursery area for herring, whiting, lemon sole, sand eel, mackerel, cod, plaice and tope shark											
Marine mammals	L	L	L	L	L	M	M	M	M	M	L	L
	Four species of cetacean are recorded as occurring regularly in the Southern North Sea, including minke whales, Atlantic white-sided dolphin, white-beaked dolphin and harbour porpoise. Common and grey seals may also be found in the proposed development area.											
Seabirds	H	H	L	L	L	L	L	H	H	H	H	H
	Seabird vulnerability is high to very high following the breeding season. Vulnerability remains high throughout the winter months, due to the large number of wintering and migratory birds. As the birds congregate in their colonies, vulnerability decreases slightly during the breeding season, falling to low to moderate.											
Offshore conservation	L	L	L	L	L	M	H	H	H	H	L	L
	Offshore conservation areas are designated to conserve the associated biological communities or species of specific conservation value. Therefore, the vulnerability of these areas is based on individual seabed characteristics or species.											
Coastal conservation	L	L	H	H	H	H	M	M	M	L	L	L
	Most of the coastal conservation areas are designated for the presence of birds, thus vulnerability is highest during the breeding season. Those designated for other reasons (e.g. vegetation) may also be more vulnerable in the summer months for the same reasons. However, vulnerability reduces throughout the winter months, when birds move offshore.											
Other users of the sea	L	L	M	M	M	M	M	M	M	L	L	L
	Other users are likely to concentrate any activities within the better months of weather in the year (fisheries, offshore development or construction) but in general, fishing, oil and gas operation, shipping and aggregate extraction are the main marine activities all year round.											

	None	L	Low	M	Moderate	H	High	VH	Very high

As part of the 29th Licensing Round, DEFRA, JNCC and CEFAS have also identified seasonal concerns for certain Blocks, regarding particularly environmentally sensitive periods during each year for seismic surveys or drilling operations (Table 3.7; OGA, 2017b). Seasonal concerns for Blocks 48/22 and 48/23 are set out in Table 3.7 below. Block 48/22 is recorded as a potential area where herring might spawn and therefore this is a concern prior to the commencement of any drilling operations. Furthermore, any siting of infrastructure within Block 48/22 requires the Ministry of Defence (MoD) to be notified at least twelve months in advance.

Table 3.7: Block Specific Seasonal Concerns (OGA, 2017b)

Block	Period of Concern for Seismic Surveys	Period of Concern for Drilling
48/22 (Elgood)	January to May, August to October (DEFRA)	August to October (DEFRA and CEFAS)
48/23 (Blythe)	January to May (DEFRA)	August to October (CEFAS)

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Section 4

Identification of Concerns and Potential Impacts

4. IDENTIFICATION OF CONCERNS AND POTENTIAL IMPACTS

4.1 Introduction

This section describes the scoping methods used to identify any environmental impacts associated with the proposed operations at the Blythe Hub Development and to determine which of these may be potentially significant. The following scoping methods were used:

- An Environmental Issues Identification (ENVID) workshop by members of the project team;
- An informal consultation meeting was held with BEIS on 5 October 2017;
- An Early Consultation Document (ECD) which outlined the project and main environmental receptors to be assessed was circulated to a range of statutory and non-statutory consultees and comments invited.

The purpose of these scoping activities was to identify the main environmental concerns at an early stage of the project, so that they could be addressed and mitigated during the Environmental Impact Assessment (EIA) process.

4.2 ENVID Workshop

The first scoping activity undertaken for this project was an Environmental Issues Identification (ENVID) workshop, which was attended by key members of the IOG Blythe Hub Development project team.

4.2.1 ENVID Methodology

IOG operations can be divided into office based activities, seismic, site and environmental surveys, offshore exploration and appraisal drilling and offshore production activities. Each of these categories can further be divided into sub categories of planned and accidental events, with the individual activities therein further classified as normal, abnormal (non-routine) and emergency events. Prior to the commencement of any field development operations, IOG will prepare an appropriate EMS listing all activities undertaken by IOG (or those undertaken on behalf of IOG) that may interact with the environment. Such activities are referred to as ‘environmental aspects’.

Aspects relevant to the proposed Blythe Hub Development were identified and evaluated as part of the ENVID, the results of which are detailed within the appropriate Environmental Aspects and Impacts Register. For each individual activity, aspects which may have an impact on one or more of the following general environmental issues were identified:

- Marine environment;
- Land contamination;
- Water pollution;
- Air pollution;
- Climate change;
- Resource use;
- Other users of the sea.

Where specific environmental features within the marine environment are affected, such as seabed communities, seabirds or marine mammals, these were recorded additionally.

As part of the ENVID, the significance of each environmental aspect was systematically assessed using the scoring system and associated criteria provided below.

For all planned operations and accidental events, the potential significance of aspects was evaluated based on the relation between the Magnitude of the Effect and the Value of the Receptor. To ensure that scoring was consistent, the matrix in Table 4.1 was used to score the Magnitude of Effect against the Value of the Receptor. Table 4.2 was used to define the value of each receptor.

Where the final significance score is ranked a score between 1 and 11, a potential interaction was identified, but the associated impacts are deemed to be insignificant, and as such do not require further assessment or control. Where the aspect is ranked a score between 12 and 50, it was regarded as potentially significant and will require further assessment and management measures to control it.

The only exception to this is Section 8 on climate change, as the scoring system described above is not appropriate to quantify the potential effects which are comparatively so small that they are impossible to assess on an individual basis. However, it is acknowledged that they will contribute to the overall cumulative issue of climate change and are therefore of key concern to overall sustainability objectives. Therefore, those environmental issues identified to contribute to climate change have been automatically scoped in to be discussed further in the detailed impact assessment.

Table 4.1: Environmental Aspect Significance Matrix

Magnitude of Effect		Nature Conservation, Socio-economic or Heritage Value	Negligible	Low	Medium	High	Very High
			1	2	3	4	5
Negligible	a. Minor change to the natural environment which is unlikely to be noticed or measurable against background variation. b. An environmental effect not likely to last more than a few days. c. Effects that are only detectable at source. d. No implications to other users of the sea or local communities. e. No risk to reputation of the company or commercial success. f. No discernible change in the existing view or other landscape characteristics. g. Usage of renewable or non supply-limited resources with no measurable effect on current or future supply.	1	*1*	*2*	*3*	*4*	*5*
Minor	a. A detectable change to the natural environment which is within scope of existing variability. b. A transient environmental effect not lasting more than a few weeks. c. Unlikely to contribute to cumulative effects. d. May affect behaviour, but not a nuisance to other users of the sea or general public. e. Transient issues regarding external relationships but with no long term reputational consequences. f. Virtually imperceptible change in landscape receptors causing very minor changes to the view or other landscape characteristics over a wide area or minor changes over a limited area. g. Usage of finite resources with no measurable effect on current supply and not affecting market price.	2	*2*	*4*	*6*	*8*	*10*
Moderate	a. Change in habitats and biological communities within the footprint of the development. b. Change in habitats and biological communities leading to short term (< 2 years) damage with a good recovery potential. c. Similar scale of effect to existing variability, but may have cumulative implications. d. May cause measurable nuisance to some other users of the sea or local communities. e. Risk of undermining reputation of the company within industry or with regulators. f. Moderate change in localised areas causing minor changes to the existing view or other landscape characteristics over a wide area or noticeable change over a limited area. g. Usage of finite resources that may affect short-term availability and local market price.	4	*4*	*8*	*12*	*16*	*20*
Major	a. Change in habitats and biological communities extending beyond the immediate footprint of the development. b. Change in habitats and biological communities leading to medium term (>2 years) damage, but with a likelihood of recovery within 10 years. c. Cumulative implications are understood to occur in relation to activities of this type. d. Financial loss or safety implications to other users of the sea or local communities. e. Undermining the reputation of the company with serious commercial implications. f. Notable change in landscape characteristics over an extensive area ranging to a very intensive change over a more limited area. g. Reduction in stock resource, affecting national availability and market price.	6	*6*	*12*	*18*	*24*	*30*
Severe	a. Widescale change to the offshore environment or effects on coastal receptors. b. Change in the natural environment leading to long term (>10 years) damage and poor potential for recovery to baseline conditions. c. Will make a significant contribution to national or global issues, individually or cumulatively. d. Long-term economic loss or strategic business changes for other users of the sea or local communities e. Damage to company reputation of sufficient gravity to incur irreparable damage to the business. f. Extensive long lasting (>10 years) to permanent change in landscape characteristics over an extensive area. g. Reduction in stock resource, affecting global availability and market price.	10	*10*	*20*	*30*	*40*	*50*

Table 4.2: Environmental Receptor Significance Matrix

	Receptor Category	Selected Examples
Very High (5)	Natural Environment (marine, coastal, terrestrial)	1. Internationally designated site or protected species. 2. A regularly occurring, globally threatened species or habitat essential for maintaining such species. 3. Species and habitats essential to conserve biodiversity at an international level.
	Socio-economic Other Users of the sea,	4. A major fishing area contributing at a national level. 5. An internationally defined shipping lane. 6. Any areas licensed for use by other industries.
	Landscape	7. Internationally designated or recognised landscape of exceptional quality and distinctive intact character with a large number of features and strong sense of place, and uninterrupted views (visual amenity).
	Resource use	8. Rare, finite and non-reusable resource only scarcely available on the world market
High (4)	Natural Environment (marine, coastal, terrestrial)	1. Nationally designated site or protected species. 2. A nationally threatened species or habitat essential for maintaining such species. 3. Species and habitats of principal importance for the conservation of biodiversity at a national level.
	Other Users	4. An area of regional importance for fisheries or of local importance but with no nearby alternatives. 5. Major shipping activity located in a restricted area. 6. Extensive use by multiple other industries.
	Landscape	7. Nationally designated or recognised landscape of high quality and distinctive character, with a strong sense of place, and susceptible to change which would permanently alter key characteristics and elements of the landscape (National Parks and AONBs). Partial or interrupted views (visual amenity).
	Resource use	8. Finite resource with restricted availability on the world market
Medium (3)	Natural Environment (marine, coastal, terrestrial)	1. Sites or species protected on a local level, or of acknowledged conservation value. 2. The presence of a locally threatened species or habitat. 3. Species and habitats of importance for the conservation of biodiversity at a local level.
	Other Users	4. Areas used by local fisheries, but with nearby alternatives. 5. Areas of moderate-high commercial shipping intensity 6. Multiple other stakeholder interest or extensive use for a single purpose.
	Landscape	7. Locally designated or recognised landscape with some distinctive character and features in reasonable condition. Capable of tolerating low levels of change without affecting key characteristics and elements (e.g. Local Green Space). Partial or interrupted views (visual amenity).
	Resource use	8. Non-reusable finite resource presently plentiful/abundantly available on world market
Low (2)	Natural Environment (marine, coastal, terrestrial)	1. No sites or species of conservation interest. 2. No resident or regularly occurring threatened species or habitat present. 3. A natural and diverse habitat supporting widespread and common species.
	Other Users	4. Areas of low intensity fishing, not essential for supporting local communities. 5. Areas of low shipping intensity. 6. Areas of low intensity anthropogenic use.
	Landscape	7. Undesignated landscape of defined character type, but of low quality. Capable of tolerating moderate levels of change/improvement/enhancement. Views lack distinctive characteristics and/or are of low quality (visual amenity).
	Resource Use	8. Reusable or recyclable resource, abundantly available on world market
Negligible (1)	Natural Environment (marine, coastal, terrestrial)	1. No sites or species of conservation interest. 2. Not capable of supporting any threatened species or conservation interest. 3. A poor habitat with low biodiversity and productivity.
	Other Users	4. No commercially exploitable fisheries present. 5. Areas of very low shipping intensity. 6. Areas of no discernible anthropogenic use or socio-economic benefits.
	Landscape	7. Poor quality landscape, not representative of a wider type within the local area and capable of accommodating high levels of change/improvement/enhancement, with few or no views (visual amenity).
	Resource use	8. Renewable or non supply-limited resource, readily available at point of use
Adapted from Ratcliffe, 1977; Hill et al., 2005; IEEM, 2006; Langhammer et al., 2007; Highways Agency, 2007; IEEM, 2010; Seafish, 2012		

4.2.2 Results of the ENVID Workshop

During the ENVID, the significance of each environmental aspect was systematically assessed using the methodology described in Section 4.2.1 and noted in the ENVID scoring matrix. The ENVID matrices generated for planned operations and accidental events are presented in full in Appendix 2. The following environmental aspects associated with the proposed Blythe Hub Development were found to have a potentially significant impact:

- Underwater noise from the rig platform and support vessels impacting on marine mammals and fish;
- Disturbance to the seabed due to the installation and removal of spud cans impacting on the seabed environment;
- The physical presence of the rig which may impact on other users of the sea such as fishing vessels and other shipping activity;
- The installation and physical presence of subsea infrastructure such as pipelines and flowlines on the seabed impacting on other users of the sea (fisheries) and the seabed environment;
- The installation and physical presence of protective materials such as concrete mattresses or rock on the seabed impacting on other users of the sea (fisheries) and the seabed environment;
- Deposition of drill cuttings, associated muds and excess cement directly on to the seabed potentially impacting on the seabed environment;
- Use and discharge of chemicals and discharge of produced water during production operations;
- Atmospheric emissions from fuel use and flaring; and
- Accidental events comprising hydrocarbon spills and vessel/rig collisions.

4.3 Informal Consultation

An informal meeting was undertaken between representatives from IOG and BEIS on 5 October 2017. During this meeting BEIS were informed about the project IOG agreed to prepare and issue an Early Consultation Document (ECD) in order to ouline the proposed development and summarise the perceived environmental sensitivities. This ECD was subsequently circulated to a range of statutory and non-statutory stakeholders who were invited to comment on the proposals. Details of the comments and concerns raised by the consultees are summarised in Table 4.3, with the text in italics reflecting IOG's response.

Table 4.3: Informal Consultation Comments and Concerns

Consultee	Consultee Comment and IOG Response
ConocoPhillips	ConocoPhillips advised that it is actively decommissioning Southern North Sea (SNS) infrastructure including installations and subsea pipelines in the wider SNS area and, because of the potential for the decommissioning activities to impact on protected sites, BEIS is undertaking a strategic Habitats Regulations Assessment (HRA) to determine whether the decommissioning activities may cause likely significant effects on the designated features of the protected sites. ConocoPhillips is required to consider the potential impacts associated with the decommissioning activities and other proposed by other users of the sea and therefore anticipate similar undertaking from IOG. *IOG notes the comments from ConocoPhillips and will undertake necessary assessments as may be required for any decommissioning activities associated with the Blythe Hub development.*
DEME Building Materials	DEME advised that it does not believe that the proposed Blythe Hub Development will interfere with any proposed dredging activities at its licensed sites. However, DEME requests to be kept informed of the project as it develops. *IOG notes the comments from DEME and commits to ensuring DEME is kept informed of the project as it progresses.*
Dudgeon Offshore Wind Farm Limited (DOWFL)	DOWFL requested further information on the proposed development including more information on the drilling, construction and maintenance phases of the proposed operations, as well as further details of the installations, pipelines and wells proposed to be installed as part of the Blythe Hub Development. *IOG recognises that DOWFL is a key consultee in the process and will maintain ongoing dialogue regarding the proposed development. Further information on the infrastructure associated with the Blythe Hub Development is detailed in Section 2 of the ES.*

Consultee	Consultee Comment and IOG Response
DOWFL	DOWFL noted that the proposed Blythe Hub Development will be situated very close to the Dudgeon Offshore Windfarm and requested that proximity agreement is established between DOWFL and IOG prior to the commencement of first construction work. *IOG undertakes to maintain a consultative dialogue with DOWFL as it approaches the field operations phases of the Development.*
DOWFL	DOWFL enquired as to whether there is a minimum safety zone requested by IOG for the construction of the project. *IOG undertakes to advise DOWFL of any statutory safety zones that will be established as part of the field operations phases of the Development.*
DOWFL	DOWFL requested that the appropriate channels of communication are followed at all times when any works are ongoing such as maintaining normal radio contact with any vessels that may be working on the windfarm. *IOG is committed to undertaking the proposed works in a safe environment and will ensure that appropriate warnings are issued ahead of any construction or vessel activities and will maintain a continual line of communication with nearby operators.*
Environment Agency	The Environment Agency advises that any near-shore works to facilitate recommissioning of the Thames to Bacton pipeline should consider the requirements of the Water Framework Directive (within 1nm of the coast), and potential impacts on coastal processes or flood risk management. Regard should be given to the Anglian river basin district River Basin Management Plan (RBMP) and the North Norfolk Shoreline Management Plan (SMP). *No near-shore works are proposed to be undertaken as part of the refurbishment of the pipeline. An overview of all the operations covered by this EIA is detailed in Section 2.*
Health and Safety Executive (HSE)	The HSE advised that IOG may have certain responsibilities, particularly with respect to design and operational notifications, under the Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015. *IOG will ensure that any operations associated with the development of the Blythe Hub are undertaken in compliance with relevant legislation.*
Historic England	Historic England advised that there is the potential for unknown archaeological materials to be present within the areas of sandbank located to the east of the proposed development and therefore any proposed site and route surveys should support archaeological analysis and interpretation of survey data collected. Historic England also recommended that visual inspection methodologies are used to support inspection of seabed anomalies with surface expression to determine whether they are of archaeological interest. *IOG will undertake a geophysical survey across the site and proposed pipeline route. Any anomalies observed during the survey will be ground-truthed by visual inspection (i.e. video or stills photography), where possible.*
Historic England	Historic England confirmed that there are no historic shipwrecks in the project area designated under the Protection of Wrecks Act 1973. However, whilst no designated archaeological sites exist within the proposed development site, known and unknown features of the historic environment may still be present. *IOG will undertake a geophysical survey across the site and proposed pipeline route. If any signs are observed that would potentially indicate any features of the historic environment, IOG will notify Historic England accordingly.*
Historic England	Historic England recommended that the EIA considers the likelihood of encountering submerged and buried elements of prehistoric landscapes containing archaeological materials and that any acquisition programmes for geophysical and geotechnical data should capture the setting of archaeological artefacts. *IOG will undertake a geophysical and geotechnical survey across the site and proposed pipeline route. If any signs are observed that would potentially indicate the presence of elements of archaeological importance, IOG will notify Historic England accordingly.*

Consultee	Consultee Comment and IOG Response
JNCC	JNCC welcomed further discussion with IOG to ensure that the correct information regarding protected habitats is included in the ES and whether any of the proposed operations may adversely affect habitats of conservation importance. *The impacts of the proposed operations on protected sites and species are considered within the ES in Sections 5 to 9.*
JNCC	JNCC advised that IOG check the status of all European sites discussed in the ES prior to submission and refer to them accordingly. *In the preparation of this ES, IOG has used the most up to date information available regarding protected sites as presented in Section 3.4*
JNCC	JNCC advised that seabed disturbance is likely to occur during the installation of subsea infrastructure, drilling operations, deposition of drill cuttings and anchor placement and recommended that best practices are followed to minimise the footprint of operations and reduce potential disturbance. *IOG will observe best practice and guidance during any operations associated with the development of the Blythe Hub. Impacts from physical presence are considered in Section 5.*
JNCC	JNCC requested that reports detailing relevant specialist studies undertaken in support of the EIA should be provided to them for review to help better understand the site. *A copy of the habitat and site survey reports will be made available to JNCC.*
JNCC	JNCC provided advice on reference material that may be useful when compiling the ES. *IOG has made use of the suggested data sources proposed by JNCC and, where appropriate, included them in the ES.*
Maritime Coastguard Agency (MCA)	The MCA stated that the potential for navigation and collision risk should be considered as part of the EIA particularly from a cumulative perspective given other activities in the area. Information on mitigation options in respect of pipeline trenching, mattressing and overtrawlability should be discussed within the ES. *The potential for impacts on navigation are considered in Section 5 where mitigation measures are also discussed. Information on pipeline trenching and use of mattresses is also detailed in Section 2 of the ES.*
Natural England	Natural England advised that there are ongoing issues with pipelines becoming exposed in the area around the Cromer Shoals Chalk Beds MCZ and recommend that a sustainable plan for management of the pipeline is developed in consultation with Natural England as part of this development. *IOG is developing Operations & Maintenance for the pipeline in consultation with the HSE and industry specialists.*
Norfolk County Council	The EIA should provide an assessment of the impact of the development on the landscape and seascape character (where visible from onshore), visual intrusion caused by the development including a Zone of Visual Intrusion map, photomontages, cumulative impact of the development together with other operational developments such as windfarms and an assessment on the heritage landscape. *Assessments of the impact of the development on the landscape and seascape character are discussed in this EIA in Section 5.*
Norfolk County Council	The EIA should consider potential impacts on a range of receptors including ecological, cultural heritage and archaeology and socio-economic. *Assessments of relevant receptors are discussed in this EIA in Sections 5 to 9 and summarised in Section 10.*
Perenco (UK) Limited	The proposed pipeline route appears to cross Perenco operated pipelines PL876 & PL877. It would be expected that crossing agreements or proximity agreements are secured. *IOG notes the comment and will continue to maintain close contact with Perenco (UK) Limited on proximity issues.*
RSPB	Recommended a potentially useful study on tracking of seabirds around the UK and Ireland. *IOG has considered the Wakefield et al. 2017 study as part of this EIA.*

Consultee	Consultee Comment and IOG Response
Sea Watch Foundation	The Sea Watch Foundation provided advice on useful sources of data for consideration in the EIA. *Consideration of potential impacts from the proposed operations on marine mammals has been considered in Section 7 of the ES.*
Trinity House	Trinity House advised that all the platforms should comply with the Standard Marking requirements for Offshore Installations and confirmation provided when submitting the Consent to Locate application BEIS. The positions of the subsea wellheads should be provided to Trinity House as marking will be dependent on location and water depths. Any vessels used in the laying of any new pipeline should exhibit signals as per collregs. *IOG will ensure that any infrastructure is appropriately marked and lit and positions of subsea infrastructure provided to Trinity House. Any vessels will be marked and lit in accordance with the International Regulations for Preventing Collisions at Sea 1972 (COLREGs).*
The Crown Estate	TCE recommended liaison with additional stakeholders who might be interested in the Blythe Hub Development. *IOG provided an Early Consultation Document (ECD) to a wide range of stakeholders as detailed in this ES. The ES will be subject to 28 days of public consultation during which any interested parties may comment on the proposed operations.*
The Crown Estate	TCE noted that that the pipeline within 12 nm would require permissions from TCE and that IOG will be required to enter into a lease agreement for the appropriate rights to construct and operate the pipeline. *IOG has engaged with TCE with a view to establishing all necessary agreements and permissions.*
Westminster Gravels	Advised that the proposed operations at the Blythe and Elgood fields would not impact on their operations at marine aggregate extractions site Areas 515/1 and 515/2. *IOG notes the comments from Westminster Gravels.*
The Wildlife Trusts (TWT)	TWT queried what survey work will be undertaken to ascertain the suitability of the Thames to Bacton 24” pipeline for recommissioning and whether any survey work would damage the features of the Cromer Shoal Chalk Beds MCZ. *IOG has developed an inspection programme to ascertain the suitability of the 24” pipeline (PL370) in consultation with the HSE and industry specialists. The proposed survey methods do not involve physical disturbance of the Cromer Shoal Chalk Beds MCZ.*
The Wildlife Trusts (TWT)	TWT recommend a full and comprehensive HRA to be undertaken and further survey work undertaken to determine the presence of *Sabellaria spinulosa* within the development site. *If a HRA proves necessary IOG will provide supporting information for the regulator to undertake the Appropriate Assessment. Survey work will be undertaken in Q1 2018 to establish the environmental baseline at the proposed project location.*
UK Hydrographic Office (UKHO)	The UKHO offered advice on when any notifications relating to the proposed operations should be provided to them to allow adequate time to inform other users of the sea. *IOG will ensure that any required notifications are provided timeously to the UKHO and any other appropriate body.*

4.4 Concerns Identified for Further Assessment

The results from the ENVID workshop and the issues raised during the informal consultation process, as outlined in Sections 4.2.2 and 4.3, identified the potentially significant concerns associated with the proposed Blythe Hub Development at the early planning stage. These concerns have driven the environmental considerations throughout the project and have helped guide mitigation measures incorporated into the project planning in order to reduce, or eliminate, the potential environmental impacts. Each concern is fully addressed in the subsequent sections of the ES and any residual impacts, once mitigation measures have been applied, are described.

The key concerns relating to this project are addressed under the following headings:

- Physical Presence (Section 5);
- Marine Discharges (Section 6);

- Underwater Noise Generation and Wildlife Disturbance (Section 7);
- Atmospheric Emissions/Impacts (Section 8);
- Accidental Events (Section 9).

In line with the requirements of the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999, any potential cumulative and transboundary impacts derived from this project have also been assessed, in the individual impact sections. Cumulative impacts are those from activities or events which individually may not be significant, but when combined with impacts arising from different sources that have an overlapping sphere of influence to the activities and events under consideration, may produce potentially significant impacts. Transboundary impacts comprise any potential environmental impacts on the seabed, water column and/or atmosphere, which extend beyond the boundaries of the UKCS.

4.5 Detailed Impact Assessment Methodology

As detailed in Section 4.2.1, each issue raised during the ENVID is assessed in the same manner, in Sections 5 to 9 of the ES. Each impact assessment describing IOGs understanding of the concern, describing and quantifying the effects from the proposed development, recognising any gaps in understanding and explaining how these are dealt with, and defining measures taken to mitigate the impacts. The assessment also considers potential cumulative, in combination and/or transboundary effects.

The first step of the detailed impact assessment assesses the magnitude of the potential environmental impact for each receptor, independently of its value or designated status, using the magnitude defined in Table 4.1. The sensitivity of each receptor is considered when assessing the likely magnitude of the impact. Ecological sensitivity is defined as the relative change of a system or population in relation to the level of disturbance (Miller *et al*. 2010). The sensitivity of socio-economic and socio-ecological systems may be defined in a similar manner (Holling, 2001).

For the Blythe Hub Development, the types of operations were broken down into general operations, drilling operations, installation and commissioning, production operations and accidental events. The environmental aspects were identified for each of these operations and scored against environmental receptors to determine their impact and whether further detailed assessment and mitigation was required. This was calculated by multiplying the magnitude of effect Table 4.1 and the value of the receptor Table 4.2.

Whilst this approach is considered appropriate for specific environmental and socio-economic receptors, climate change impacts from IOG’s planned operations are comparatively so small that they are impossible to assess. However, it is acknowledged that they will contribute to the overall cumulative issue of climate change and are therefore of key concern to overall sustainability objectives. Therefore, environmental issues identified to contribute to climate change have been considered in the detailed impact assessment.

INDEPENDENT OIL & GAS PLC

Section 5

Physical Presence

5. PHYSICAL PRESENCE

The following issues and concerns were raised during the ENVID and informal consultation, and will therefore be considered in this section on physical presence:

- Physical presence of the rig, installation and infrastructure impacting other users of the sea;
- Stabilisation and protection of infrastructure (rock dumping, concrete mattresses, grout bags) impacting seabed communities and other users;
- Trenching and laying of flowlines impacting seabed communities;
- Visual impact of the development from the shore.

This section assesses the potential impacts of the presence of the subsea infrastructure, and drilling and construction activities upon the seabed, benthic communities and other users of the sea, as well as the visual impact from the shore.

5.1 Seabed and Associated Communities

5.1.1 Physical Extent of the Area Affected by the Proposed Operations

Jack-Up Rig

Both wells will be drilled by a conventional jack-up rig. The jack-up will be towed to location and the legs lowered on to the seabed. The wells are expected to be drilled with a 116-C class jack-up, as commonly used in the Southern North Sea for this type of operation. The installation of the jack-up platform legs on the seabed will affect approximately 1,359.5 m^2 of seabed per well, based on the physical footprint of the three spud cans and the associated stabilisation material (see Section 2.3.5).

Blythe Platform

The Blythe facility will comprise the installation of a newly built lattice jacket with four legs which will be skirt piled to the seabed, with two piles per leg. Each pile cluster has a footprint of approximately 16 m^2. Therefore, the total seabed impacted by the Blythe Platform Installation is approximately 64 m^2. A single well will be drilled through the Blythe platform, with the extent of the conductor footprint approximately less than 1 m^2. The wellhead and Xmas tree will be installed on the platform, and will have no seabed footprint.

Elgood infrastructure

The Elgood infrastructure will be comprise of a single wellhead, subsea production tree and fishing friendly protection structure. Assuming the complete wellhead structure is approximately 4 m × 4 m wide (Fishsafe, 2011) the area of seabed potentially affected would be 16 $m^{2.}$

Pipelines and Crossings

The 8" flowline from Elgood to Blythe, the 10" pipeline from Blythe to the Thames export line, and chemical flowlines will be mechanically trenched and buried by a subsea trenching vehicle. The control umbilical from Blythe to Elgood will be installed into a separate trench with a suitable subsea cable plough. The 8" pipeline, 10" pipeline and the umbilical are approximately 9.3 km, 24.5 km, 9.3 km in length, respectively. Assuming that the pipeline trenching operations will cause a disturbance of up to 1.07 m (42") wide, and the umbilical trenching disturbance, approximately 0.25 m, the total area of seabed directly affected by the pipelines will be 0.134 km^2 (see Table 2.7 in Section 2.5.4 for details).

Dropped object protection for exposed sections of pipeline and umbilical at connection points, tie-in points and crossing points will be provided by 6 × 4 m concrete mattresses. Five mattresses will be laid for each pipeline crossing. The umbilical connection at Elgood will lie on the seabed surface with a 100 m length laid in a shepherd's crook arrangement. Up to 25 mattresses will be used to provide protection for this section of umbilical. Table 5.1 provides the area covered by the mattresses.

Table 5.1: Areas Seabed Covered by Mattresses

Location	Pipeline	Number of Mattresses	Area Covered [m^2]
Tie-in point at PL370	10" Blythe export	5	120
Crossing PL253	10" Blythe export	5	120
Crossing PL632	10" Blythe export	5	120
Crossing PL996	10" Blythe export	5	120
Crossing Stratos Cable	10" Blythe export	2	48
Crossing PL1570, PL876, PL877 (assumed same trench)	10" Blythe export	5	120
Connection at Blythe platform	10" Blythe export	5	120
Connection at Blythe platform	3" MEG line	5	120
Connection at Blythe platform	8" Elgood line	5	120
Connection at Elgood	8" Elgood line	5	120
Connection at Blythe platform	Umbilical	3	72
Connection at Elgood	Umbilical	25	600
Total			**1,800**

A summary of the seabed area impacted by the infrastructure is shown in Table 5.2. The total amount of seabed potentially affected by the jack-up rig, Blythe platform, subsea infrastructure and pipelines will be approximately 0.1414 km^2. The Jack-up rig will be on site for approximately 168 days, with the lifespan of the Blythe Hub Development expected to be approximately 12 years.

Table 5.2: Area of Seabed Impacted by Blythe Hub Development Infrastructure

Development Infrastructure	Area of Seabed Impacted
Jack up rig footings/rock dump	0.001360 km^2
Blythe platform and subsea infrastructure	0.000064 km^2
Elgood subsea infrastructure	0.000016 km^2
Pipelines/mattresses	0.14 km^2
Total Area	**0.14 km^2**

5.1.2 Potential Effects on Seabed Communities

The placement of the development infrastructure on the seabed is anticipated to lead to the complete loss of the underlying seabed communities in an area of up to 0.1414 km^2.

Beneath each spud can the seabed sediment habitat will be compressed downwards and a small proportion temporarily re-suspended as the spud cans are jacked down into place at the start of operations, and further disturbance and re-suspension will occur again as the spud cans are jacked up prior to demobilisation. The effects associated with the re-suspension of fine particles into the water column and the possible smothering of benthos in the surrounding area, may disrupt the feeding and respiratory functions of some animals, particularly filter feeding organisms leading to increased mortality and reduced reproductive rates. These effects are expected to be similar (albeit on a smaller scale) to those described from the discharge of WBM and cuttings described in Section 6, and their impacts is therefore considered to be negligible. Previous survey data indicate that the benthic communities found in the development area are comprised primarily of deposit feeding infauna, such as polychaetes, which typically have some resilience to sediment disturbance.

This direct physical disturbance of the seabed will result in more or less complete loss of the benthic communities beneath the spud cans and rock dump areas, within an overall area of approximately 1,359.5 m^2. It is expected that re-sedimentation processes will start to fill in these depressions immediately after the rig has vacated the drilling location, to be quickly followed by re-colonisation of the benthos. There is however little published information on the likely recovery time from such physical disturbance. The closest indications are to be derived from studies carried out on the physical and biological impacts to the seabed caused by towed fishing gear (eg as reviewed by Løkkeborg, 2005). Such research indicates that the longevity of the physical scars in the seabed left in the wake of towed gear depends on the sediment type and the energy of the local benthic environment. Scars in higher energy sandy and shallow environments, such as those present at the Blythe Hub Development location, can generally be expected to disappear within days or months of the initial disturbance. Overall, the scars from spud can disturbance around the proposed well location are likely to be smaller in area but deeper than those observed following trawling. Because of their small size, there is a strong potential for recovery via species recruitment from the surrounding areas of seabed once the jack-up drilling rig is removed.

Rock dumping will alter the seabed substrate, lead to the loss of the current habitat and potential mortality of benthic fauna creating a different habitat for benthic organisms. In the rock dumped areas, it is anticipated that colonisation by hard-substrate dwelling organisms will occur. Typically, these include tubeworms, hydroids, tunicates, bryozoans, anemones and crustaceans, usually found on submerged boulders, rocky outcrops and offshore structures. Colonisation may take some time due to the low potential for direct local recruitment from nearby areas, which will be populated with species typical of sandy and gravelly sediments. It should be noted that the area impacted by the rock dumping operations is considered very small in relation to the wider sandy and gravelly habitat still available around the platform location. As with placement of the spud cans and trenching, rock dumping can generate a localised and temporary sediment plume in the area. Any impacts resulting from sediment suspension during the rock dumping operations are anticipated to be of similar or lesser scale than those previously described in Section 5.1.2, and thus not expected to result in any significant impacts. Any seabed disturbance and alteration impacts from rock dumping will be confined to the immediate vicinity of the area of operations, and will not affect any species or habitats of conservation significance, the closest an area of potential Annex 1 sandbank habitat located 465 m from the Blythe platform. Therefore, no significant environmental impacts are expected as a result of rock dumping operations in the area.

The trenching of the pipeline could also lead to the burying of benthic fauna in the immediate area and the re-suspension of sediments, causing smothering impacts similar to the placement of spud cans. The disturbance incurred by pipe laying will be limited to the initial operation. Once the pipeline is in place under the seabed, sediment deposition will start to restore the disturbed areas followed by re-colonisation. Concrete mattresses will be put in place to cover any connection points, tie-in points and crossing points. Like rock dumping this will create a different habitat for benthic organisms, with a similar colonisation by hard-substrate dwelling organisms. Any seabed disturbance and alteration impacts due to the placement of mattresses will be confined to the immediate vicinity of the pipelines, in an area previously trenched. Hence, it is not expected that trenching will affect any species or habitats of conservation significance.

The placement of the development infrastructure will incur the loss of benthic communities and exclude the affected area from re-colonisation for the duration of the development. However, the area affected is very small compared to the surrounding area of largely homogenous seabed available for colonisation by seabed communities. The total area of lost habitat equates to approximately 0.1414 km^2. To put this into context, an area of similar size would be disturbed within a few minutes of otter trawling, based on a 70 m vessel sailing at 3 knots with a door spread of 94.5 m (adapted from data presented by Ferro *et al,* 2007).

The presence of the exclusion zones around the development will prohibit trawling in the area, thus protecting the local benthos from physical impacts associated with such activities over the duration of the development. The development will also provide new substrata, which may result in the establishment of more diverse epifaunal communities. In consideration of the above factors, disturbance of seabed communities in the local area is seen as minor, and thus is not anticipated to cause a significant impact.

5.1.3 Cumulative and Transboundary Impacts

The Southern North Sea has high levels of oil, gas and offshore wind activity, with multiple developments in the region of the Blythe Hub Development location. The physical disturbance from the placement and removal of structures will add to the physical disturbance caused by operational discharge, as described in Section 6, and the disturbance in the wider area. The impacts on seabed communities as a result of physical presence of the Blythe Hub Development are considered to be minor and therefore not likely to constitute a significant additional impact.

The UK/Netherlands median line is situated approximately 105 km east of the development area. As any physical impacts will be limited in extent to the area surrounding the development location there will be no transboundary impacts incurred by the Blythe Hub Development.

5.1.4 Mitigation Measures

No rare or sensitive species or habitats are expected within the Blythe Hub Development area, with the closest potential Annex I habitat, a sandbank, located 465 m to the southwest of the Blythe installation. An environmental baseline survey and habitat assessment has been commissioned to characterise the seabed and identify the presence of any potential Annex I habitats within the development area prior to operations commencing.

IOG will ensure that any disturbance to the seabed is minimised. Following operations, a seabed debris survey will be carried out to ensure no objects are left on the seabed that could impede seabed recovery.

5.1.5 Conclusions

Areas of the seabed affected by the development will not be able to fully recover until cessation of the development and removal of the associated infrastructure. However, the disturbance will be localised, and the area affected small in relation to the surrounding undisturbed areas. There is expected to be strong potential for the recovery of the seabed over time via re-sedimentation and re-colonisation of benthos from the surrounding areas. The development area is also largely featureless and supports no habitats of conservation concern. Overall, the impact on the seabed from the placement of the development infrastructure is therefore considered to be minor and not significant.

5.2 Visual Impacts from the Shore

The Blythe Hub Development is located approximately 35 km from the nearest shoreline. During drilling operations, the maximum elevation of the platform legs of the jack-up rig will be approximately 82 m, resulting in a geometric horizon of 37 km for a person standing on the shore. Due to the refraction of light under certain atmospheric conditions, the theoretical visual actual horizon may be even slightly further away. However, as the legs of the drilling rig only make up a small part of the overall structure, in practice it would be very hard to resolve any discernible shape at this distance, as the structure would be imperceptible to the human eye.

The maximum elevation of the Blythe platform will be 38.6 m above LAT, resulting in a geometric horizon of approximately 27 km, meaning the platform will not be visible from the shore at sea level. From higher vantage points, such as cliffs along the coast, the platform may be visible on clear days with very good visibility, however, given the size and shape of the platform it would be very hard to resolve any discernible shape at these distances.

In conclusion, the jack-up drilling rig may be just visible on clear days during the drilling operations (82.5 days at Blythe and 85.5 days at Elgood), but will be imperceptible to the human eye, under most conditions. The Blythe platform itself will not be visible from the shore at sea level. Therefore, the potential visual impacts associated with the Blythe Hub Development are deemed to be insignificant.

5.3 Fishing, Shipping and Navigation

5.3.1 Physical Extent of the Area Affected by the Proposed Operations

During the drilling phase, no shipping traffic will be permitted within the 500 m statutory safety zone around the drilling rig at both locations, amounting to an area of 1.57 km^2. During the production phase, there will be a 500 m statutory safety zone around the Blythe platform measuring 0.785 km^2 for the lifetime of the development. The Elgood subsea wellhead will be protected by a fishing friendly structure, and fishing activity will likely be excluded within a statutory 500 m from the well location, hence the total area of exclusion for fishing will total 1.57 km^2 (Figure 0.1). All export and flowlines are to be buried, so will be not form any navigational risk to general shipping activity.

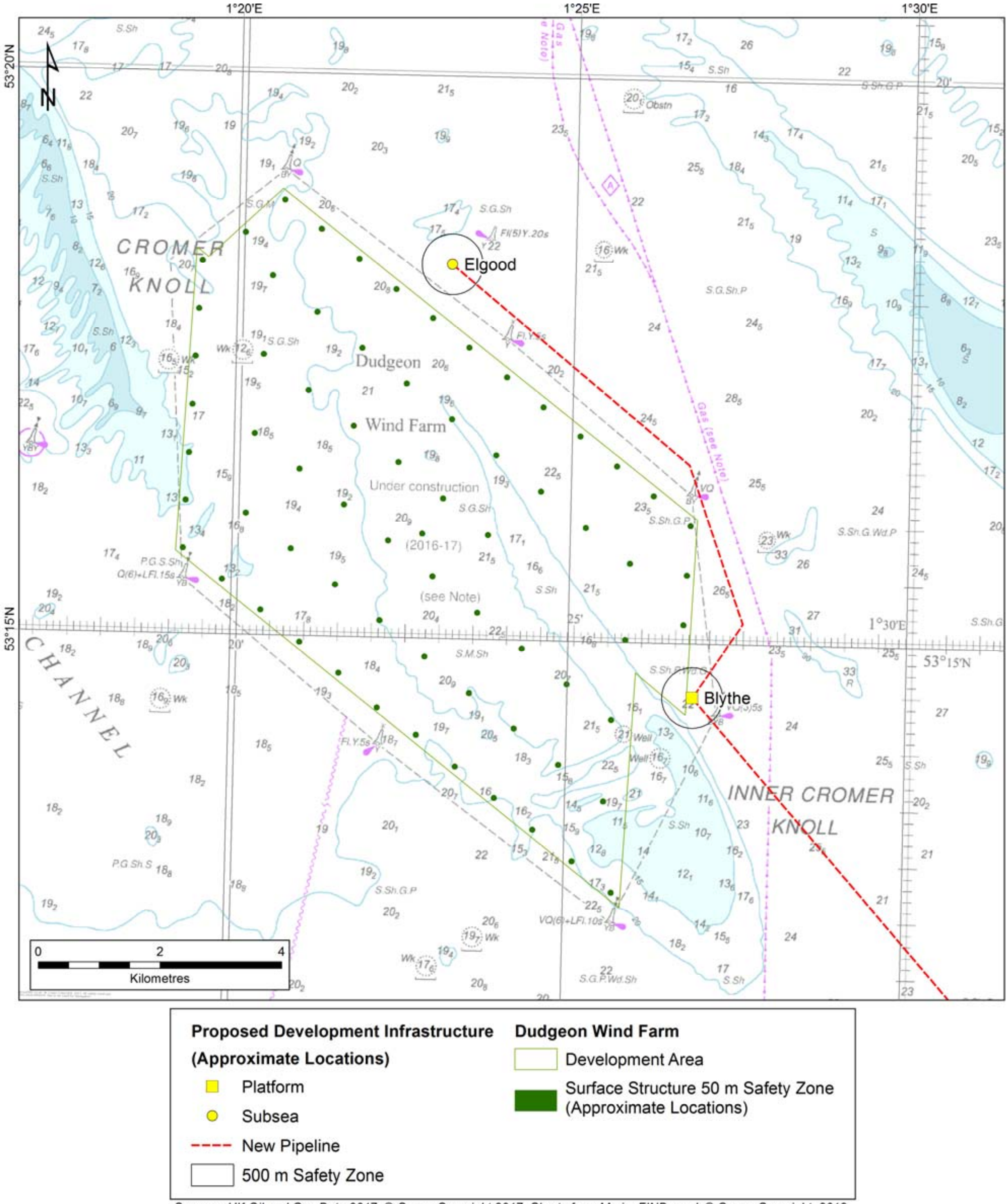

Figure 0.1: Safety zones during drilling and production phases

5.3.2 Impacts on Fisheries

For fisheries statistics purposes, the northeast Atlantic is divided into rectangles by the International Council for the Exploration of the Sea (ICES). The Blythe Hub Development lies within ICES rectangle 35F1. Each ICES statistical rectangle is 30' latitude by 1° longitude in size. ICES rectangle 35F1 is 3,712 km^2 in area.

Section 3 Local Environmental provides a detailed breakdown of the landings for the demersal, pelagic and shellfish fisheries for 35F1. Pelagic and demersal fisheries contributed a very small proportion of the total landings at 0.08% and

1.54%, respectively, between 2008 and 2013 (Table 3.5). Habitat supporting shellfisheries is the typical of the Southern North Sea, and widespread within ICES rectangle 35F1. As mentioned above, fishing will be excluded from an area totalling 1.57 km^2, representing approximately 0.04% of 35F1. Fisheries landings vary between years for many complex, often natural, reasons, so any reduction in fishing grounds must be placed in context to the inter-annual variation. Table 3.5 shows that proportional inter-annual variation for the shellfisheries varies between 17% (2009 to 2010) and a maximum of 46% (2011 to 2012). The proportion of fishing ground lost (0.04%) is significantly smaller (425 times) than the smallest inter-annual variation between 2008 and 2013. The duration of the exclusion will remain in place until the wells have been satisfactorily abandoned (anticipated to be approximately 12 years).

5.3.3 Impacts on Shipping and Navigation

The close proximity of the Blythe and Elgood infrastructure to the Dudgeon Offshore Wind Farm (OWF) means the statutory 500 m safety zones will extend to a distance of approximately 500 m from the nearest turbine location. The Marine Traffic Survey and Navigation Assessment (NA) carried for the OWF showed that small vessels would be able to navigate through the OWF, however, larger vessels would to transit around the outer extent of the OWF. The vast majority of this diverted traffic is likely to use the southern and western boundaries, as that minimises the disruption to existing routes. Only a very small proportion of traffic could therefore be directly affected by safety zones around Blythe and Elgood (noting that the Elgood statutory safety zone would only be in place for shipping whilst the drilling rig is in place for the duration of drilling operations).

5.3.4 Impacts on Other Users of the Sea

No military practice and exercise areas (PEXA) have been highlighted in the vicinity of the development, the Ministry of Defence raised no objections during the consultation process. No other significant user groups were identified during the ENVID and informal consultation.

5.3.5 Cumulative and Transboundary Impacts

The reduction of fishing grounds is so miniscule in proportion to the total available, that any increase in fisheries pressure as a result of displaced fishing effort would be undetectable against background variation in landings statistics.

The footprint of the Dudgeon OWF boundary is approximately 64 km^2, which is significantly larger than the individual 0.785 km^2 safety zones in place during the drilling operations at Blythe and Elgood, and the subsequent 0.785 km^2 safety zone around the Blythe platform. The NA conducted for the OWF predicted that the vast majority of large vessel traffic will be diverted around the southern and western boundaries of the OWF, and so away from Blythe and Elgood. The closest existing platform is the Perenco operated Waveney gas well, 7.5 km to the north-west. The NA undertaken for the Dudgeon OWF specifically considered platform supply vessel traffic to platforms in the area and assumed that this may produce a new route to the west of the OWF boundary.

The Blythe and Elgood safety zones will be 500 m from the outer extent of the OWF, so small vessels will still be able to transit through the OWF, and will only have to avoid each 500 m safety zone. As the safety zones are in relatively close proximity to the OWF, the additional diversion that larger vessels transiting past the northern and eastern extents of the OWF will be minimal. The cumulative navigational impacts with Dudgeon OWF are considered negligible, and therefore not significant.

At its nearest point, the UK/Netherlands median line is situated approximately 105 km east of the development area. As any physical impacts will be limited in extent, there will be no transboundary impacts incurred by the physical presence of the drilling rig, the platform or the subsea well.

5.3.6 Mitigation Measures

The statutory safety zones around the drilling rig will be enforced by an ERRV for the duration of drilling operations, preventing vessels from moving too close to the drilling rig. The drilling rig and other vessels operating in the area will be highly visible and have appropriate lighting, and other means of alerting all vessels of their presence.

To aid navigational safety, a Notice to Mariners will be posted prior to the drilling rig moving onto location, ensuring that all vessels, including fishing vessels, will be aware of their presence in advance and for the duration of operations. In addition, Kingfisher will be notified of the exact location of the platforms and subsea infrastructure, allowing their inclusion in their fortnightly bulletin to fishing vessels. The UK Hydrographic Office (UKHO) will be notified so that charts can be amended to mark the position of the platforms and subsea infrastructure.

The Blythe platform will have appropriate safety lighting permanently installed to alert other vessels of its presence. The installation of a protective wellhead structure on the subsea completed Elgood well will minimise the risk of snagging fishing gear.

5.4 Conclusions

Benthic communities of the types directly under the footprint of the infrastructure on the seabed are common and widespread throughout the Southern North Sea. No potential Annex 1 habitats or protected areas are directly affected by the installation. The magnitude of effects of the direct impact on seabed communities is therefore considered to be minor, and therefore not significant.

The jack-up drilling rig may be just visible from the shoreline on clear days during the drilling operations (82.5 days at Blythe and 85.5 days at Elgood), but will be imperceptible to the human eye, under most conditions. The Blythe platform itself will not be visible from the shore at sea level. Therefore, the potential visual impacts associated with the Blythe Hub Development are deemed to be insignificant.

The pre-existing Dudgeon OWF will result in diversion of the majority of larger vessel traffic to the south and west of the OWF extent, and therefore away from Blythe and Elgood. It is considered that the impact of 500 m statutory safety zones around Blythe and Elgood would have a minor effect, and is therefore not significant.

The proportion of fishing grounds lost as a result of the statutory safety zones around Blythe and Elgood is a tiny proportion of the available grounds with ICES rectangle 35F1. The proportion of area lost is 425 smaller that the smallest inter-annual variation of landings for shellfish between 2008 and 2013. The impact is considered to be negligible, and therefore not significant.

No other users of the sea have been identified during the consultation stage that could be significantly affected by the development.

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Section 6

Marine Discharges

6 MARINE DISCHARGES

A limited number of the proposed operations at the Blythe and Elgood fields will result in discharges to the marine environment, either close to the seabed or at the sea surface. During the ENVID the following potential issues were scoped in for further assessment:

- Deposition of drill cuttings and associated muds directly to the seabed;
- Deposition of excess cement directly to the seabed.

These discharges have the potential to affect the marine environment through both physical and chemical mechanisms. This section will quantify the extent of these discharges and assess the potential significance of their associated effects.

6.1 Drilling and Cement Discharges

A detailed description of the well designs, section diameters and lengths, and drilling and cementing methods for both wells are provided in Section 2, Project Description. The drilling, cementing and discharge methods used will be the same for both wells.

Drill cuttings consist of the chips of crushed rock broken off by the drill bit as it extends the wellbore. Drill cuttings therefore vary in nature depending on the characteristics of the rock layers present and the drill bit used, but generally range in size between very fine clay sized particles (<2 µm) to coarse gravels (>30 mm) (Neff, 2005).

Seawater and high viscosity sweeps are used to clear the cuttings from the 36" top-hole sections. Sweeps are similar to drilling muds, but have a higher viscosity, and may incorporate agents such as bentonite or guar gum. These types of sweeps are of low environmental risk.

Drilling muds are fluids pumped down to the drill pipe to lubricate and cool the drill bit and to carry the cuttings to the surface. WBM will be used for the 17½" sections. WBM typically consist of a base fluid, either seawater or brine, within which clays and other mineral weighting agents such as bentonite are suspended. Additional chemical additives, including organic polymers such as glycol, may also be used to maintain the optimal performance of the mud. These chemicals are generally of low environmental risk and many are classified as PLONOR.

LTOBM will be used to drill the lower sections of the well. The discharge of LTOBM is prohibited in UK waters. The LTOBM will be used in a closed system where cuttings and drilling fluids will be circulated back to the rig via the conductor, passed through a mud recovery system, and then shipped to shore for treatment and disposal. LTOBM and associated cuttings will not be discharged into the marine environment during the course of the operations. Completion chemicals and well bore clean up chemicals will also be returned to the rig, and shipped to shore for treatment and disposal.

The casings used to prevent the well from collapsing will be cemented into place by pumping cement down the casing string, out through the bottom, and back up to the surface through the annulus. For the conductor (30") and surface casing (13⅜") it is critical to get cement back to seabed to ensure the structural integrity of the well and therefore some cement will be discharged to the seabed. The casing strings of lower well sections will not be cemented in place so it is highly unlikely that any additional cement will return to the rig. However, in the event it does, it will be captured in the skip and ship system and returned to shore for processing due to the presence of oil based mud in the well at this time.

6.1.1 Discharges at the Seabed

Cuttings and viscous sweeps from the 36" sections will be discharged at the seabed, as is normal practice on the UKCS. Table 6.1 provides the estimated worst-case volumes and masses of drill cuttings and fluids that may be discharged for the Blythe and Elgood wells. It is estimated that 400 tonnes of cuttings and 310 tonnes of sweeps will be discharged for each 36" section.

Table 6.1: Estimated Worst-case Cuttings and Drilling Fluids Discharges at the Seabed

Field	Section	Mud System	Discharge Point	Cuttings Volume [m^3]	Cuttings Generated [Tonnes]	Sweeps Discharged [Tonnes]
Blythe	36"	Seawater and viscous sweeps	Seabed	154	400	310
Elgood	36"	Seawater and viscous sweeps	Seabed	154	400	310

It is anticipated that over time the WBM and cuttings will be dispersed naturally by the strong tidal currents present. The distribution of these cuttings is expected to follow the prevailing tidal current direction, which is approximately north-south at both Blythe and Elgood.

For the 30" conductor the cement will be pumped down the drill string and up the conductor annulus to the seabed. Rather than mixing a large batch of cement for this job it will be mixed on demand ("on the fly") and when cement is observed at seabed by the Remotely Operated Vehicle (ROV), mixing and pumping will be terminated to minimise the volume discharged. The worst-case estimated cement discharge for this section is 31 m^3 or 60 tonnes. This is based on the entire excess reaching seabed, in the event that the hole is in gauge (so estimated excess proves to have been unnecessary) and the ROV was unable to see the cement returns due to poor visibility or poor weather preventing ROV launch.

Assuming a pump rate of 0.8 m^3/min (5 barrels/min), it will take approximately 40 minutes for the 31 m^3 of cement to emerge from the wellbore. The proportions of excess cement that may set on the seabed or that may be washed away are highly variable, and depend on complex factors including the current speed and the chemical composition of the specific cement batch used. The worst-case scenario is that the majority of any excess cement would set on the seabed, however it is likely that a proportion will be dispersed to the water column.

6.1.2 Discharges at the Sea Surface

Cuttings and drilling fluids from the 17½" section will be returned to the rig via the conductor, and pass through a recovery system to recover as much of the drilling mud as possible. Once reconditioned, this mud will be used again, thereby minimising the amount of drilling mud required. Cuttings from the 17½" section will be discharged at the sea surface. It is anticipated that the cuttings and any residual WBM will be dispersed naturally by the strong tidal currents, and that there will be no requirement for mechanical cuttings relocation or dredging. The cuttings are also expected to be predominantly distributed along the prevailing tidal current direction i.e. north-south.

Table 6.2 provides the estimated worst-case volumes and masses of drill cuttings and fluids that may be discharged for the Blythe and Elgood wells. It is estimated that 376 tonnes of cuttings and 1,250 tonnes of WBM will be discharged for each 17½" section.

Table 6.2: Estimated Worst-case Cuttings and Drilling Fluids Discharges at the Sea Surface

Field	Section	Mud System	Discharge Point	Cuttings Volume [m3]	Cuttings Generated [Tonnes]	WBM Discharged [Tonnes]
Blythe	17½"	WBM	Rig/sea surface	145	376	1,250
Elgood	17½"	WBM	Rig/sea surface	145	376	1,250

The 13⅜" casing will also be cemented in place but in this case any excess cement returns will be returned to the rig before being discharged overboard. The estimated worst case for cement discharge from cementing the 13⅜" casing is 20 m^3 (31 tonnes).

A small volume of cement will also be discharged following each cement job during the process of cleaning the cement pump and mixing tank. The volume of cement being discharged at this time will be very small and is unlikely to exceed 2 m^3.

As the cement is being discharged at the sea surface into well mixed and strongly tidal waters, it is anticipated that the majority of the cement will be more widely dispersed to the marine environment. Emitted cement will react with the seawater and is expected to settle through the water column over time.

6.1.3 Environmental Effects

Extent, Persistence, and Proximity to Protected Sites and Annex 1 Habitats

Near-bed current velocities and sediment mobility in the Southern North Sea are generally sufficient to prevent detectable local accumulation of cuttings after drilling has ceased (DTI, 2001; OSPAR, 2007; Henry et al., 2017). Any immediate local accumulation of cuttings would be short term in duration and very quickly dispersed to the wider environment.

In general, when the cuttings are not displaced from the wellhead during drilling, top-hole cuttings piles are up to a few metres thick near the centre (i.e. close to the point of discharge), becoming more thinly dispersed with increasing distance from the well head to typically less than 1 mm beyond 100 m from the well location.

An OSPAR review of environmental monitoring results from the United Kingdom, the Netherlands and Norway concluded that the effects of WBM cuttings discharge on the seabed fauna tend to be very subtle or undetectable. Any disturbance of the fauna typically only occurs within 50 m from single well locations, and the presence of drilling material on the seabed is often only chemically detectable at distances beyond this (OSPAR, 2007). All potential Annex 1 habitat or protected areas are well over 50 m away from the well locations (Table 6.3) and therefore would not be affected by WBM and cuttings discharges.

Table 6.3: Proximity of Wells to Nearest Annex 1 Habitats or Protected Areas

Well Location	Habitat or Protected Area	Distance [m]
Blythe	Nearest potential Annex 1 sandbank habitat	465
Elgood	Nearest potential Annex 1 sandbank habitat	4,280
Elgood	Nearest potential Annex 1 stony reef habitat	13,010
Blythe	North Norfolk Sandbanks SAC	15,580

Physical Effects on Benthic Communities

Considerable data have been gathered from studies into the effects of drill cuttings and WBM on benthic communities, conducted at various sites on the UKCS and worldwide as part of academic research and general environmental monitoring of the oil and gas industry including DTI, 2001; Neff, 2005; OSPAR, 2007. This work has led to a broad consensus on the potential effects that discharged cuttings and associated fluids can have on benthic organisms and communities.

The primary impact identified with regard to WBM cuttings discharges is the direct smothering effect of burial by material discharged as it settles on the seabed (Neff, 2005; OSPAR, 2007; Gates and Jones, 2012). Vulnerability to the impact caused by cuttings discharge varies between different benthic groups, depending on their physiology and ecology, and some species (such as sessile species) are likely to be more sensitive than others. For example, in the case of burrowing organisms, which feed on subsurface sediments, many such species are capable of burrowing up through deposited sediment ranging from 10 mm to 300 mm in thickness to live at the new sediment surface (e.g. Maurer et al, 1979; Kukert, 1991). However, it is unlikely that whole communities would survive burial under more than a few centimetres.

The presence of cuttings material on the seabed also prevents the flow of oxygen and nutrients to the affected areas. This oxygen depletion and associated disruption of nutrient flow can be sufficient to reduce the abundance and diversity of the benthos (Neff, 2005; Trannum et al, 2010).

Although there are no studies available into the specific effects of cement discharges, it is anticipated that the primary effects of particulate discharges will also arise from the physical smothering of organisms within the area of cement deposition.

Increased concentrations of suspended particles in the water near the seabed may also cause damage to feeding and respiratory organs, causing metabolic stress and reducing growth, and also affecting reproductive and survival rates. This, for example, has been demonstrated in scallops and other bivalves (Cranford et al, 1999; Bechmann et al, 2006). Larger individuals are generally more resistant to elevated levels of suspended solids in the water column, and some species are likely to be more sensitive than others. It should also be noted that effects related to increased suspended sediment levels will mostly take place close to the well location and for a limited time period.

The accumulation of cuttings, WBM particles and cement at the Blythe and Elgood wells is, therefore, likely to chiefly affect the local benthic community by burying animals and also by impairing the feeding and respiration activities of others.

Chemical Effects on Benthic Communities

The majority of constituent chemicals used in both the WBM itself and additional drilling chemicals are generally highly water soluble and show low persistence, toxicity and likelihood to be incorporated into the tissues of marine organisms. Weighting agents found in drilling muds, such as barite, may contain naturally occurring elevated levels of barium and other metals, which will typically be higher than those found in local seabed sediments.

However, field studies have found that the metals and metal salts associated with barite, clay, and cuttings particles are not readily bio-accumulated by animals living in close association with cuttings piles and the metals are not passed efficiently through marine food chains (Neff, 1987; Neff et al, 1989; URS, 2002; Neff, 2010). Field studies of organisms around cuttings piles have observed that upon intake by ingestion or adhesion to epithelial surfaces, the majority of metals remain bound to cuttings grains in an insoluble form and are not bioavailable. Jenkins *et al.* (1989) found that around 97% of the barium content remained in granular form and were not assimilated into the study species' tissues. In general, any toxic effects of WBM associated with cuttings discharge have been generally deemed to be negligible (Neff, 2005; Neff, 2010; OSPAR, 2007).

The hydrodynamic regime of the Southern North Sea is conducive to rapid dilution and dispersion of solutes. The chemical additives in the WBM are generally water-soluble and will therefore dissolve and disperse naturally in the water column.

6.1.4 Potential for Recovery

As the physical and chemical effects of the cuttings and mud discharges are of greatest concern, the long-term recovery of affected communities will be influenced by the persistence of the discharged material itself. Cuttings piles associated with WBM are known to be significantly less persistent than those formed with oil based fluids. Cuttings piles in the Southern North Sea will disperse far more rapidly than those in the central and northern North Sea, which will typically disperse over a timescale of 1 year to 10 years (DTI, 2001). The process of dispersion would begin immediately after the cessation of drilling (DTI, 2001; Henry et al., 2017)

Recovery of the benthic communities in the Southern North Sea has been shown to begin soon after the discharge has ceased, via colonisation from surrounding areas and planktonic recruitment (Daan & Mulder, 1996). As mentioned in Section 3 Local Environment, the seabed communities at the Blythe Hub Development are typical of those found in surrounding areas of the Southern North Sea, therefore the potential for such recruitment is likely to be strong. The altered substrate will be dispersed relatively quickly, particularly where it is more thinly deposited, allowing communities consistent with those present pre-drilling to be re-established.

6.2 Production Discharges

6.2.1 Produced Water and Production Chemical Discharges

No produced water will be discharged from the Blythe platform, with all reservoir fluids and production chemicals being exported to Bacton Terminal for treatment. Fluids and materials mobilised by pipeline pigging operations will also be exported along PL370 for treatment at the Bacton Terminal.

6.2.2 Discharges at the Sea Surface

A number of chemicals will be used on the drilling rig for maintenance, such as detergents to wash the rig floors and lubricants for certain equipment and machinery. The use and subsequent potential discharge of these chemicals were considered to have negligible environmental effects and were scoped out at the ENVID stage, and will be managed and regulated under the existing chemical and oil discharge permitting regimes.

6.3 Cumulative and Transboundary Impacts

The closest existing active well is the Perenco operated Waveney gas well, 7.5 km to the northwest, where production started in 1998. The Blythe and Elgood wells, separated by just over 9 km, are closer to each other than to any other wells to be drilled within a relevant timeframe. The nearest marine infrastructure to the development is the Dudgeon OWF, with the closest individual turbine approximately 1 km to the south-west. At its nearest point, the UK/Netherlands median line is situated approximately 105 km east of the development area. As the zone of influence of the drilling discharges is anticipated to be limited to 50 m from each individual well, no cumulative and transboundary impacts are anticipated.

6.4 Mitigation Measures

All chemicals used for the drilling operations are regulated under the Offshore Chemicals Regulations 2002 (as amended), which aims to replace chemicals with poor environmental characteristics by more environmentally friendly chemicals. Selection of all chemicals that may be used in drilling the proposed well will be based upon both their technical specifications, including their environmental performance. The use of all chemicals will be minimised where practicable.

For cement discharges, the amount discharged onto the seabed during installation of the conductor casing will be minimised by visual monitoring of the operation by a ROV. Once returns are observed, pumping will be stopped in order to minimise discharged volume.

The lower well sections that will be drilled with LTOBM, will have all cuttings and drilling fluids returned to the drilling rig, and shipped to shore for appropriate treatment and disposal. This will minimise the cuttings and drilling fluids discharged at sea.

In addition, the drilling mud, cuttings and minor quantities of cement discharged from the drilling rig will be discharged at the sea surface, allowing dilution and dispersion over a larger area and thereby minimising the overall environmental impact.

6.5 Conclusions

All chemicals used will be approved by Cefas, and will be in accordance with UK chemicals regulations. Wherever practicable and technically feasible, chemicals without substitution warnings will be prioritised over those that do have warnings.

The effects of WBM and cuttings discharges on the benthic environment are related to the total quantity discharged and the oceanic energy regime encountered at the discharge site, particularly the currents close to the seabed itself (Neff, 2005).

Based on these factors, the discharge of cuttings and drilling fluids at the Blythe and Elgood well locations have the potential to cause a temporary localised impact to the benthic environment, primarily through direct physical changes to the seabed. This effect is expected to be chiefly limited to within 50 m of the well location. Recovery of the benthos is expected to begin soon after discharges cease.

The areas of the seabed directly affected by drilling discharges are not protected, or potential Annex 1 habitat, and are typical and widespread in the Southern North Sea. Bearing these factors in mind, the magnitude of environmental effects is considered to be minor and thus not significant.

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Section 7

Noise Generation and Wildlife Disturbance

7 NOISE GENERATION AND WILDLIFE DISTURBANCE

The following issues and concerns were raised during the ENVID and informal consultation, and will therefore be considered in this section on noise generation and wildlife disturbance:

- Sound produced by vessels, jack up rig platform and helicopters including thrusters, propellers and engines resonating through the water column may have a significant effect on the marine environment, specifically marine mammals and fish;
- Sound produced by piling operations associated with the installation of the platform and fixing infrastructure to the seabed may have a significant effect on the marine environment, specifically marine mammals and fish.

During the drilling operations at the Blythe Hub Development, noise will be generated by the jack up drilling rig during drilling and also by support vessels (i.e. the standby vessel and supply vessels) and helicopters. However, the loudest anticipated sound source will be piling noise generated during platform installation. Once the platform is in place, underwater noise generation will be minimal and will be mainly limited to that generated by vessels and helicopters visiting the platform. The remainder of this section will therefore primarily focus on the piling noise, which has the potential to affect behaviour, and in extreme cases even injure local wildlife.

This section further assesses the requirement for a wildlife disturbance licence, using the criteria for undertaking such an assessment outlined in the latest version of the JNCC draft guidance notes (JNCC, 2010a).

7.1. Quantification of Noise

7.1.1. Ambient Noise

Ambient or background noise in the ocean consists of a broad range of individual sound sources and is made up of natural, as well as manmade sources (Hildebrand, 2004). The ambient acoustic environment of the ocean is highly variable.

The dominant source of naturally occurring noise is associated with ocean surface waves generated by the wind. This noise occurs across a range of frequencies from 1 Hz to 100 kHz (NRC, 2003). Other natural sounds in the sea include currents, rain, ice-breaking, echo-location and communication noises generated by cetaceans and fish and other natural sources such as tectonic activity.

In addition to naturally occurring sounds, there is anthropogenic noise generated by air traffic, shipping activity and the oil and gas industry, amongst other activities. Of these, shipping is the dominant source of sound in the world's oceans, generally within a range from five to a few hundred Hertz (NRC, 2003). These anthropogenic 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 little time to adapt to these changes in an evolutionary sense. Table 7.1 shows various examples of anthropogenic sources and received levels of sound in the marine environment.

Table 7.1: Sound Sources from Various Examples of Maritime Activities

Activity	Dominant Frequency Range [kHz]	Average Source Level [dB re 1µPa-m]	Estimated Received Level at Different Ranges [km]			
			0.1 km	1 km	10 km	100 km
High resolution geophysical survey; pingers, sidescan, fathometer	10 - 200	<230	190	169	144	69
Low resolution geophysical seismic survey; seismic air gun	0.008 - 0.2	248	210	144	118	102
			208	187	162	87
Production drilling	0.25	163	123	102	77	2
Jack-up drilling rig	0.005 - 1.2	85 - 127	45 - 87	24 - 66	<41	0
Semi-submersible rig	0.016 - 0.2	167 - 171	127 - 131	106 - 110	81 - 85	6 - 10
Drill ship	0.01 - 10	179 - 191	139 - 151	118 - 130	93 - 105	18 - 30
Large merchant vessel	0.005 - 0.9	160 - 190	120 - 150	99 - 129	74 - 104	<29
Military vessel	Not known	190 - 203	150 - 163	129 - 142	104 - 117	29 - 42
Super tanker	0.02 - 0.1	187 - 232	147 - 192	126 - 171	101 - 146	26 - 71

Adapted from: Evans & Nice, 1996 and Richardson *et al*, 1995.

Figure 7.1 represents ambient noise as a function of frequency; the ambient noise spectrum normally lies between the two thick green lines shown.

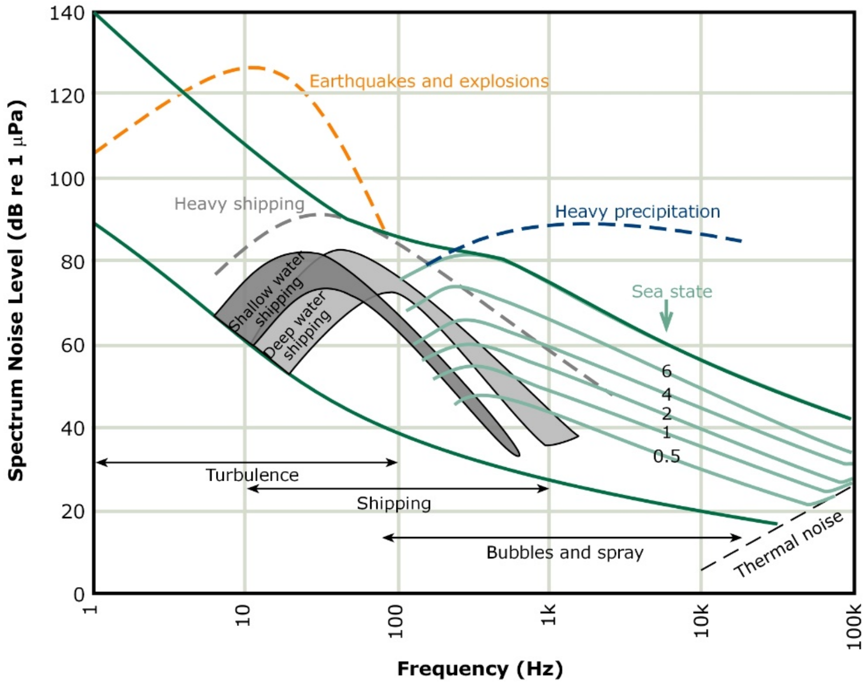

Figure 7.1: Ambient Noise Spectra in the Open Ocean

Source: Adapted from Wenz, 1962; NRC, 2003; and Harland *et al*, 2005.

7.1.2. Underwater Noise from Piling During Platform Installation

Wyatt (2008) shows there is a strong correlation between the diameter of the pile and the piling noise generated. The pin piles for the Blythe platform will have a diameter of 91.4 cm (36"), corresponding to an estimated peak to peak sound pressure level of 229 dB re 1µPa at 1 m. Piling generates underwater sound over a wide frequency range, however, the peak frequency levels of piling noise can be expected between 200 Hz and 500 Hz, with a significant roll off in pulse energy above 8 kHz, with low intensity levels reaching frequencies up to 22 kHz (Lepper *et al*, 2007). Each platform leg will require 2 pin piles. In total 8 piles will be driven into the seabed over a 4 day period.

7.1.3. Underwater Sound Behaviour

As sound spreads underwater, it decreases in strength with distance from the source. This transmission loss is the sum of spreading loss and attenuation loss. Spreading loss is the geometric weakening of a sound signal as it spreads outwards from a source. Attenuation losses are the physical processes in the sea that distort the mathematical spreading laws. A number of factors including sound absorption or scattering by organisms in the water column, reflection or scattering at the seabed and sea surface, and the effects of temperature, pressure, stratification and salinity affect these physical processes. Variations in temperature and salinity with depth cause sound waves to be refracted downwards or upwards causing increases or decreases in sound attenuation and absorption. Actual sound transmission therefore has considerable temporal and spatial variability that is difficult to quantify.

Variations in water depth will influence the propagation of low frequency sound signals, but to a much lesser degree than the impact on sound waves with higher frequencies. Therefore, sound attenuation for piling noise can be expected to follow a spherical decay law, which can be expressed as:

$$SPL = SL - 20 \log (R)$$

SPL = Sound pressure Level (at distance ‘R’ from the sound source)

SL = Source level

R = Distance from sound source (in metres)

7.2. Impacts from Sound Generated by the Proposed Activities

This section assesses potential impacts from underwater sound, focussing on marine mammals and fish which are the species believed to be most at risk from noise impacts which may arise from the proposed Blythe Hub Development.

Sound is a particularly efficient way to propagate energy through the ocean, and many marine animals use hearing as their primary sense. Cetaceans are heavily dependent on sound for food-finding, communication, reproduction, detection of predators and navigation (Weilgart, 2007; Hildebrand, 2004).

As described in Section 7.1, the ocean is a naturally noisy environment and cetaceans in particular have evolved ears that function well within this context. A review of anatomical and behavioural studies by Ketten (2004) indicated that whales and dolphins may be more resistant than many land mammals to temporary threshold shifts. However, these data also show that they are subject to disease and aging processes and are therefore not immune to hearing loss. Increasing ambient noise via human activities is a potential candidate for exacerbating or accelerating such losses.

The introduction of additional noise into the marine environment could potentially interfere with an animal’s ability to determine the presence of other individuals, predators, prey and underwater features and obstructions. Significant adverse noise could also cause behavioural changes, such as avoidance of preferred feeding areas or migration routes and, in more extreme cases, cause auditory damage.

7.2.1. Effects on Marine Mammals

Marine mammals use sound in various important contexts, such as in social interactions, foraging, and response to predators (Southall *et al*, 2007). Hearing is the primary sensory system for marine mammals, which is clearly shown by their level of ear and neural auditory centre development (Ketten, 2004). As the sea has never been a silent place, the ears of marine mammals, and those of whales and dolphins in particular, have evolved to function well within this context of ambient noise. However, little information exists to describe how marine mammals respond physically and behaviourally to intense sounds and to long term increases in ambient noise levels (NRC, 2003).

Marine mammals vary in regard to their hearing sensitivities and in order to assess the impacts of sound on them, Southall *et al* (2007) classed marine mammals into functional hearing groups. Table 7.2 applies this classification to the species that may be present in the wider area around the Blythe Hub Development. According to this classification, harbour porpoises are regarded as high-frequency cetaceans with an estimated auditory bandwidth between 200 Hz to 180 kHz. All other toothed whales (odontocetes) are classified as mid-frequency cetaceans, with an estimated auditory bandwidth between 150 Hz to 160 kHz. This classification is based on the fact that odontocetes have highly advanced echolocation systems that use intermediate to very high frequencies. They also produce social sounds in a lower-frequency band, including generally low to intermediate frequencies (1 kHz to tens of kHz). Consequently, their functional hearing is expected to cover this whole range; however, their hearing sensitivity typically peaks at or near the frequency where echolocation signals are strongest.

The large baleen whales (mysticetes) are all categorised as low-frequency cetaceans. No direct measurements of hearing exist for these animals and theories regarding their sensory capabilities are consequently speculative. In these species, hearing sensitivity has been estimated from behavioural responses (or lack thereof) to sounds at various frequencies, most common vocalisation frequencies, body size, ambient noise levels at the frequencies they use most, and cochlear morphology. At present, the lower and upper frequencies for functional hearing in mysticetes, collectively, are estimated to be 7 Hz and 22 kHz (Southall *et al*, 2007).

Table 7.2: Functional Hearing Groups for Marine Mammals Potentially Present in the Blythe Hub Area

Functional Hearing Group	Estimated Auditory Band Width	Species Potentially Present
Low-frequency cetaceans	7 Hz to 22 kHz	Minke whale
Mid-frequency cetaceans	150 Hz to 160 kHz	Atlantic white-sided dolphin, White-beaked dolphin
High-frequency cetaceans	200 Hz to 180 kHz	Harbour porpoise
Pinnipeds in water	75 Hz to 75 KHz	Grey seals, Common seal
Pinnipeds in air	75 Hz to 30 kHz	Grey seals, Common seal

Sources: Southall *et al*, 2007; Pollock *et al*, 2000; Reid *et al*, 2003; DECC, 2016.

Research indicates that marine mammals can react differently to the introduction of additional noise into the marine environment. Reactions may vary depending on sound source level, propagation conditions and ambient noise, in addition to species, age, sex, habitat, individual variation, and previous habituation to noise (Richardson *et al*, 1995). It should also be noted that marine mammals react differently to stationary noise, compared to 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 noises, outwith an immediate zone of discomfort to the animal, seem to have a lesser effect in disturbing migration patterns and animal feeding, although data and observations on this matter are limited (Davis *et al*, 1990).

Injury Thresholds for Cetaceans

The planned piling operations will produce intermittent sound pulses, which are considerably more intense than the continuous noise emitted by most industrial noises in the ocean, including those generated during the planned drilling and production operations. There are few direct data regarding the effects of intense sound on cetaceans, making it difficult to predict accurate safe exposure levels for these mammals (Finneran *et al*, 2000). Nonetheless, Southall *et al* (2007) have attempted to develop a set of injury criteria for individual marine mammals exposed to discrete noise events, such as piling 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 pulsed sounds, when adjusted for the main low frequencies produced by the piling (i.e. frequencies below 500 Hz), are 230, 231 and 231 dB for low-, mid- and high-frequency cetaceans, respectively. These sound thresholds are in the same range as those generated during piling (229 dB). It should be borne in mind that the attenuation will be very rapid within short distances of the piling operations itself, and will be attenuated to approximately 209 dB within 10 m from the pile, assuming spherical spreading. Furthermore, it is generally considered unlikely that marine mammals would remain close to any noise source that caused discomfort for any length of time (Richardson *et al*, 1995). On the basis of all this, it is judged that the piling noises are unlikely to cause physical injury to any cetaceans in the area, unless they are located very close (i.e. within a few metres) of the actual piling event.

Behavioural Responses of Small Odontocetes to Piling Operations

Although it is unlikely that the proposed piling operations will cause injury, they may evoke a certain level of behavioural responses from any cetaceans in the vicinity of such operations. For example, Brandt *et al* (2013) found a clear negative impact of pile driving during wind farm construction on porpoise acoustic activity within several kilometres from the piling operations. No effect was observed between 16 to 22 km from the piling operations at two separate locations. Effects lasted up to 70 hrs after pile driving had stopped. The same authors quote a study by Tougaard *et al*. (2009) finding effects up to a similar distance of ~20 km. It should be noted however, that these studies refer to pile sizes that are at least twice the diameter of the proposed pin piles that will be used for the Blythe Hub platform, and thus would have required significantly more energy to drive the piles into the seabed.

There is limited other information available of the behavioural effects of the larger baleen whale species to piling operations. However, as sound levels and dominant frequencies of piling sound are in many ways quite similar to the sound generated during offshore geophysical (i.e. seismic) surveys, the following examples have been used as a proxy to describe some of the anticipated effects and spatial extent.

Behavioural Responses of Baleen Whales to Geophysical Survey Operations

Baleen whales have hearing sensitivity ranges between 10 Hz and 10 kHz, with greatest sensitivities usually below 1 kHz (Evans, 1998; Southall *et al*, 2007). This hearing range overlaps the low frequency sounds produced by the planned piling operations, which may mask long distance communication between whales and prevent the detection of other faint sounds (Evans & Nice, 1996).

Most studies on low-frequency cetaceans report behavioural responses to 'pulsed sound', such as that produced by piling operations or seismic surveys, at received sound levels around 140 to 160 dB re 1 µPa, and sometimes even higher (e.g. Southall *et al*, 2007; Richardson *et al*, 1995). These responses typically consist of subtle effects on surfacing and respiration patterns. Sound levels of 150 to 180 dB will generally evoke behavioural avoidance reactions (Richardson *et al*, 1995).

Taking into account the factors explained above, and using the formula for spherical spreading (Section 7.1.3), some avoidance behaviour may be expected within 9 km distance from the piling location. More subtle effects may be noticed up to a distance of approximately 28 km from the platform.

Given the intermittent nature and short overall duration of the piling operations (4 days), the fact that the impact on cetaceans is expected to be limited to some potential avoidance responses for individual animals in the immediate vicinity of the platform piling operations (i.e. within 9 kilometres) and that mitigation measures outlined in the JNCC Guidelines will be followed, the impact of piling operations on cetaceans is considered to be not significant.

Impacts on Pinnipeds

Pinnipeds (seals, sea lions and walruses) also produce a diversity of sounds, although generally over a lower and more restricted bandwidth (generally from 100 Hz to several tens of kHz). Their sounds are used primarily in critical social and reproductive interactions (Southall *et al*, 2007). Most pinniped species have peak sensitivities between 1 and 20 kHz (NRC, 2003). Common seals are most sensitive to sounds between 6 kHz to 12 kHz (Wolski *et al*, 2003), although their threshold for hearing and responding to sound lies at much lower frequencies. Kastak & Shusterman (1998) measured the underwater sound detection threshold of a common seal to be between 101.9 dB and 62.8 dB for frequencies between 75 Hz and 6,400 Hz respectively. The audiograms of common and grey seals are very similar (Thompson, 1998), and their reaction to anthropogenic underwater sound is therefore also expected to be similar.

Very few studies have been conducted on the effects of impulsive noise on pinnipeds, even though they are known to have good underwater hearing and their feeding grounds often overlap with areas subject to manmade high intensity underwater noise activities.

Russell et al (2013) found that seal usage (abundance) was significantly reduced up to 25 km from piling operations at a wind farm location in the Southern North Sea. Within 25 km of the centre of the wind farm, there was a 19 to 83% decrease in usage of the area compared to during breaks in piling. This amounted to significant displacement starting from predicted received levels of between 166 and 178 dB re 1 µPa(p-p). Within 2 hours of cessation of pile driving, seals were distributed as per the non-piling scenario.

A review of the effects of seismic survey on marine mammals by Gordon *et al* (2004) quotes one single study by Thompson *et al* (1998) on the behavioural and physiological responses of grey and common seals to small airguns. The study indicated that reactions observed in common seals included initial fright responses as the air guns were switched on, generally followed by strong avoidance behaviour, demonstrated by swimming rapidly away from the sound source. However, the study also reported that one seal showed no detectable response and approached to within 300 m of the airgun (source levels of the airgun were 215 to 224 dB re 1 µPa-m peak-to-peak). The seals ceased feeding during this time. The behaviour of the common seals seemed to return to normal soon after the air guns were switched off.

Bearing in mind that the piling operations will be intermittent over a short overall period of 4 days, and any affected seals are expected to return to the area quickly after piling operations have seized, the overall impacts from piling are not believed to cause any long-term effects on pinnipeds and therefore are deemed insignificant.

7.2.2. Effects on Fish

The inner ear of fishes including elasmobranchs (sharks, skates and rays), is very similar to that of terrestrial vertebrates, and hearing is understood to be present in virtually all fishes (NRC, 2003). Most species of fish are able to detect sounds from below 50 Hz (some as low as 10 Hz or 15 Hz) to upward of 1,000 Hz. Moreover, a number of fish species have auditory adaptations that enhance sound detection and enable them to detect sounds of 3 kHz and above, giving them better sensitivity than non-specialist species at lower frequencies (NRC, 2003; Popper, 2003). Many species of fish use sound to find prey, to avoid predators, and for social interactions. In addition, the sensory systems used by fishes to detect sounds are very similar to those of marine (and terrestrial) mammals, and, as a consequence, sounds that damage or affect marine mammals could in other ways have similar consequences for fishes (Popper, 2003). Some fish species, such as herring, have swim bladders which may be susceptible to damage by underwater high noise levels, making these species comparatively more sensitive.

The effect of piling operations on fish is strongly related to their life cycle stage. Adult and juvenile fish are rarely affected by piling operations because they are able to detect and physically avoid the area but fish eggs and larvae may be more vulnerable. Fish can detect seismic sound sources over large distances (up to 30 km), yet they seldom react to the sound before it is above a certain threshold. Alarm responses in adult or juvenile fish can be expected at distances of 1 km to 5 km from the piling operations, depending upon their auditory thresholds and the level of sound transmission loss (Nakken, 1992). Given the limited spatial extent of the anticipated impact and the limited (4 day) period over which the piling will take place, and the ability of fish to temporarily avoid areas of adverse noise, the proposed piling operations is not anticipated to cause any significant impacts on fish.

7.3. Assessment of the Requirement for a Wildlife Disturbance Licence

Under the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (or Offshore Marine Regulations, OMR), as amended by the Offshore Marine Conservation (Natural Habitats, &c.) (Amendment) Regulations 2009 and 2010, it is an offence to deliberately disturb European Protected Species (EPS; species listed in Annex IV of the Habitats Directive), in such a way that is likely to:

- Impair their ability to survive, to breed or reproduce, or to rear or nurture their young; or in the case of a hibernating or migratory species, to hibernate or migrate;
- Affect significantly the local distribution or abundance of the species to which they belong.

IOG has therefore assessed if any of the proposed operations taking place on the UKCS would potentially cause a 'disturbance offence' to any EPS, and subsequently would require a disturbance licence under these regulations. The potential disturbance caused by the proposed piling operations mainly refers to (underwater) noise.

The EPS include all cetaceans, turtles and sturgeon. In UK waters, the latter two are at the limits of their global distributions (which are centred elsewhere in the West Atlantic or Europe) and only occur in low numbers around the UK. It is therefore extremely unlikely that a significant group of these animals would be present, or that their local abundance or distribution would be significantly affected by marine impacts (JNCC, 2010a). Therefore, only cetaceans will be considered.

As described in Section 7.2.1, none of the proposed operations at the Blythe Hub are considered likely to cause any injury to cetaceans, and only a certain level of avoidance responses is expected within a 9 km of the platform during operations. Therefore, this assessment is based on whether these behavioural responses could potentially result in a disturbance offence in relation to marine EPS, as defined under Regulations 41(1)(b) and 39(1)(b) of the Habitats Regulations and Offshore Marine Regulations, respectively.

Table 7.3 identifies the cetacean species that may be present in the wider area and, therefore, may be affected by underwater noise from the proposed piling operations. It also specifies the number of individuals per species that can be expected to be in the area in which potential 'disturbance' effects could be expected to occur. Further information about each of these species is presented in Section 3.2.4.

Table 7.3 also shows that only a few individual cetaceans would potentially be affected by the proposed operations at the Blythe Hub. Of these, Harbour porpoise is recorded as being the most abundant of the species identified in the area. The harbour porpoise is common in shelf waters of the Northern and Central North Sea, however the Southern North Sea, especially south eastern parts of the North Sea, hosts relatively lower densities on an annual basis. There are fewer records from deeper waters however it may be more abundant in deep water than surveys suggest, as it is difficult to detect this species in rough conditions. This species occurs in very small groups of up to three individuals (Reid *et al*, 2003).

The abundance data in Table 7.3 is based on the mean values and does not take into account the fact that certain cetacean species live in larger pods or groups and therefore their distribution in reality will be much more clustered. The Harbour porpoise is also one of the most abundant cetaceans in north-western European shelf waters, with an abundance estimate of 53,485 individuals recorded in SCANS III survey area O, which covers an area of water over 60,000 km^2 (Hammond *et al*, 2017). Therefore, only 0.42% of the Harbour porpoise population in this survey area would be expected to show any avoidance behaviour, whereas some 4% may be temporarily affected showing subtle behavioural responses with animals expected to return to the area within 3 days once the piling operations have been completed.

Table 7.3: Numbers of Cetaceans Estimated to be Present in the Blythe Hub Development Area

Cetacean Species	Abundance Data (Animals/km^2)	Data Source	Estimated Number of Animals Within 9 km Radius of the Blythe Platform	Estimated Number of Animals Within 28 km Radius of the Blythe Platform
Harbour porpoise	0.888	SCANS III	226	2187
White beaked dolphin	0.002	SCANS III	0.51	4.93
Atlantic white sided dolphin	No data	SCANS III	Not observed in area O during SCANS III survey	
Minke whale	0.01	SCANS III	2.54	24.63

Risso's dolphins and coastal bottlenose dolphins have been identified by the JNCC as the two EPS most likely to require a wildlife disturbance licence for any activity in UK offshore waters that might affect their distribution or abundance (JNCC, 2010a). There are no known resident coastal bottlenose dolphins in the vicinity of the Blythe Hub Development and there have been no recordings of this species at all in the immediate vicinity (Hammond *et al*, 2017). Therefore, the proposed operations are not believed to pose any risk to bottlenose dolphins or Risso's dolphins.

Potential disturbance effects on Harbour porpoise, as the most abundant cetacean species recorded in the area, should also be considered when determining the requirement for a species disturbance licence.

No physical injuries are expected as a result of the piling operations at the Blythe Hub Development. Cetaceans in the vicinity may exhibit avoidance responses within 9 km of the piling operations, while more subtle behavioural effects may occur up to a distance of 28 km. It should be noted that the thresholds used to predict zones of effect are precautionary, representing the lower limits of responsiveness from published studies, as reviewed by Southall *et al* (2007). As a consequence, not all marine mammals exposed to these levels of noise will respond as predicted, and some may show no measurable effects. In addition, the type and intensity of an animal's response is believed to vary depending on the ratio between the anthropogenic sound and ambient noise levels, the rate of change of the sound; and also the behavioural context and motivations at the time, the previous experience of exposed individuals and how the animal interprets the sound, i.e. as a predator or just an annoying stimulus (JNCC, 2010a).

Piling operations will only take place intermittently over a period of 4 days, with any effects not expected to last over 3 days after piling has been completed. Therefore, it is considered unlikely that the proposed piling operations would adversely affect any animals in such a way as to cause 'deliberate disturbance' of an EPS.

7.4. Cumulative and Transboundary Impacts

Noise is transmitted through water very efficiently and may be detectable over many kilometres from its source. This has led to concerns that increasing anthropogenic activity in the sea, and consequent increasing noise levels, may have effects on marine mammals through interruption of their communication and hearing mechanisms. The potential outcomes of having multiple noise sources in the sea include more frequent masking, behavioural disruptions and short-term displacement, although potentially this could be mitigated by a certain level of habituation. Prolonged or repeated disturbance is generally considered to be of more concern than isolated short-term disturbance.

The piling operations during the installation of the Blythe platform will temporarily add to the ambient noise in the Southern North Sea which includes various sources of industrial noise such as shipping and fishing activity, windfarms, other oil and gas installations and aggregate extraction.

As described above, the ambient noise around in the Blythe Hub Development area is likely to be dominated by shipping sound. The Blythe Hub Development lies adjacent to the Dudgeon Offshore Wind Farm (DOWF) and a busy shipping corridor lies to the west. Furthermore, the development will be situated 5 km to the southeast of the Waveney field which will be another source of manmade sound in the wider area, which to some extent, produce (low frequency) underwater sound.

The long term, synergistic and cumulative impact of sound sources is not known, and the introduction of additional low-frequency noise into the marine environment from the proposed piling operations at the Blythe Hub should be considered to have the potential to contribute to the overall cumulative effect of anthropogenic generated underwater noise. However, the risks in this instance are considered to be low, for the following reasons:

- Noise generation associated with the proposed piling operations will be intermittent and transitory; occurring over a period of up to 4 days;
- Although the Southern North Sea can be regarded as important for certain species of cetacean (Section 3.2.4), the highest densities of cetaceans present in the Blythe Development area are mid-frequency cetaceans (Tables 7.2 and 7.3), which are generally regarded to be more sensitive to higher sound frequencies than the dominant frequencies produced by the piling operations.

Therefore, the temporary increase in local anthropogenic underwater noise from the planned piling operations in the area is considered to be insignificant. IOG is not aware of any piling operations (or any other type of high intensity sound producing activities) proposed to take place in the immediate vicinity of the Blythe Development Hub during platform installation.

With regard to potential transboundary effects, the location of the Blythe Hub is 105 km east of the UK/Netherlands transboundary line. At this distance any underwater sound will have attenuated to a low level therefore no observable effects are expected to occur. Consequently, no significant cumulative and/or transboundary impacts from noise generated during the piling operations are anticipated.

7.5. Mitigation Measures

The amount of underwater sound generated during piling operations will be kept to a minimum, where possible. The main priority is to minimise the time over which sound energy is emitted into the marine environment. Only 8 relatively small pin piles will be hammered into the seabed, over a period of 4 days. Therefore, any noise associated with the operations will be transitory. It should be noted that piling will not take place continuously during this 4 day period, with each pile only expected to take several hours to install.

The planned operations will be conducted in accordance with the latest JNCC guidelines for minimising acoustic disturbance to marine mammals to mitigate potential impacts to cetaceans, at all times. This will include the use of ‘soft start’ procedures during piling operations (JNCC, 2010b).

7.6. Conclusions

Anthropogenic noise from shipping is currently believed to be the main source of background noise in the area of the proposed well location. The planned piling operations to install the Blythe platform jacket firmly onto the seabed operations may cause avoidance response reactions in cetaceans within 9 kilometres of the platform. However, given the short duration of such operations (up to 4 days), any effects are expected to be transient and are not considered to be significant.

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Section 8

Atmospheric Impacts

8 ATMOSPHERIC IMPACTS

During the proposed drilling and installation operations at the Blythe Hub, atmospheric emissions will be produced as a result of power generation onboard the jack-up drilling rig, as well as from the pipeline laying vessel (PLV), heavy lift barge, supply vessels, standby vessels and helicopter activity. Such emissions contribute to a variety of environmental effects and associated impacts, including climate change. During the during production phase, power generation for the Blythe platform will be provided by a combined part renewable energy system (wind and solar energy) and a part traditional diesel engine system for when renewable energy is not in full supply. Therefore, combustion emissions from the platform have not been considered further in this ES.

Although the individual climate change impact of the planned drilling and installation operations at the Blythe Hub are comparatively so small that they are impossible to assess on their individual merit, it is acknowledged that they will contribute to the overall cumulative issue of climate change, which is of key concern to overall sustainability objectives and atmospheric emissions are therefore considered in this section of the ES.

However, it should be noted that the overall strategy to address cumulative global environmental issues, such as climate change, from a UK perspective, ultimately lies with the government. Individual climate change effects from a single operation cannot be assessed. Therefore, the estimated atmospheric emissions and their associated global warming potential in this chapter are only presented to provide context to the proposed drilling operations and to allow for generic comparison with the overall values for emissions for the UK offshore oil and gas industry.

8.1 Quantification of Atmospheric Emissions

The quantification of emissions in this section of the ES is based on generic emission factors, and should be used as an indication of the order of magnitude only. The calculations are based on the fuel consumption estimates presented in Tables 2.1 and 2.2 of the project description.

8.1.1 Atmospheric Emissions from Drilling Operations at Blythe and Elgood

Generation of power onboard the jack-up drilling rig and support vessels will result in the emissions of various combustion gases.

At Blythe, diesel consumption onboard the jack-up drilling rig during drilling operations is around 15 m^3 per day (based on general industry figures for 116-C Class jack-up rigs). During transit to the well location this increases to 50 m^3/day. With a total operational time of approximately 82.5 days for Blythe and 85.5 for Elgood, each including 4 days transit time to and from the respective sites, this will amount to a total of approximately 1,237 m^3 and 1,283 m^3 of diesel being used for power generation at Blythe and Elgood respectively.

In addition to the fuel used by the jack-up drilling rig itself, all support vessels (anchor handling tugs, supply vessels and the standby vessel), together with aircraft support, will also consume fuel and produce exhaust emissions. Table 8.1 and Table 8.2 lists the predicted emissions from these sources, based on their total fuel consumption.

Table 8.1: Estimated Emissions from the Jack-up Drilling Rig and Associated Vessels at Blythe

		Supply Vessel	ERRV Vessel	Helicopter Flights	Anchor Handling Tug	Jack-up Drilling Rig	Total
Consumption [m^3]		230.00	346.00	28.10	600.00	1,237.50	2,441.60
Emissions ([tonnes])	CO_2	736.00	1,107.20	89.92	1,920.00	3,960.00	7,813.12
	CO	1.84	2.77	0.15	4.80	10.27	19.83
	NO_x	13.57	20.41	0.35	35.40	45.05	114.78
	N_2O	0.05	0.08	0.01	0.13	0.27	0.54
	SO_2	0.92	1.38	0.11	2.40	4.95	9.77
	CH_4	0.06	0.09	0.00	0.16	0.14	0.46
	VOC	0.55	0.83	0.02	1.44	1.49	4.33
	GWP	**826.00**	**1,242.59**	**250.32**	**2,154.79**	**4,300.57**	**8,774.28**

Calculations according to UKOOA atmospheric emissions guidance (1999) and the GWP conversion factors as shown in Table 8.7.

Table 8.2: Estimated Emissions from the Jack-up Drilling Rig and Associated Vessels at Elgood

		Supply Vessel	ERRV Vessel	Helicopter Flights	Anchor Handling Tug	Jack-up Drilling Rig	Total
Consumption [m³]		205.00	358.00	29.53	600.00	1,282.50	2,475.03
Emissions ([tonnes])	CO_2	656.00	1,145.60	94.49	1,920.00	4,104.00	7,920.09
	CO	1.64	2.86	0.15	4.80	10.64	20.10
	NO_x	12.10	21.12	0.37	35.40	46.68	115.67
	N_2O	0.05	0.08	0.01	0.13	0.28	0.54
	SO_2	0.82	1.43	0.12	2.40	5.13	9.90
	CH_4	0.06	0.10	0.00	0.16	0.14	0.46
	VOC	0.49	0.86	0.02	1.44	1.54	4.35
	GWP	**736.22**	**1,285.69**	**263.05**	**2,154.79**	**4,456.96**	**8,896.70**

Calculations according to UKOOA atmospheric emissions guidance (1999) and the GWP conversion factors as shown in Table 8.7.

8.1.2 Atmospheric emissions during platform installation at Blythe

Emissions of various combustion gases will also occur during the installation of the platform infrastructure such as the jacket foundation and the platform topsides. Vessels involved in the installation of the field infrastructure will include a heavy lift barge, supply vessels and tugs. Diesel consumption onboard the heavy lift vessel during platform installation operations is around 20 m^3 per day (based on actual general industry figures for heavy lift vessels). During transit to the well location this increases to 50 m^3/day. With a total operational time of approximately 82.5 days (including 4 days transit time to and from the site), this will amount to a total of approximately 1,283 m^3 of diesel being used for power generation.

In addition to the fuel used by the jack-up drilling rig itself, all support vessels (anchor handling tugs, supply vessels and the standby vessel), together with aircraft support, will also consume fuel and produce exhaust emissions. Table 8.3 lists the predicted emissions from these sources, based on their total fuel consumption.

As no platform infrastructure is to be installed at Elgood no estimate of emissions is provided for that site.

Table 8.3: Estimated Emissions During Platform Installation at Blythe

		Heavy Lift Barge	Tug	Total
Consumption [m³]		200.00	20.00	220.00
Emissions ([tonnes])	CO_2	640.00	64.00	704.00
	CO	1.60	0.16	1.76
	NO_x	11.80	1.18	12.98
	N_2O	0.04	0.00	0.05
	SO_2	0.80	0.08	0.88
	CH_4	0.05	0.01	0.06
	VOC	0.48	0.05	0.53
	GWP	**718.26**	**71.83**	**790.09**

Calculations according to UKOOA atmospheric emissions guidance (1999) and the GWP conversion factors as shown in Table 8.7.

8.1.3 Atmospheric Emissions from pipeline installation at Blythe and Elgood

Emissions of various combustion gases will occur during the installation of the field infrastructure such as the pipelines and manifolds. Vessels involved in the installation of the field infrastructure will include pipelay vessels and Diving Support Vessels (DSV) which will consume fuel and produce exhaust emissions. Table 8.4 and 8.5 list the predicted emissions from these sources, based on their total fuel consumption.

Table 8.4: Estimated emissions during pipeline installation at Blythe

		PLV	DSV	Total
Consumption [m^3]		166.00	268.00	434.00
Emissions ([tonnes])	CO_2	531.20	857.60	1,388.80
	CO	1.33	2.14	3.47
	NO_x	9.79	15.81	25.61
	N_2O	0.04	0.06	0.10
	SO_2	0.66	1.07	1.74
	CH_4	0.04	0.07	0.12
	VOC	0.40	0.64	1.04
	GWP	**943.59**	**1,523.38**	**2,466.97**

Calculations according to UKOOA atmospheric emissions guidance (1999) and the GWP conversion factors as shown in Table 8.7.

Table 8.5: Estimated emissions during pipeline installation at Elgood

		PLV	Diving Support Vessel	Total
Consumption [m^3]		91.00	178.00	269.00
Emissions ([tonnes])	CO_2	291.20	569.60	860.80
	CO	0.73	1.42	2.15
	NO_x	5.37	10.50	15.87
	N_2O	0.02	0.04	0.06
	SO_2	0.36	0.71	1.08
	CH_4	0.02	0.05	0.07
	VOC	0.22	0.43	0.65
	GWP	**517.27**	**1,011.80**	**1,529.07**

Calculations according to UKOOA atmospheric emissions guidance (1999) and the GWP conversion factors as shown in Table 8.7.

8.1.4 Total Estimated Atmospheric Emissions from Drilling and Installation Operations at the Blythe Hub

The total estimated emissions of various combustion gases arising during the drilling and installation operations at the Blythe Hub, are listed in Table 8.6.

Table 8.6: Total Estimated Emissions from Drilling and Installation Operations at Blythe and Elgood

		Supply Vessel	ERRV Vessel	Helicopter Flights	Jack-up Drilling Rig	Heavy Lift Barge	Tug	DSV	AHT	PLV	Total
Consumption [m^3]		435.00	704.00	57.63	2,520.00	200.00	20.00	446.00	1,200.00	257.00	5,619.63
Emissions [tonnes]	CO_2	1,392.00	2,252.80	184.41	8,064.00	640.00	64.00	1,427.20	3,840.00	822.40	17,982.81
	CO	3.48	5.63	0.30	20.92	1.60	0.16	3.57	9.60	2.06	45.55
	NO_x	25.67	41.54	0.72	91.73	11.80	1.18	26.31	70.80	15.16	271.93
	N_2O	0.10	0.15	0.01	0.55	0.04	0.00	0.10	0.26	0.06	1.24
	SO_2	1.74	2.82	0.23	10.08	0.80	0.08	1.78	4.80	1.03	22.48
	CH_4	0.12	0.19	0.01	0.28	0.05	0.01	0.12	0.32	0.07	1.10
	VOC	1.04	1.69	0.05	3.02	0.48	0.05	1.07	2.88	0.62	10.37
	GWP	**1,562.22**	**2,528.28**	**513.38**	**8,757.53**	**718.26**	**71.83**	**2,535.18**	**4,309.57**	**1,460.86**	**21,667.02**

Calculations according to UKOOA atmospheric emissions guidance (1999) and the GWP conversion factors as shown in Table 8.7.

8.2 Environmental Impacts Resulting from Atmospheric Emissions

The exhaust gases produced from the planned operations are known to have the potential to contribute to a number of environmental processes and impacts including global warming (greenhouse gases), acidification (acid rain), the formation of low level ozone, and local air pollution.

The most commonly used general indicator of atmospheric emissions is the Global Warming Potential (GWP), expressed in tonnes of carbon dioxide (CO_2) equivalents. GWP is a measure of the relative radiative effect of a given gas compared to that of CO_2, integrated over a chosen time horizon (often a 100 year time period). Simply stated, the GWP of a specific gas is a measure of its climate change impact relative to carbon dioxide (AEA, 2007). All gaseous substances that contribute towards global warming (e.g. CO_2, CH_4, N_2O, CO, and NO_x) have a GWP factor that allows the conversion of individual emissions into CO_2 equivalents. As such, GWP can be used to estimate the potential future impacts of gaseous emissions upon the climate system. The GWP factor of each of the most common combustion gases is given in Table 8.7.

Table 8.7: Environmental Effects of Atmospheric Emissions

Gaseous Emission	Environmental Effect	100 year GWP Factor*
Direct Greenhouse Gases		
Carbon dioxide (CO_2)	CO_2 is a greenhouse gas, meaning that it inhibits the radiation of heat into space, which may increase temperatures at the Earth's surface.	1
Methane (CH_4)	May contribute to climate change.	25
Nitrous oxide (N_2O)	May contribute to climate change.	298
Indirect Greenhouse Gases		
Carbon monoxide (CO)	Direct effects upon human health (asphixiant). May contribute indirectly to climate change.	3
Oxides of nitrogen (NO_x)	NO_2 has direct effects upon human health and vegetation and has the potential to cause respiratory illness and irritation of the mucous membranes. NO_x acts as a precursor to low-level ozone formation. NO_x contributes to acid deposition (wet and dry) which impacts both freshwater and terrestrial ecosystems.	5**
Volatile organic compounds (VOC)	Volatile organic compounds (VOC), which include non-methane hydrocarbons (NMHC) and oxygenated NMHC (e.g. alcohols, aldehydes and organic acids), have short atmospheric lifetimes (fractions of a day to months) and small direct impact on radiative forcing. VOC influence climate through their production of organic aerosols and their involvement in photochemistry, i.e. production of ozone (O_3) in the presence of NO_x and light. Generally, fossil VOC sources have already been accounted for as the release of fossil C in the CO_2 budgets and therefore are not counted as a source of CO_2.	-
Sulphur dioxide (SO_2)	SO_2 has direct health effects - causes respiratory illness. SO_2 contributes to acid deposition (wet and dry) which impacts both freshwater and terrestrial ecosystems.	-
Other		
Particulate matter (PM)	The environmental effect of particulate matter is mainly determined by the size (and shape) of the particles. Particles emitted from modern diesel engines (commonly referred to as Diesel Particulate Matter, or DPM) are typically in the size range of 100 nanometers (0.1 micrometer) and can penetrate the deepest part of the lungs. In addition, these soot particles also carry carcinogenic components. In high concentrations particulate matter can also affect plant growth.	-

* *Direct GWPs are from IPCC (2007) and indirect from IPPC (2001) and refer to the 100 year horizon values.*

** *The GWP factor of 5 is for surface emissions. Higher altitude emissions (i.e. from aircraft) have greater impacts both because of longer NO_x residence times and more efficient tropospheric O_3 production, as well as enhanced radiative forcing sensitivity. NO_x emissions from aircraft can therefore have GWPs in the order of 450 for considering a 100 year time horizon. It must be noted however that these numerical values are subject to very large quantitative uncertainties.*

Greenhouse gases can be divided into 'direct' and 'indirect' greenhouse gases. Direct greenhouse gases have an effect on the balance of energy entering and exiting the atmosphere ('radiative forcing') and include combustion gases such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), as well as naturally occurring gases such as tropospheric ozone (O_3). Reactive gases such as carbon monoxide (CO), volatile organic compounds (VOC), nitrogen oxides (NO and NO_2) and sulphur dioxide (SO_2) are termed indirect greenhouse gases. These pollutants are not significant as direct greenhouse gases but, through atmospheric chemistry, they impact upon the abundance of the direct greenhouse gases thereby increasing the overall greenhouse effect. The environmental effects of the most common combustion gases are presented in Table 8.7.

8.3 Wider Scale Impacts

The estimated GWP of the emissions associated with the proposed operations is presented in Tables 8.1 to 8.6. All UK operators report their atmospheric emissions to the Environmental Emissions Monitoring System (EEMS). The EEMS report does not account for emissions from support vessels and helicopters, hence those values are not included in the following comparisons. In 2015, a total GWP of 14.7 million tonnes of CO_2 equivalent were released on the UKCS, equating to 3% of the total UK emissions (Oil and Gas UK, 2016). Compared to this value, the GWP generated by the jack-up drilling rig including mobilisation and demobilisation (i.e. 8,758 tonnes of CO_2 equivalents) would account for less than 0.06 %, a minor proportion of overall annual exploration and production operations undertaken on the UKCS. In this context, the atmospheric emissions generated during the proposed drilling operations are not considered to be significant.

8.4 Localised Impacts

Combustion emissions have the potential to reduce local air quality through the introduction of contaminants such as oxides of nitrogen (NO_x), volatile organic compounds (VOCs) and particulates which contribute to the formation of local low level ozone and photochemical smog. However, seafaring vessels, such as heavy lift ships and supply vessels, are built and operated to standards that preclude impacts to the health of crews, whilst other environmental receptors present in the immediate vicinity of the operations (e.g. flora and fauna) tend to be sparsely distributed and/or mobile in their distribution. Local impacts are further mitigated by the open and dispersive nature of the offshore environment. Any impacts at this level are therefore difficult to measure and to distinguish from background variation. On this basis, localised impacts from combustion emissions at the Blythe Hub development are considered to be negligible, and thus not significant.

8.5 Cumulative and Transboundary Impacts

The assessment of the impacts of atmospheric emissions, as discussed above, is unchanged by the consideration of other emission sources local to the proposed operations. Whilst emissions from the proposed drilling and installation operations have the potential to combine with those from local shipping, and oil and gas infrastructure in the Southern North Sea region, this is unlikely to increase any local impacts significantly due to the distance between these developments and the highly dispersive nature of the offshore environment. The proposed operations are therefore not expected to have any significant cumulative effects in combination with other local sources of emissions.

As indicated in Section 8.3 above, on a wider scale the additive contribution to the emissions of the overall UK oil and gas industry from the proposed operations can be viewed as of little significance and therefore their cumulative effect is also expected to be minimal. It would be impossible, however, to assess the cumulative impact of atmospheric emissions from the proposed operations to potential global environmental impacts such as global climate change.

Local wind conditions may result in the transboundary transport of atmospheric emissions generated at the proposed well location. However, as the quantities involved are minimal in relation to national scale emissions and of a relative short duration, the resulting incremental effects of transboundary emissions on other nation's total emissions levels are not expected to be detectable. Transboundary atmospheric emissions require international collaborative action to control their formation and effects.

8.6 Mitigation Measures

All equipment will be well maintained according to a strict maintenance regime. This will ensure all equipment will operate at optimum efficiency, and thus minimise the overall fuel consumption. Only low sulphur diesel will be used onboard the jack-up drilling rig as standard. When scheduling the operations, the effect of weather down time with regard to additional fuel use was considered. Operations will be planned in conjunction with appropriate weather windows therefore reducing the potential for weather down time thus avoiding unnecessary fuel use. In addition, all fuel use onboard the jack up drilling rig, together with its associated atmospheric emissions, will be monitored and reported under the environmental EEMS reporting scheme.

8.7 Conclusions

Atmospheric emissions will be produced during drilling and installation operations, as a result of power generation onboard the jack-up drilling rig, heavy lift vessel, as well as on the standby vessel, supply vessels and helicopter activity. These emissions will contribute to local and global environmental effects. At a local level, impacts are mitigated by health and safety measures in place to control emissions and by the dispersive nature of the offshore environment. As such, any local air pollution effects are expected to be negligible, and thus not significant.

Emissions will also contribute to global environmental issues, including climate change. The contribution of the proposed drilling programme is comparable to similar operations, and small in comparison to emissions at an industry wide level. Therefore, it may be concluded that the individual GWP generated by the drilling operations and its resulting impacts are too small to be assessed. The ultimate cumulative global implications of global climate change are still poorly understood and therefore very hard to asses. The overall strategy to address this issue ultimately lies with national and international governance.

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Section 9

Accidental Events

9 ACCIDENTAL EVENTS

As well as assessing operational processes, the EIA process also examines potential accidental events that may result in impacts upon the environment and for which mitigation measures may be implemented. The following issues and concerns were raised during the ENVID workshop and informal consultation, and are considered in this section which addresses the potential impacts from accidental events that could occur during operations at the proposed Blythe Hub Development:

- Potential impacts on the marine and coastal environment, and other users of the sea, from a large hydrocarbon spill to sea. This refers to a large spill with the potential to reach the shore, thus requiring additional onshore response personnel and equipment;
- The potential impacts on the marine environment and other users of the sea from vessels colliding with the field infrastructure and damage to that infrastructure;
- Potential impacts on the marine environment from a chemical spill during transfers of chemicals to the rig or platform.

The remainder of this section describes the potential impacts of hydrocarbon spills and from the catastrophic loss of the jack-up drilling rig, a vessel or helicopter.

9.1. Sources of Hydrocarbon Spills

The risk of an accidental hydrocarbon spillage to sea is often one of the main environmental concerns associated with oil-industry activities. Spilled oil at sea can have a number of environmental and economic impacts, the most conspicuous of which are on seabirds and coastal areas. The actual impacts depend on many factors, including the volume and type of hydrocarbon spilled, the sea and weather conditions at the time of the spill, and the oil spill response.

During the proposed operations at the Blythe Hub Development, the following events have been identified as having the potential to cause a large hydrocarbon spill:

- Release of hydrocarbons from a well blow out;
- Release of hydrocarbons from complete rupturing of diesel storage tanks(s) or associated system(s);
- Release of hydrocarbons from a pipeline failure.

The expected hydrocarbon from the Blythe and Elgood production wells is natural gas and condensate. Therefore, in the event of a well blow-out or pipeline failure, the risk of a surface spill would arise due to the condensate fraction.

As described in Section 2.5.3, the wells at the proposed Blythe Hub Development will be drilled using WBM and LTOBM. LTOBM will be recycled throughout the drilling programme as it is used in a closed system, therefore minimising the overall amount required.

9.1.1 Potential Condensate Spillages

The only potential source of a large hydrocarbon spill during the proposed drilling operations would come from an uncontrolled well blow-out incident. For a blow-out to occur, the primary well control element, the hydrostatic pressure exerted by the drilling mud, would have to be overcome by the inflowing hydrocarbons. The secondary well control measure, the blow-out preventer (BOP), would also have to fail to close off the well. The actual flow rate and duration of any such event, and hence the severity of the incident, are dependent upon the pressure and geology of the well, which vary with each well.

The Blythe Hub Development well will target the Leman Sandstone Formation. The expected hydrocarbon from the well is gas and condensate, with a density of around 735 kg/m^3 (61°API; ITOPF Group I).

The flow rate encountered during an uncontrolled blow-out event may be very different from that expected during production, as there may not be equipment or other measures in place to restrict the flow. In order to investigate this, potential individual flow rates of the well during an uncontrolled blow-out situation were modelled. It was assumed that there would be no physical restriction to the flow inside the well, such as drill string or tubing obstructing the wellbore, chemical build-up coating in the wellbore, a disconnected riser, or damaged wellhead and well control equipment on top of the well.

The modelling showed that the well would be expected to flow at an initial rate of 493.5 m^3/day condensate and that this rate would be expected to continue for the first 81 days until the well is killed by drilling a relief well. The modelling simulated a 96 day flow for the well, which resulted in a worst-case scenario total hydrocarbon release of 39,973.5 m^3 condensate.

9.1.2 Potential Diesel (Fuel Oil) Spillages

Diesel will be the main fuel used for power generation during the proposed drilling operations and, with a maximum capacity of approximately 1,138.35 m^3, will be the largest volume of hydrocarbons stored on the jack-up drilling rig whilst on site. The worst-case diesel spill scenario considered for the purposes of this EIA is the complete loss of the diesel inventory from the fuel tank(s).

Smaller diesel spills can result from equipment failures, such as the rupture of pipes or open valves. As explained in Section 9.2.3, small spills most frequently occur during bunkering operations and are generally caused by hose failures.

To allow operations to continue without interruption, offshore drilling units are reliant on refuelling in the field. This is facilitated by the regular transfer of diesel from a supply vessel to the drilling unit, via a flexible hose. As the hose is suspended between the two vessels, there is the potential for a direct diesel release to sea, if there is a problem with the hose. The requirement for, and frequency of, diesel bunkering is dependent on the expected duration of operations and the drilling unit used. It is anticipated that the jack-up rig will at least be bunkering once, at each well location, whilst at the Blythe and Elgood wells.

9.1.3 Potential Condensate Leakage from a Pipeline Failure

If a pipeline was to become damaged and rupture, it could result in the release of condensate into the sea. For a pipeline to fail and rupture it would most likely be the result of pipeline spanning where the sediment beneath the pipeline is eroded or scoured away and the pipeline is no longer supported by the seabed. When this occurs, the pipeline is placed under stresses which may result in the pipeline rupturing and condensate flowing into the sea. Due to the sandy nature of the seabed in the area it may be surmised that there is increased scope for erosion and scouring to occur compared to an area where the substrata is harder.

The modelling assumes that, in the event of a pipeline failure, an instantaneous release of 31.8 m^3 of condensate will occur over one hour (based on the loss of the complete pipeline inventory of the pipeline between Blythe and the pipeline tie-in point at PL370). The model was run for 15 days from the beginning of the condensate release which is based on industry guidance and best practice, and on the behaviour of the condensate, which is a very light oil which would evaporate quickly.

9.1.4 Other Potential Sources of Oil

The amounts of helicopter fuel and lubricating, hydraulic and waste oil will be stored onboard the jack-up drilling rig, however, the amounts will be very small in comparison to the main fuel supply. The probability of a 'large' spillage of any of these sources is considered to be minimal, as the containers are relatively small, sealed and stored in bunded areas. Therefore, the risk to the environment from these oils is regarded as negligible and is not considered further within this section.

9.2. Likelihood of a Hydrocarbon Spill

Historical data, covering the period between 1990 and 2016, indicate that the possibility of a large hydrocarbon spill from a MODU operating on the UKCS is very low. As shown in Figure 9.1, OBMs have been the largest source of hydrocarbon spills during this period both in terms of number of spills (262) and in the actual amount of oil spilled (47% of total oil spilled, or 952.9 tonnes).

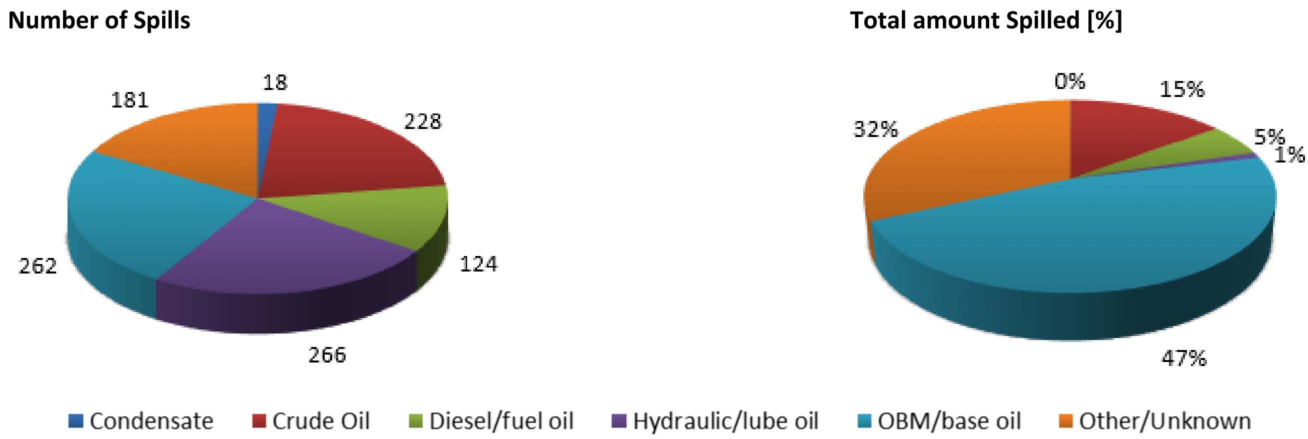

Figure 9.1: Oil spills on the UKCS from MODUs between 1990 and 2016
Source: Fugro, 2018.

The Health and Safety Executive produces periodic statistical review of offshore industry data. The most recent dataset providing cumulative time spent by MODUs on the UKCS covers the time period between 1990 and 2005 (HSE, 2007). During this time, MODUs operated on the UKCS for a cumulative period of 1,106 rig years. Meanwhile, some 703 spills from MODUs were reported via Petroleum Operations Notice 1 (PON1) during this time. Hence, the probability of an oil spill occurring during this time was 0.0017 spills per rig day, or one spill every 575 rig days. Extrapolating these statistics to the proposed Blythe and Elgood exploration wells, suggests a 14.4% and 14.9% chance of a spill of any size or hydrocarbon type occurring, respectively. It should be noted however, that the vast majority of these spills were small in size, with 87.37% of all spills being less than 1 tonne (Figure 9.2). Furthermore, the historical dataset covering 1990 to 2016 indicates a general trend of decreasing numbers of spills overtime, so if more recent data on MODU presence were available, the probability of a spill occurring during the proposed drilling operations would be expected to be slightly lower than this.

Oil Spills on the UKCS from MODUs between 1990 and 2016

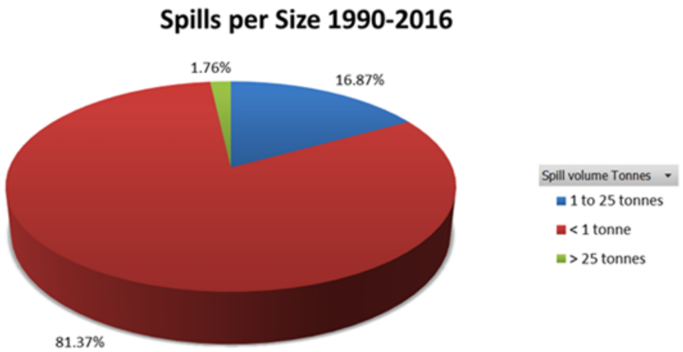

Figure 9.2: Percentage of Hydrocarbon Spills on the UKCS, by Size, Between 1990 and 2016
Source: Fugro, 2017.

9.2.1 Condensate Spills

Figure 9.1 shows that just 18 condensate spills from mobile drilling rigs were recorded during the period 1990 to 2016, comprising 1.67 % of the total number of spills (Fugro, 2017). All recorded condensate spills from mobile drilling rigs between 1990 and 2016 were of less than 1 tonne (Fugro, 2017).

9.2.2 Uncontrolled Well Blow-Out

The probability of an uncontrolled well blow-out event occurring is very low. Well blow-outs resulting in the uncontrolled release of hydrocarbons have happened too infrequently on the UKCS for a meaningful analysis of the historic frequency to be carried out. However, the following paragraphs give a brief overview on historic well control events on the UKCS.

Prior to 1990, only two significant uncontrolled blow-outs occurred in the North Sea. These events occurred during drilling operations on the West Vanguard semi-submersible on the Norwegian continental shelf and on the Ocean Odyssey semi-submersible on the UKCS, during 1985 and 1988 respectively (DTI, 2007). Both blow-outs involved gas, and did not result in hydrocarbon spills to sea. Moreover, lessons learnt from these events resulted in major legislative and operational changes for offshore drilling on the UKCS to prevent such events from happening again.

Between 1990 and 2007, a total of 343 well incidents were recorded from MODUs (both drilling and production). These incidents included several issues of varying severity, but only 17 resulted in loss of well control. Furthermore, none of the 17 recorded incidents resulted in an uncontrolled well blow-out with a crude oil spill of any size (OGUK, 2009).

The most recent well control incident in the North Sea involved a gas and condensate blow-out from Well 22/30c-G4, located close to the Elgin Platform, in March 2012. This incident resulted in the temporary cessation of production from the Elgin/Franklin area. IOG will review the lessons learnt from this incident, with consideration to the proposed drilling operations at Blythe and Elgood.

9.2.3 Diesel Spills

Diesel spills from mobile drilling units account for 5.5% of oil spilled on the UKCS from MODUs (Figure 9.1). Diesel will be the main fuel used for power generation during the proposed drilling operations and, therefore, will be the largest volume of hydrocarbons stored on the jack-up rig, whilst on site.

Spill records indicate that most diesel spills tend to occur during bunkering operations and that they are mostly caused by hose failures. Therefore, the volumes of diesel spilled tend to be relatively small. For example, of the 123 recorded diesel spills, 92.7% were of 1 tonne or less (Fugro, 2017). If a diesel spill of this size were to occur, it is likely that only onsite response personnel and equipment would be required to control the incident, due to the tendency of diesel to evaporate and disperse relatively quickly from the sea surface (see Section 9.3). Only three of the recorded diesel spills were greater than 5 tonnes, and each of these also occurred during bunkering operations.

The jack-up drilling rig will have a maximum storage capacity of approximately 1,138.4 m^3, which constitutes enough fuel for approximately 80 days during drilling operations. With an estimated duration of 82.5 and 85.5 days activity at the Blythe and Elgood wells respectively, it is expected that bunkering will not be required more than once at each well location which will significantly reduce the likelihood of a diesel spill occurring.

The worst-case scenario, complete loss of the diesel inventory, will only occur as a result of a major accident, such as a catastrophic collision with another vessel. The probability of such an event occurring is very low, as discussed in Section 9.6.5.

9.3. Fate and Behaviour or a Hydrocarbon Spill at Sea

Oil Spill Movement

A Spill on the Sea Surface

The fate of hydrocarbons spilled to the sea surface is relatively well understood. As soon as oil is released, the weathering process begins and the oil begins to move across the sea surface. Oil characteristics, spill location and wave and wind conditions govern the fate of the spilled oil. These processes are described below.

Spreading

Due to the influence of gravity, oil starts to spread out over the sea surface as soon as it is spilled. Oil slicks can spread very quickly to cover extensive areas of the sea surface, the speed of which depends mainly on the viscosity of the oil. Lighter oils spread out more quickly and, therefore, a spill of condensate could be expected to spread more quickly than a spill of crude oil. Although a spill will spread quickly in the first few days, the processes of evaporation and dispersion quickly remove the lighter, more volatile and water soluble, fractions of a slick from the sea surface. Then, as only the heavier, more viscous fractions are left, slick spreading will slow down.

Initially an oil spill will spread out as a single slick, covering an increasingly larger area while the slick becomes correspondingly thinner. However, as the slick spreads further, it will start to break up into smaller breakaway slicks due to the wind and water movement. Wind and wave conditions across the Southern North Sea can be regarded as very dynamic, due to a combination of the relatively high wind speeds and water movement. As such, it is expected that a large condensate slick in this area would tend to break up quickly into smaller patches.

Direction of Movement

Wind and surface current speed and direction are the main factors influencing the movement of an oil slick. Any oil slick will travel roughly at the same speed and direction as the surface water current, while the prevailing wind drives a slick downwind at 3% to 4% of the wind speed.

Water depths in the Southern North Sea are relatively shallow compared with the central and northern areas. The proposed development area is situated in the shallow, coastal waters of the Southern North Sea at water depths ranging from approximately 20 to 30 m. Inputs of North Atlantic water strongly influence the hydrography of the North Sea, with minor inflows from the English Channel and the Baltic Sea. The generalised pattern of water movement in the North Sea is anti-clockwise, with North Atlantic water moving south, balanced by a northerly outflow along the Norwegian coast. The southern North Sea water moves in a broadly north easterly direction as part of this general circulation. This means that the current vector would, under most circumstances, move any surface slick in an easterly or north easterly direction.

Although offshore winds in the area may blow from any direction, they most frequently originate from the south and south-west (Section 3.1.2). Therefore, the wind vector would also direct any surface slick to the north and north-east, under prevailing wind conditions.

The Weathering Process

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 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 9.3. Evaporation and dispersion are the two main mechanisms that act to remove oil from the sea surface.

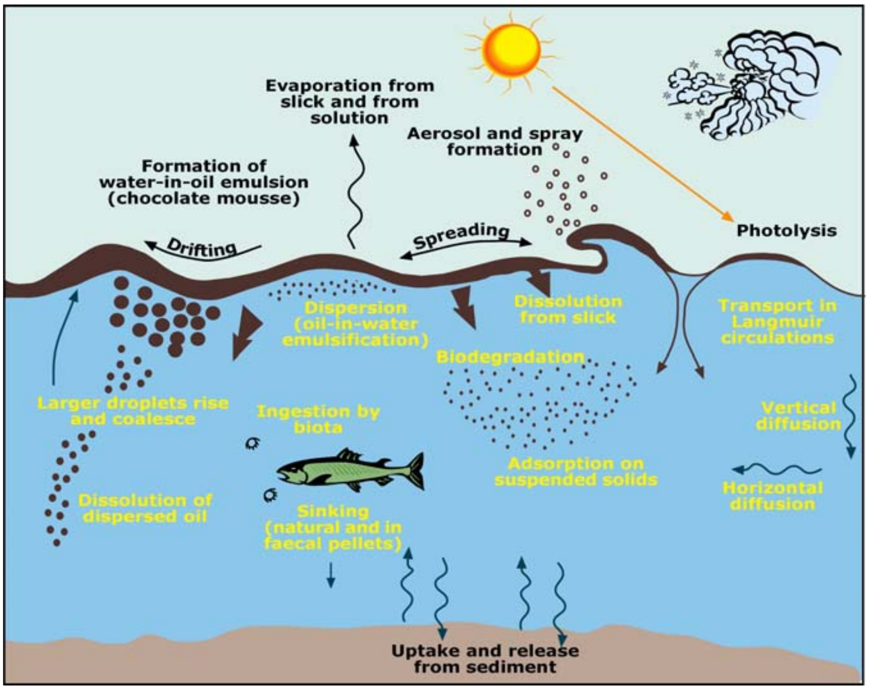

Figure 9.3: Fate and behaviour of spilled oil at sea

Evaporation

Following a hydrocarbon spill, evaporation is the initial predominant mechanism of reducing the mass of oil, as the light fractions (including aromatic compounds such benzene and toluene) evaporate quickly. Evaporation can cause considerable changes in the density, viscosity and volume of the spill. If the spilled oil contains a high percentage of light hydrocarbon fractions, a large part of it will evaporate relatively quickly in comparison to heavier oil.

Both condensate and diesel display very high evaporative losses upon exposure to air. Under ideal environmental conditions, i.e. a warm, sunny day with only moderate wind, a large proportion of the spill volume may be lost by evaporation in the first few hours after release. Winds in the Southern North Sea are strongest during the winter months, falling to moderate wind speeds in summer. The earliest start for drilling operations at the Blythe Hub Development is currently proposed as Q3 2019, with a latest end date of the end of Q4 2019. Therefore, it is anticipated that drilling through the reservoir, the period during which the risk of an uncontrolled blow-out spill would be highest, would be undertaken during the autumn and winter months. The lower temperatures and higher wind speeds experienced at this time of year would therefore mean that evaporation for any spilled condensate or diesel would be lower than would be expected during the summer months.

Dispersion

After the light fractions have evaporated from the slick, natural dispersion becomes the dominant mechanism in reducing slick volume. The speed at which oil disperses is largely dependent upon the nature of the oil and the sea state. Lighter and less viscous oils tend to have more water-soluble components, allowing them to mix and remain suspended within the water column.

The process of dispersion is dependent upon waves and turbulence at the sea surface, which can cause a slick to break up into fragments and droplets of varying sizes. This turbulence mixes these droplets into the upper levels of the water column, where some of the smaller droplets will remain suspended, while the larger ones will tend to rise back to the surface. Therefore, rough seas will break up a slick and disperse the oil at a faster rate than calm seas. In the North Sea, there have been incidences of large oil spills being broken up and dispersed into the water column during large storm events, with little visible effect on the surrounding environment. As oil droplets are dispersed into the water column, the oil has a greater surface area which encourages the natural processes of dissolution, biodegradation and sedimentation.

Water movement at the sea surface is affected by wind speed. The Southern North Sea is a highly variable environment with wind speeds typically highest in the winter months and the sea state reaches a Beaufort Force 7 for around 30% of the time. Water movement and wave size is also related to fetch, the distance over which the wind can blow without being interrupted. The development area experiences winds prevailing mainly from the south and south-west with waves heights reaching 4 m or more < 15% of the time.

Emulsification

The immiscible components of an oil spill may either emulsify and disperse as small droplets in the water column (an oil-water emulsion) or aggregate into tight water-in-oil emulsions, often referred to as ‘chocolate mousse’. The rate at which this happens, and the type of emulsion formed, is dependent upon the oil type, sea state and the thickness of the oil slick. Large, thick oil slicks tend to form water-in-oil emulsions, while smaller thinner slicks tend to form oil-in-water emulsions that usually disappear by natural dispersion. In practice, usually only one of the two processes will dominate.

When a water-in-oil emulsion (chocolate mousse) is formed, the overall volume of the slick 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. The formation of this thick layer causes the surface area available to weathering and degradation processes to diminish, which can make ‘chocolate mousses’ difficult to break up using dispersants. In their emulsified form, and with their drastically increased volume, they can also cause difficulties for mechanical recovery devices. A water-in-oil emulsion is very unlikely to occur in spills of condensate or diesel, due to the very light properties of these oils.

9.4 Oil Spill Modelling

The amount of time a hydrocarbon spill remains on the sea surface before becoming insignificant, and the extent to which it spreads from the point of release, may dictate the severity of any impacts on the marine life, particularly seabirds. Whether it reaches the shore is also a major consideration, due to the sensitivity of the coastline, and the additional clean up resources required. Oil spill modelling has been conducted to provide information on whether a spill might beach and, if so, how much time this would take to occur. In view of this, the end points for the oil spill risk assessment are considered to be:

- Probability of oil reaching a shoreline, or crossing a median line to reach international waters;
- Minimum time taken for oil to reach a shoreline, or crossing a median line to reach international waters.

Stochastic oil spill modelling has been conducted to assess these two criteria. Stochastic oil spill modelling is based on actual statistical wind speed and direction frequency data, and provides a probability range of sea surface oil and beaching, representative of the prevailing conditions.

All modelling has been undertaken using SINTEF's Oil Spill Contingency and Response (OSCAR) model (Version 9.0.1). As discussed in Section 9.1, the three scenarios which may result in a large release of hydrocarbons to sea are an uncontrolled well blow-out, resulting in a release of gas and condensate, a rupture of the jack-up rig's fuel tanks, resulting in a large diesel release and loss from a pipeline rupture resulting in an instantaneous release of the total pipeline inventory. Modelling has therefore been undertaken for each of these scenarios.

The proposed Blythe and Elgood well operations are planned to take place during Q3 and Q4 of 2019. However, oil spill modelling for both scenarios has been carried out for all four seasons. This provides a range of risk profiles throughout the year in the event of a delay to operations.

9.4.1 Uncontrolled Well Blow-out

The worst-case scenario maximum release of hydrocarbons in the event of a well blow-out from the planned Blythe and Elgood wells is discussed in Section 9.1.1. The parameters used in the modelling are detailed in Table 9.1, whilst Table 9.2 provides a justification for the parameters selected for the modelling.

Table 9.1: Condensate Blow-Out Modelling Parameters

Condensate Blow-out Parameters								
Loss from Well/ FPSO / Rig / Other		Well			Instantaneous Loss?		No	
Worst Case [m^3]		39,9735.5 m^3 / 81 days			Will the Well Self-Kill?		No	
Flow Rate [m^3/day]		493.5 m^3						
Justification for Predicted Worst Case Volume		Blow out, it would be expected to take 81 days to drill a relief well						
Location								
Spill Source Point		53° 18' 19.88" N, 01° 23' 10.31" E						
Installation / Facility Name		Elgood			Quad/Block		48/22	
Hydrocarbon Properties								
Hydrocarbon Name		Elgood condensate						
Assay Available		No			Was an Analogue used for Spill Modelling?			Yes
	Name	ITOPF Category	Specific Gravity	API	Viscosity [cP]	Pour Point [°C]	Wax Content [%]	Asphaltene Content
Hydrocarbon	Elgood condensate	1	-	61	1.2621	-	-	-
Analogue	Modelled oil	1	0.745	58.4	1.0	-30 °C	-	-
Metocean Parameters								
Air Temperature (°C)		2°C – 15°C			Sea Temperature (°C)		7°C – 14°C	
Wind Data		2 years' (2012 – 2013) European Centre for Medium-Range Weather Forecasts (ECMWF) wind data						
Current Data		2 years' (2012 – 2013) UK Oil & Gas (Shelf daily currents data)						
Modelled Release Parameters								
Surface or Subsurface		Surface			Depth [m]		0 m (on surface)	
Release Duration [days]		81 days			Instantaneous?		No	
Persistence Duration [days]		89 days			Release Rate [m^3/hour]		493.5 m^3/day	
Total Simulation Time [days]		96 days			Total Release [m^3]		39,973.5 m^3	
Oil Spill Modelling Software								
Name of Software		MEMW-OSCAR			Version		8.0.1	

Source: OSRL, 2018.

Table 9.2: Justification for Condensate Blow-out Modelling Parameters

Parameter	Justification
Flow rate	The initial expected flow rate of 493.5 m^3/day condensate has been used for the duration of the model, although in reality the flow would be expected to decline.
Hydrocarbon properties	As the Elgood exploration well is the first to be drilled in this prospect, the expected condensate is not available in OSCAR's database of known oils. Therefore, a modelled oil, which most closely matches the expected properties for Elgood condensate, was used in the modelling.
Metocean parameters	Oil and Gas UK dataset approved for use in oil spill modelling on UKCS.
Depth of release	The most likely release location for hydrocarbons in the event of an uncontrolled well blow-out would be at the surface, and so this release depth has been modelled.
Release duration	In the event of an uncontrolled well blow-out, if initial actions to regain control of the well failed, it may be necessary to drill a relief well. This procedure is expected to take up to 81 days, and so this duration has been used for the release.
Model duration	Following the 81 day release period, the model was allowed to continue to run for a further 15 days, in order to assess the ongoing dispersion of hydrocarbons.

The results of the condensate well blow-out modelling scenario are provided in Table 9.3. Minimum arrival time of surface oiling is shown in Figure 9.4 and probability of surface oiling in Figure 9.5. It should be noted that surface oiling is shown with a thickness threshold of 0.3 µm, in accordance with OPRED's oil spill modelling requirements. However, shoreline oiling is shown with no threshold. Therefore, amounts of shoreline oiling are actually very low indeed.

Potential impacts relating to the modelling results are described in Section 9.5.

Table 9.3: Condensate Blow-Out Modelling Results

Condensate Well Blow-out Modelling Summary				
Spill Scenario / Descriptor	Elgood exploration well blow-out			
Median Crossing				
Identified Median Line	**Highest Probability and Shortest Time to Reach**			
	Dec to Feb	Mar to May	Jun to Aug	Sep to Nov
Does not leave United Kingdom waters	-	-	-	-
	-	-	-	-
Landfall				
Predicted Locations	**Highest Probability and Shortest Time to Reach**			
	Dec to Feb	Mar to May	Jun to Aug	Sep to Nov
United Kingdom	27%	78%	32%	12%
	9 days, 0 hours	5 days, 16 hours	4 days, 21 hours	5 days, 0 hours
Lincolnshire	4%	4%	-	-
	12 days, 15 hours	44 days, 5 hours	-	-
Norfolk	25%	78%	32%	12%
	5 days, 0 hours	5 days, 16 hours	4 days, 21 hours	5 days, 0 hours
Shoreline Impact				
Mass of oil onshore	1 MT	6 MT	4 MT	1 MT
Volume of oil onshore	1 m^3	8 m^3	5 m^3	1 m^3
Water content	0 %	0 %	0 %	0 %
Volume of emulsion onshore	1 m^3	8 m^3	5 m^3	1 m^3
Key Sensitivities At Risk				
Sensitivities / Sites of Concern	**Highest Probability and Shortest Time to Reach**			
Southern North Sea	100 %	100 %	100 %	100 %
	1 day, 9 hours	1 day, 12 hours	1 day, 12 hours	1 day, 3 hours

Source: OSRL, 2018.

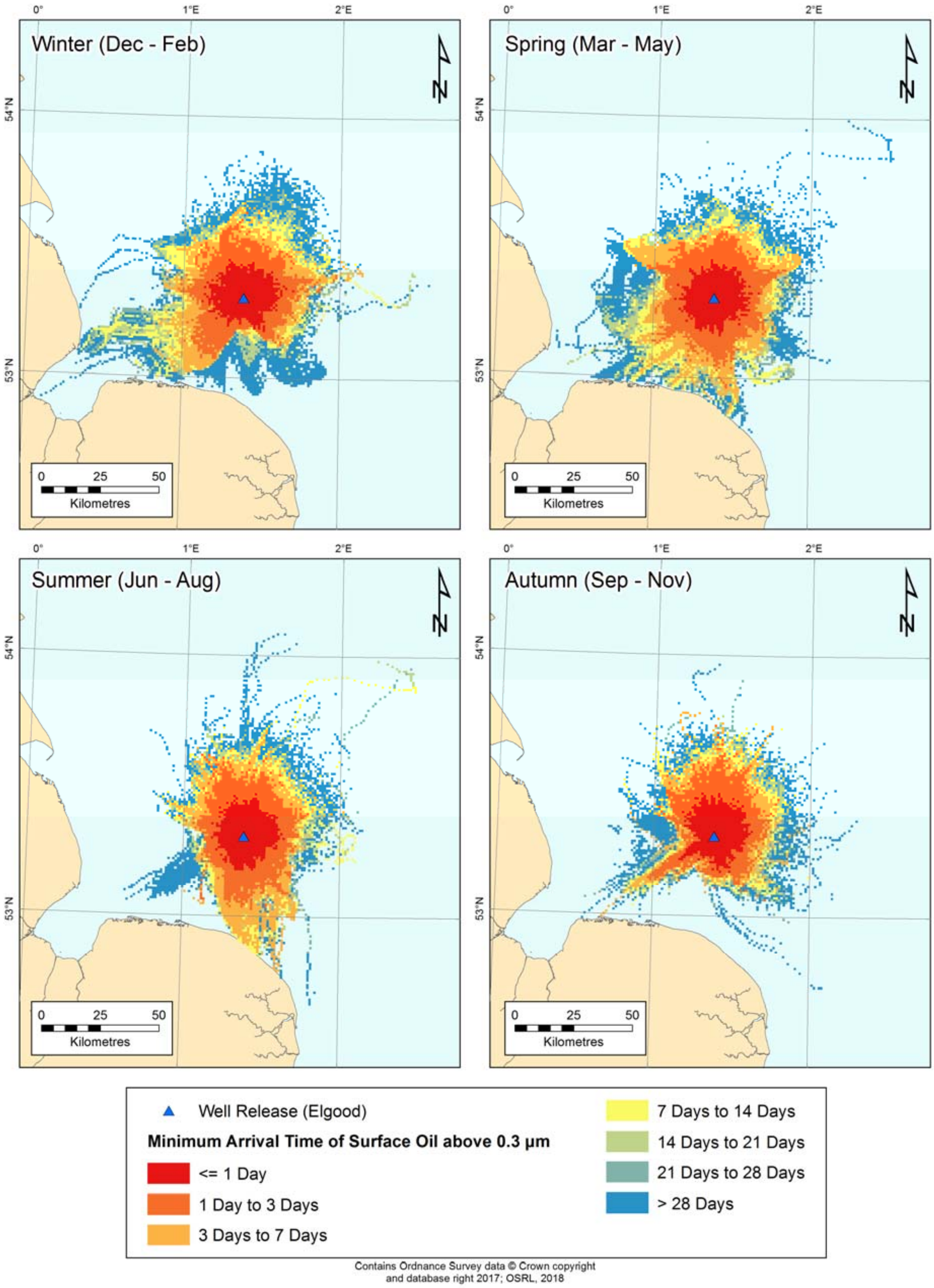

Figure 9.4: Condensate blow-out modelling: arrival time plot
Source: OSRL, 2018.

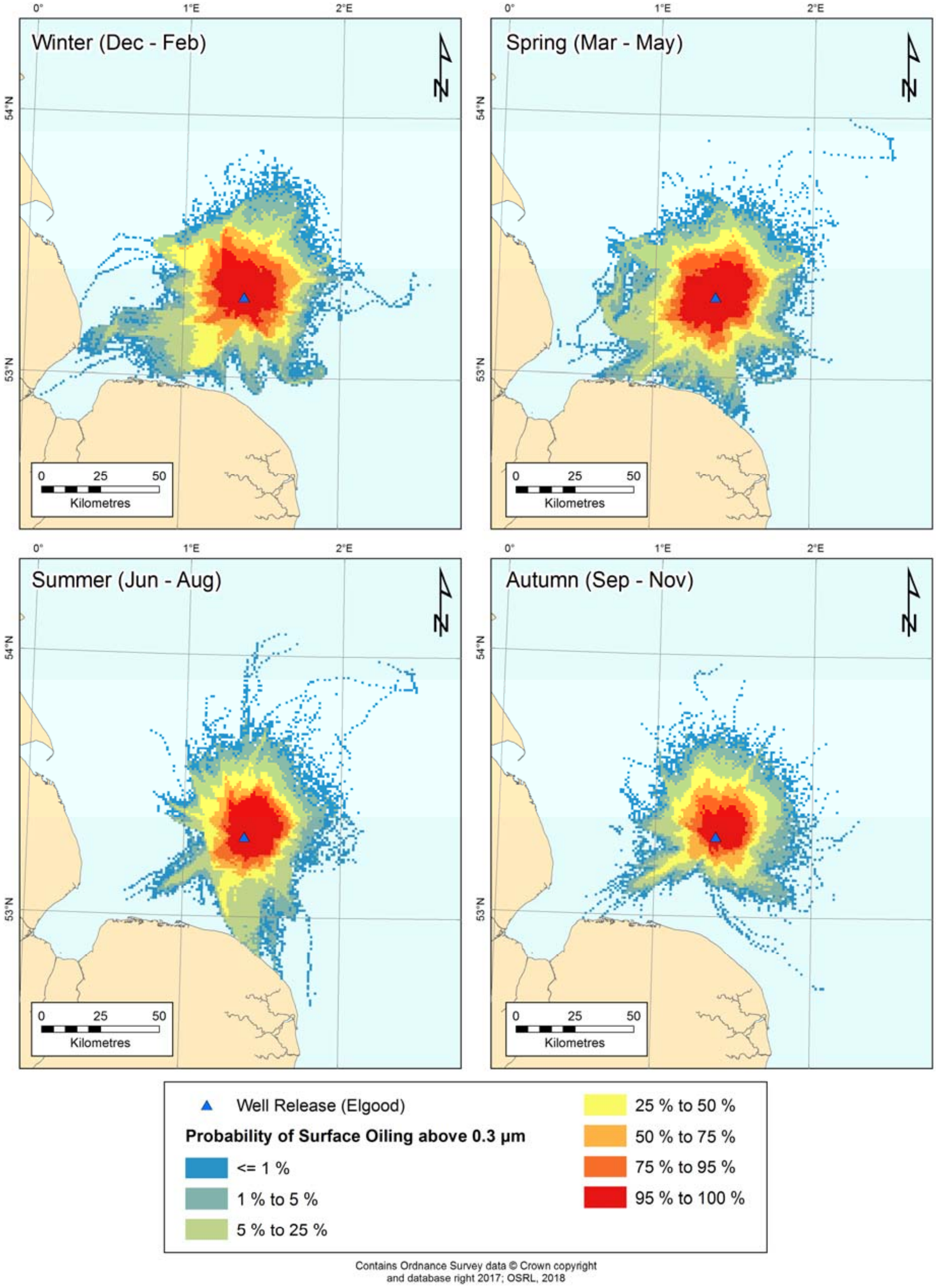

Figure 9.5: Condensate blow-out modelling: probability of surface condensate
Source: OSRL, 2018.

9.4.2 Diesel Spill

The worst-case scenario release of diesel as a result of the planned Blythe and Elgood wells is discussed in Section 9.1.2. The parameters used in the modelling are detailed in Table 9.4, whilst Table 9.5 provides a justification for the parameters selected for the modelling.

Table 9.4: Diesel Spill Modelling Parameters

<table>
<tr><th colspan="9">Diesel Spill Parameters</th></tr>
<tr><td colspan="2">Loss from Well/ FPSO / Rig / Other</td><td colspan="2">Diesel release</td><td colspan="2">Instantaneous Loss?</td><td colspan="3">Yes</td></tr>
<tr><td colspan="2">Worst Case [m^3]</td><td colspan="2">1,138.35 m^3</td><td colspan="2" rowspan="2">Will the Well Self-Kill?</td><td colspan="3" rowspan="2">NA</td></tr>
<tr><td colspan="2">Flow Rate [m^3/day]</td><td colspan="2">Instantaneous</td></tr>
<tr><td colspan="2">Justification for Predicted Worst Case Volume</td><td colspan="7">Maximum diesel inventory of jack-up drilling rig (ENSCO 92 used as a proxy)</td></tr>
<tr><td colspan="9">Location</td></tr>
<tr><td colspan="2">Spill Source Point</td><td colspan="7">53° 14' 31.35" N, 01° 26' 51.14" W</td></tr>
<tr><td colspan="2">Installation / Facility Name</td><td colspan="2">ENSCO92</td><td colspan="2">Quad/Block</td><td colspan="3">48/23</td></tr>
<tr><td colspan="9">Hydrocarbon Properties</td></tr>
<tr><td colspan="2">Hydrocarbon Name</td><td colspan="7">Diesel</td></tr>
<tr><td colspan="2">Assay Available</td><td colspan="2">No</td><td colspan="4">Was an analogue used for Spill Modelling?</td><td>Yes</td></tr>
<tr><td></td><td>Name</td><td>ITOPF Category</td><td>Specific Gravity</td><td>API</td><td>Viscosity [cP]</td><td>Pour Point [°C]</td><td>Wax Content [%]</td><td>Asphaltene Content</td></tr>
<tr><td>Hydrocarbon</td><td>Diesel</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Analogue</td><td>Modelled oil</td><td>2</td><td>0.843</td><td>36.4</td><td>3.9 cP</td><td>-36 °C</td><td>-</td><td>-</td></tr>
<tr><td colspan="9">Metocean Parameters</td></tr>
<tr><td colspan="2">Air Temperature (°C)</td><td colspan="2">2°C – 15°C</td><td colspan="2">Sea Temperature (°C)</td><td colspan="3">7°C – 14°C</td></tr>
<tr><td colspan="2">Wind Data</td><td colspan="7">2 years' (2012 – 2013) European Centre for Medium-Range Weather Forecasts (ECMWF) wind data</td></tr>
<tr><td colspan="2">Current Data</td><td colspan="7">2 years' (2012 – 2013) UK Oil & Gas (Shelf daily currents data)</td></tr>
<tr><td colspan="9">Modelled Release Parameters</td></tr>
<tr><td colspan="2">Surface or Subsurface</td><td colspan="2">Surface</td><td colspan="2">Depth [m]</td><td colspan="3">0 m (surface)</td></tr>
<tr><td colspan="2">Release Duration [days]</td><td colspan="2">1 hour</td><td colspan="2">Instantaneous?</td><td colspan="3">Yes</td></tr>
<tr><td colspan="2">Persistence Duration [days]</td><td colspan="2">2 days, 7 hours</td><td colspan="2">Release Rate [m^3/hour]</td><td colspan="3">1,138.35 m^3/hour</td></tr>
<tr><td colspan="2">Total Simulation Time [days]</td><td colspan="2">15 days</td><td colspan="2">Total Release [m^3]</td><td colspan="3">1,138.35 m^3</td></tr>
<tr><td colspan="9">Oil Spill Modelling Software</td></tr>
<tr><td colspan="2">Name of Software</td><td colspan="2">MEMW-OSCAR</td><td colspan="2">Version</td><td colspan="3">9.0.1</td></tr>
</table>

Table 9.5: Justification for Diesel Spill Modelling Parameters

Parameter	**Justification**
Flow rate	The maximum diesel capacity of the jack-up drilling rig, ENSCO 92, has been modelled as an example a jack-up rig
Hydrocarbon properties	The modelling has been based on the known properties of diesel.
Metocean parameters	Oil and Gas UK dataset approved for use in oil spill modelling on UKCS
Depth of release	The most likely release location for hydrocarbons in the event of a large diesel spill would be the sea surface, and so this release depth has been modelled.
Release duration	A worst-case scenario diesel release would involve a rupture of the diesel tanks resulting in an instantaneous release.
Model duration	Following the instantaneous release, the model was allowed to continue to run for a further 15 days, in order to assess the ongoing dispersion of hydrocarbons.

The results of the diesel spill modelling scenario are provided in Table 9.6. Minimum arrival time of surface oiling is shown in Figure 9.6 and probability of surface oiling in Figure 9.7. It should be noted that surface oiling is shown with a thickness threshold of 0.3 µm, in accordance with OPRED's oil spill modelling requirements. However, shoreline oiling is shown with no threshold. Therefore, amounts of shoreline oiling are actually very low indeed.

Table 9.6: Diesel Spill Modelling Results

Diesel Spill Modelling Summary				
Spill Scenario / Descriptor	Maximum diesel inventory of example jack-up drilling rig, ENSCO92			
Median Crossing				
Identified Median Line	**Highest Probability and Shortest Time to Reach**			
	Dec to Feb	Mar to May	Jun to Aug	Sep to Nov
Netherland	5%	4%	18%	4%
	4 days, 2 hours	4 days, 0 hours	4 days, 2 hours	3 days, 17 hours
Landfall				
Predicted Locations	**Highest Probability and Shortest Time to Reach**			
	Dec to Feb	Mar to May	Jun to Aug	Sep to Nov
United Kingdom	15 %	47 %	11 %	11 %
	1 day, 13 hours	1 day, 11 hours	1 day, 14 hours	1 day, 8 hours
East Riding of Yorkshire	4 %	<1%	-	1 %
	3 days, 10 hours	7 days, 20 hours	-	6 days, 20 hours
Lincolnshire	9%	11 %	-	2 %
	2 days, 4 hours	2 days, 5 hours	-	9 days, 20 hours
Norfolk	6 %	40 %	11 %	9 %
	1 day, 13 hours	1 day, 11 hours	1 day, 14 hours	1 day, 8 hours
North East Lincolnshire	<1 %	-	-	-
	4 days, 17 hours	-	-	-
North Yorkshire	-	-	-	<1 %
	-	-	-	8 days, 22 hours
Suffolk	-	2 %	<1 %	-
	-	10 days, 20 hours	10 days, 14 hours	-
Shoreline Impact				
Mass of oil onshore	760 MT	725 MT	676 MT	631 MT
Volume of oil onshore	902 m^3	860 m^3	802 m^3	749 m^3
Water content	0.1 %	0.1 %	0.1 %	0.1 %
Volume of emulsion onshore	902 m^3	861 m^3	803 m^3	749 m^3
Key Sensitivities At Risk				
Sensitivities / Sites of Concern	**Highest Probability and Shortest Time to Reach**			
Doggar Bank (GBR)	-	-	6 %	7 %
	-	-	4 days, 16 hours	4 days, 17 hours
Dogger Bank (NLD)	-	-	2 %	-
	-	-	14 days, 1 hour	-
Flamborough Head	-	-	-	<1 %
	-	-	-	6 days, 9 hours
Southern North Sea	82 %	62 %	94 %	91 %
	9 hours	11 hours	11 hours	8 hours

Source: OSRL, 2018

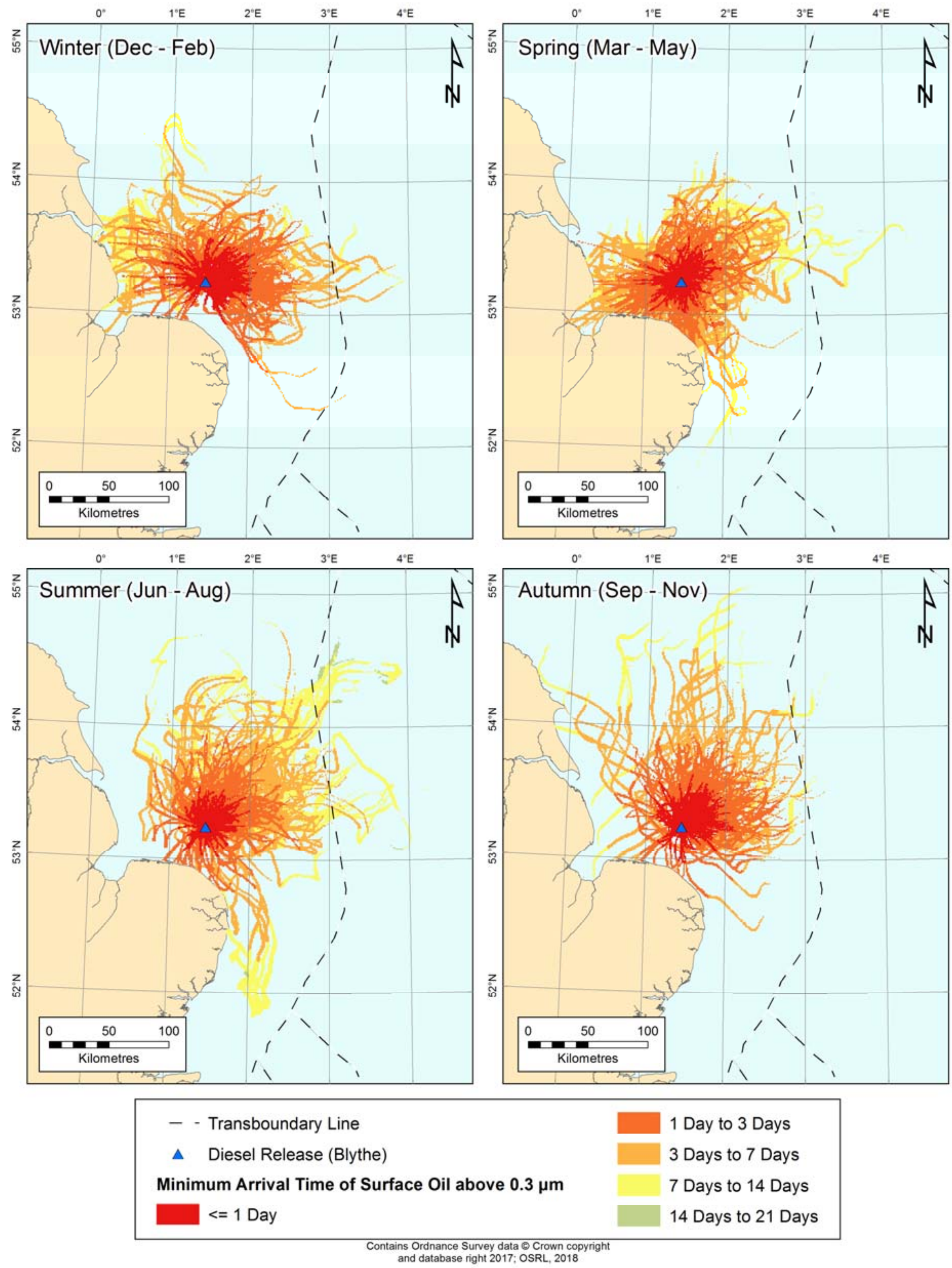

Figure 9.6: Diesel spill modelling: arrival time plot
Source: OSRL, 2018

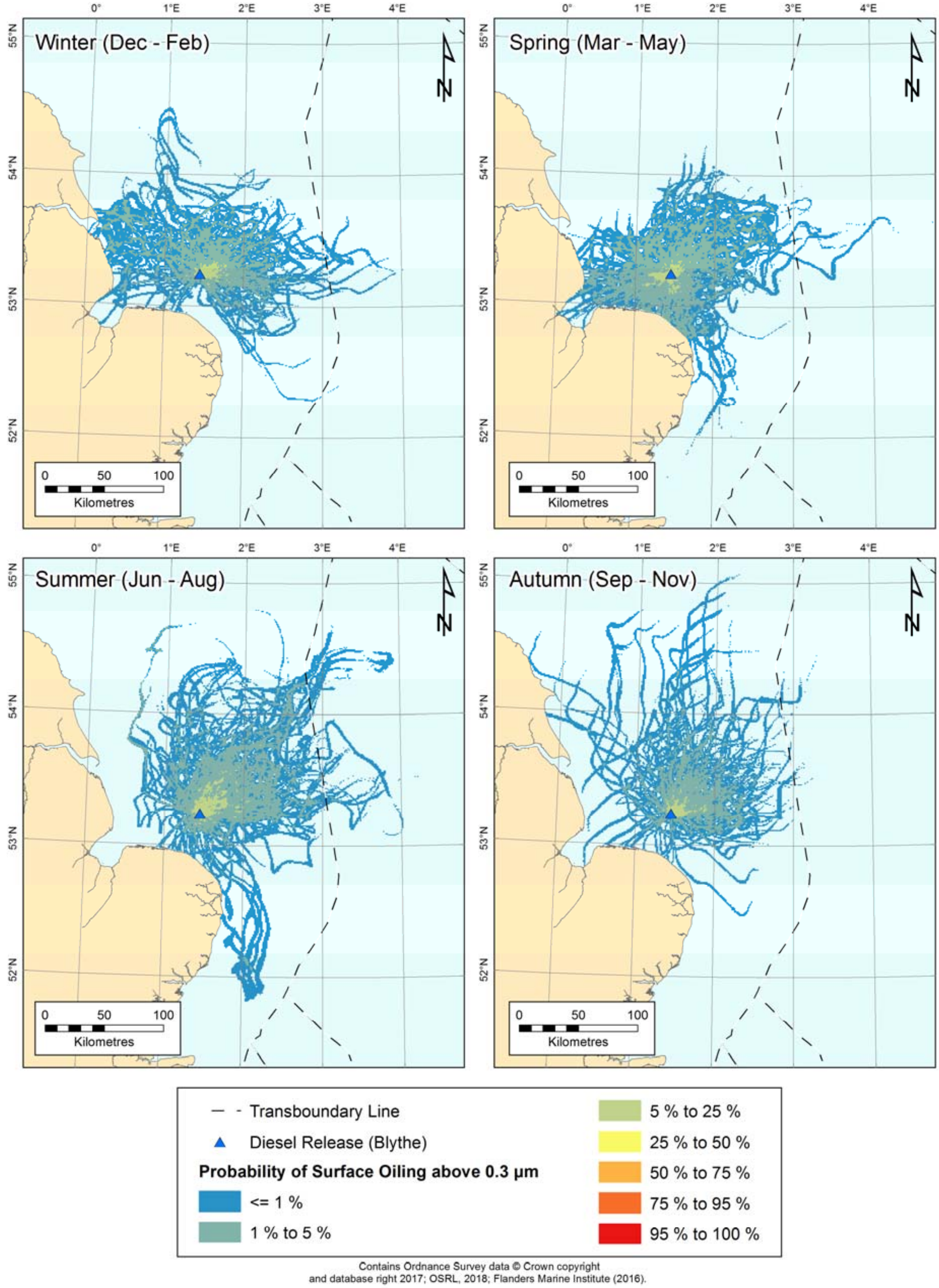

Figure 9.7: Diesel Spill Modelling: Probability of Surface Diesel
Source: OSRL, 2018

9.4.3 Pipeline Inventory Loss

The worst-case scenario release from a pipeline inventory loss as a result of the planned Blythe and Elgood wells is discussed in Section 9.1.3. The parameters used in the modelling are detailed in Table 9.7, whilst Table 9.8 provides a justification for the parameters selected for the modelling.

Table 9.7: Pipeline Loss Modelling Parameters

<table>
<tr><th colspan="9">Diesel Spill Parameters</th></tr>
<tr><td colspan="2">Loss from Well/ FPSO / Rig / Other</td><td colspan="3">Pipeline</td><td colspan="2">Instantaneous Loss?</td><td colspan="2">Yes</td></tr>
<tr><td colspan="2">Worst Case [m³]</td><td colspan="3">31.8 m³</td><td colspan="2" rowspan="2">Will the Well Self-Kill?</td><td colspan="2" rowspan="2">N/A</td></tr>
<tr><td colspan="2">Flow Rate [m³/day]</td><td colspan="3">Instantaneous</td></tr>
<tr><td colspan="2">Justification for Predicted Worst Case Volume</td><td colspan="7">Highest possible release volume</td></tr>
<tr><th colspan="9">Location</th></tr>
<tr><td colspan="2">Spill Source Point</td><td colspan="7">53° 14' 31.35" N, 01° 26' 51.14" W</td></tr>
<tr><td colspan="2">Installation / Facility Name</td><td colspan="3">Blythe pipeline</td><td colspan="2">Quad/Block</td><td colspan="2">48/23</td></tr>
<tr><th colspan="9">Hydrocarbon Properties</th></tr>
<tr><td colspan="2">Hydrocarbon Name</td><td colspan="7">Condensate</td></tr>
<tr><td colspan="2">Assay Available</td><td colspan="3">No</td><td colspan="3">Was an Analogue used for Spill Modelling?</td><td>Yes</td></tr>
<tr><td></td><td>Name</td><td>ITOPF Category</td><td>Specific Gravity</td><td>API</td><td>Viscosity [cP]</td><td>Pour Point [°C]</td><td>Wax Content [%]</td><td>Asphaltene Content</td></tr>
<tr><td>Hydrocarbon</td><td>Condensate</td><td>1</td><td>-</td><td>61</td><td>1.2621 cP</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Analogue</td><td>Modelled oil</td><td>1</td><td>0.745</td><td>58.4</td><td>1.0 cP</td><td>-30 °C</td><td>-</td><td>-</td></tr>
<tr><th colspan="9">Metocean Parameters</th></tr>
<tr><td colspan="2">Air Temperature (°C)</td><td colspan="3">2°C – 15°C</td><td colspan="2">Sea Temperature (°C)</td><td colspan="2">7°C – 14°C</td></tr>
<tr><td colspan="2">Wind Data</td><td colspan="7">2 years’ (2012 – 2013) European Centre for Medium-Range Weather Forecasts (ECMWF) wind data</td></tr>
<tr><td colspan="2">Current Data</td><td colspan="7">2 years’ (2012 – 2013) UK Oil & Gas (Shelf daily currents data)</td></tr>
<tr><th colspan="9">Modelled Release Parameters</th></tr>
<tr><td colspan="2">Surface or Subsurface</td><td colspan="3">Subsurface</td><td colspan="2">Depth [m]</td><td colspan="2">22.43 m</td></tr>
<tr><td colspan="2">Release Duration [days]</td><td colspan="3">1 hour</td><td colspan="2">Instantaneous?</td><td colspan="2">Yes</td></tr>
<tr><td colspan="2">Persistence Duration [days]</td><td colspan="3">18 hours</td><td colspan="2">Release Rate [m³/hour]</td><td colspan="2">31.8 m³/hour</td></tr>
<tr><td colspan="2">Total Simulation Time [days]</td><td colspan="3">15 days</td><td colspan="2">Total Release [m³]</td><td colspan="2">31.8 m³</td></tr>
<tr><th colspan="9">Oil Spill Modelling Software</th></tr>
<tr><td colspan="2">Name of Software</td><td colspan="3">MEMW-OSCAR</td><td colspan="2">Version</td><td colspan="2">9.0.1</td></tr>
</table>

Table 9.8: Justification for Pipeline Loss Modelling Parameters

Parameter	Justification
Flow rate	The maximum volume of condensate likely to be released has been modelled
Hydrocarbon properties	The modelling has been based on the known properties of condensate
Metocean parameters	Oil and Gas UK dataset approved for use in oil spill modelling on UKCS
Depth of release	The most likely release location for hydrocarbons in the event of a pipeline loss is at the seabed, and so this release depth has been modelled
Release duration	A worst-case scenario release would involve an instantaneous release of condensate
Model duration	Following the instantaneous release, the model was allowed to continue to run for a further 15 days, in order to assess the ongoing dispersion of hydrocarbons

The results of the pipeline loss modelling scenario are provided in Table 9.9. The minimum time for condensate to arrive at the sea surface is shown in Figure 9.8 and the probability of surface oiling is shown in Figure 9.9. It should be noted that surface condensate is shown with a thickness threshold of 0.3 µm, in accordance with OPRED's oil spill modelling requirements.

Table 9.9: Pipeline Loss Modelling Results

Diesel Spill Modelling Summary				
Spill Scenario / Descriptor	Pipeline condensate release			
Median Crossing				
Identified Median Line	**Highest Probability and Shortest Time to Reach**			
	Dec to Feb	Mar to May	Jun to Aug	Sep to Nov
Does not leave United Kingdom Waters	-	-	-	-
	-	-	-	-
Landfall				
Predicted Locations	**Highest Probability and Shortest Time to Reach**			
	Dec to Feb	Mar to May	Jun to Aug	Sep to Nov
United Kingdom	2 %	4 %	2 %	< 1 %
	3 days, 5 hours	2 days, 19 hours	4 days, 1 hour	4 days, 22 hours
Norfolk	2 %	4 %	2 %	<1 %
	3 days, 5 hours	2 days, 19 hours	4 days, 1 hour	4 days, 22 hours
Shoreline Impact				
Mass of oil onshore	<1 MT	<1 MT	<1 MT	< 1 MT
Volume of oil onshore	<1 m^3	< 1 m^3	<1 m^3	<1 m^3
Water content	0 %	0 %	0 %	0 %
Volume of emulsion onshore	<1 m^3	<1 m^3	<1 m^3	<1 m^3
Key Sensitivities At Risk				
Sensitivities / Sites of Concern	**Highest Probability and Shortest Time to Reach**			
No sensitivities impacted	-	-	-	-
	-	-	-	-

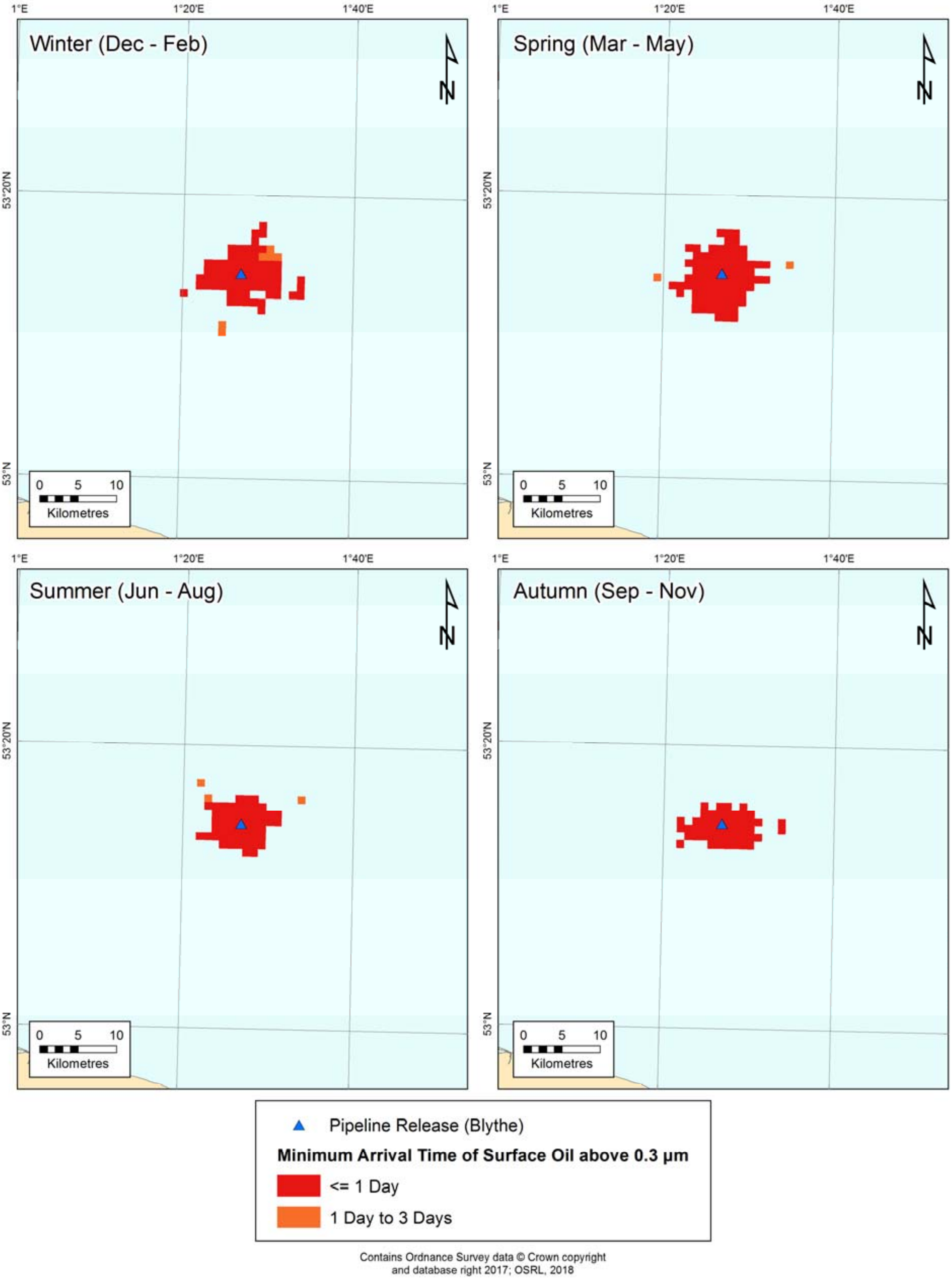

Figure 9.8: Pipeline release modelling: arrival time plot

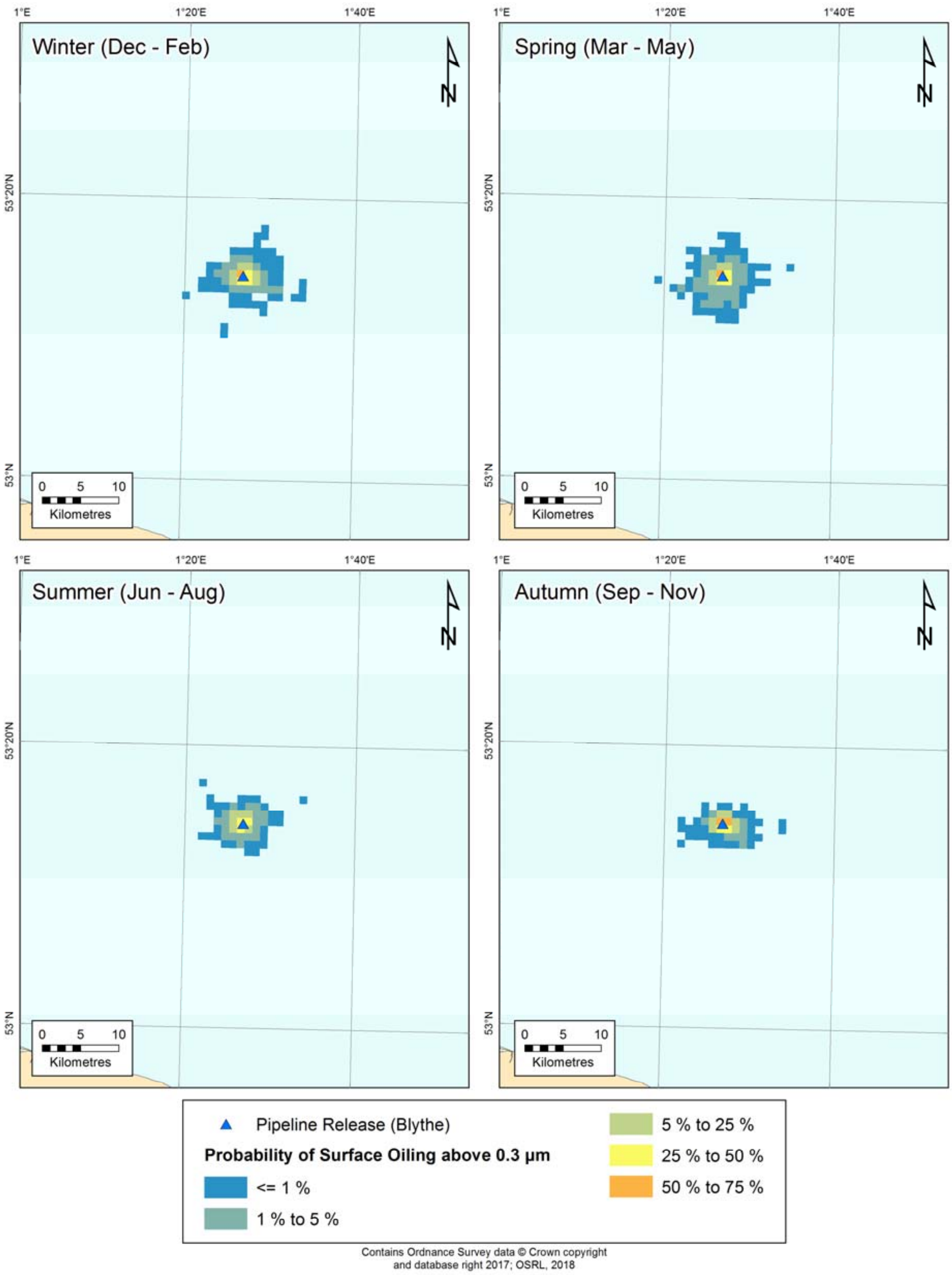

Figure 9.9: Pipeline release modelling: Probability of surface condensate

9.5 Potential Environmental Impacts

9.5.1 Impacts on Marine Life

The risk of accidental hydrocarbon spillage to the marine environment is one of the main environmental concerns associated with oil-industry activities. Although the effects of hydrocarbon spills are well understood, the effects of each individual spill are unique and some assumptions have been made with regards to predicting the effects of a large condensate or diesel spill from the Blythe and Elgood wells.

Plankton

Oil, particularly diesel, is toxic to a wide range of planktonic organisms. Those living near the sea surface are particularly at risk, as water-soluble components leach from floating oil. Although oil spills may kill individuals, the effects on whole plankton communities generally appear to be short-term. Following an oil spill incident, plankton biomass may fall dramatically, due either to animal deaths or avoidance of the area. However, after only a few weeks, populations would be expected to return to previous levels through a combination of high reproductive rates and immigration from outside the affected area.

It is generally assumed those animals associated with the seabed will remain unaffected by a surface slick as the floating oil moves above them. However, a fraction of the water soluble components of a slick may dissolve into the water column, assisted by rough seas or agitation of the sea surface, where these could potentially be harmful to benthic organisms. In deeper offshore areas, these impacts would likely be very limited due to the water depth. Parameters such as local bathymetry and sediments types would significantly influence the distribution of oil contamination at the seabed.

If the spilled oil drifts inshore, the benthic communities of the shallow coastal areas may be affected. However, it should be noted that any hydrocarbons that reach these shallow areas will have travelled a considerable distance through the water column and across the sea surface, and will therefore have been affected by the range of degradation processes described in Section 9.3. These mechanisms will have contributed to remove the various toxic components of the hydrocarbons and the primary impact of the oil deposition on benthic communities is anticipated to be related to smothering. As the oil will also have become widely dispersed by this point, the physical effects of smothering are also expected to be limited.

The shoreline itself is particularly susceptible to oil beaching, and heavy mortalities of intertidal benthic organisms could result if coated with oil. The potential impacts arising from beached oil in coastal habitats are discussed separately in Section 9.5.2.

Fish

Offshore fish populations remain relatively unaffected by oil pollution, as oil concentrations below the surface slick are generally low (Clark, 2001). There is also evidence that fish are able to detect and avoid oil-contaminated waters. This avoidance may, however, cause disruption to migration or spawning patterns. Herring, Lemon sole, Sandeel, Sole and Whiting are known to spawn in the area of the proposed Blythe Hub development whilst these same species in addition to Plaice and Mackerel have been identified as using the area as nursery grounds (Section 3.3.3).

Rather than impacting the fish directly, heavily contaminated sediments may have an adverse effect on local populations of demersal fish species, due to the impact it has lower down the food chain. However, as described in the benthos section above, heavy contamination of the sediments is not expected both due to the water depth and the expected behaviour of the condensate.

Fish eggs and larvae are more vulnerable to oil pollution than adult fish. In many fish species, these stages float to the surface where contact with spilt oil is more likely. The spawning periods of Herring, Lemon sole, Mackerel and Sandeel may coincide with the proposed drilling schedule (Section 3.3.3). Certain fish stocks may be more affected than others particularly if the spill is very large and coincides with specific spawning periods or encroaches on areas with species which have restricted spawning areas.

Shellfish

If hydrocarbons reach the seabed, shellfish species that cannot swim away from contaminated sediments are susceptible to its effects. Mortalities may occur if shellfish become smothered by settling hydrocarbons. Only low levels of hydrocarbons in seawater may cause tainting in shellfish, which may be commercially damaging to shellfish fisheries. This is more common in filter feeding shellfish, principally bivalves, as they would take up fine oil droplets from the water column. In the Southern North Sea, shellfish make up the vast majority of landings from ICES rectangle 35F1 which the Blythe and Elgood developments reside. The main shellfish species landed are crabs, whelks, lobsters and scallops (Section 3.5.1) and therefore the shellfish fishery may be at risk if a spill was to occur.

Marine Mammals

Whales, dolphins, porpoises and seals are generally able to avoid a spill and are rarely affected significantly. However, if they do come into contact with a spill, possibly by surfacing in a slick to breathe, they may suffer from irritation of the eyes, mouth, nasal passages and skin. Volatile hydrocarbon fractions may also cause respiratory problems.

A thick layer of blubber protects cetaceans and adult seals from the cold and these animals are less vulnerable to the physical impacts of hydrocarbons lowering their resistance to the cold. Seal pups and otters are, however, at risk from hypothermia if their fur becomes oiled and loses its thermal properties, as they do not have sufficient blubber underneath their fur to keep them warm. The proposed drilling operations at Blythe and Elgood coincides with the pupping season for Common seals (June to September) and Grey seals (October to late November) and both species are known to make use of haul out sites in the wider area (Section 3.3.4). As a result, given the shallow water and proximity to significant seal colonies in the Wash and Humber estuary, both grey and common seals may be encountered around the proposed development area

Seabirds

Seabirds are particularly susceptible to hydrocarbon pollution on the sea surface and, during large hydrocarbon spills, seabird mortality often attracts the greatest levels of public concern. Following contact with hydrocarbons, seabirds risk loss of buoyancy and thermal insulation as the water-repellent properties of their plumage is lost. In an attempt to clean their plumage, seabirds can also ingest the oil when preening, which may lead to an array of physiological effects. In addition to the direct mortality of adult birds, only small quantities of ingested hydrocarbons can have an indirect effect on reproduction, with depressed egg production and reduced hatching success.

The aerial habits of the fulmar and gulls, together with their large populations and widespread distribution, reduce vulnerability of these species. Gannets, skuas and auk species are considered to be most vulnerable to oil pollution due to a combination of heavy reliance on the marine environment, low breeding output with a long period of immaturity before breeding, and the regional presence of a large percentage of the biogeographical population (DTI, 2003).

The vulnerability of bird species to oil pollution is dependent on several factors and varies considerably throughout the year. The JNCC has produced a Seabird Oil Sensitivity Index (SOSI) which identifies areas at sea where seabirds are likely to be most sensitive to oil pollution. The SOSI uses seabird survey data collected between 1995 and 2015, in addition to individual species sensitivity index values, combined at each location to create a single measure of seabird sensitivity to oil pollution (JNCC, 2018).

Monthly vulnerability for seabirds in the area around the Blythe and Elgood wells are presented in Table 3.4 and Figure 3.3 in Section 3.3.5. With increasing distance from shore, seabird abundance decreases and their distribution becomes increasingly patchy. These patterns are generally governed by the availability and distribution of prey, and also oceanographic features such as water depth and sea temperature. As a result, in the shallower waters of the Southern North Sea, approximately 35 km from the Norfolk Coast, seabirds are present throughout the year however most are typically low in abundance with the exception of Little gulls, Kittiwakes and Guillemots which have been recorded in greater numbers than other species (Section 3.3.5).

The vulnerability of birds in the vicinity of the proposed Blythe and Elgood wells is low to high during the breeding season, generally between March and June, when large numbers of birds congregate in coastal breeding colonies (RSPB, 2017; Table 9.4; Figure 9.6). Seabird vulnerability in the area is generally medium in September, possibly in association with the movement away from colonies after breeding. The vulnerability is increased by the numbers of auks, primarily guillemots, found at sea during this time (BODC, 1998; DTI 2003). Congregating into large groups referred to as 'rafts', these birds undergo a full moult at sea, rendering them flightless and leaving them highly susceptible to surface pollution (RSPB, 2017). Overall, on average, Blocks 48/22 and 48/23 show a high vulnerability to oil and surface pollutants following the breeding season and throughout the winter with a decrease in vulnerability during the breeding season (JNCC, 2018).

Inshore of the Blythe Hub location, seabird vulnerability is classified as high to very high throughout the year due to breeding seabirds from coastal sites foraging out at sea. The south-east of England is of international importance for the seabird breeding colonies supported at many coastal sites and their surrounding inshore waters which have been designated as Special Protection Areas (SPAs) under the European Birds Directive. These colonies may be at risk from a large surface slick.

9.5.2 Impacts on Coastal and Inshore Habitats

The coastlines of the North Norfolk/East Norfolk support a range of different habitat types and are important for nature conservation, with numerous sites along the coastlines designated under national and international legislation (Section 3.4).

In the unlikely event of a large spill, these coastlines are potentially at risk. The probability of an oil spill reaching the shore, and the amount of condensate that would do so, is considered to be low in the majority of the modelled scenarios.

However, the assessment indicates that there is a relatively high probability of a small quantity of oil (6 MT) impacting on the Norfolk shoreline during the spring season (Mar – May). Furthermore, during the winter and summer periods, there is considered to be a low to moderate risk for oil to reach the Norfolk shoreline however the quantity of oil predicted to do so is very small (4 MT or less).

During the spring months, there is a moderate risk of diesel fuel from the jack-up rig reaching the Norfolk coastline in the event of a complete and instantaneous release of diesel from the fuel tanks.

<u>Sedimentary Shores</u>

The fate of oil stranded on sediment shores depends on the nature of the substratum (IPIECA, 2008). Due to the increased sediment movement and relatively large gaps between the particles, beached heavy oil can penetrate further into the more mobile shingle or coarse sand shores. These coarse sediment shores tend to be less productive than sheltered mudflats, where waterlogged sediments, rich in organic matter, can accommodate huge numbers of invertebrates. Gaps between the shingle or sand grains allow the water to drain away quickly between the tides and the movement of the sediment itself is very abrasive, meaning few animals can survive in it. If the beaching of an oil spill becomes inevitable, sandy beaches have in the past been considered as sacrificial areas. A spill may be directed towards a sandy beach in order to protect other, more sensitive, shorelines. Soft sediment areas are common along the Norfolk coastline with sandy beaches a frequent occurrence along the coastline.

In contrast, oil does not readily penetrate the sediments in areas of firm waterlogged mud or fine sand, and tends to be carried away with the next tide (Clark, 2001). However, there is a concern over oil beaching on sheltered mudflats or associated sensitive areas of saltmarsh and these are often priority areas for protection following oil spills. These are generally highly productive areas, with high numbers of invertebrates living within the sediments which may provide a valuable food source for juvenile fish and birds (Little, 2000). Recovery times tend to be longer in these sheltered areas, due to the reduced bacterial degradation and persistence of the oil, particularly if it penetrates into the sediment (IPIECA, 2008). The process of cleaning the sediments and vegetation can be very difficult in these areas and could potentially exacerbate any damage to the habitat. In the most sheltered of intertidal areas, where very fine sediments accumulate, saltmarshes may be found. The presence of mud flats and salt marshes along the Norfolk coast means that these areas would likely be a priority for protection measures following any spill as these are typically highly productive area with high numbers of invertebrates providing a food source for fish and birds. Indeed the North Norfolk Coast is an important breeding ground for a range of migratory and overwintering bird species such as pink footed geese (Natural England, 2018).

<u>Rocky Shores</u>

Oil spill modelling indicates that, under the majority of scenarios assessed, any hydrocarbon release would most likely move to the north or east of the development site however there is potential for interaction with the Norfolk coastline, at certain times of the year, from a well blowout or diesel release as discussed in Section 9.4. Along the Norfolk coastline rocky shores and sea cliffs are not especially commonplace, compared to soft sediment areas. Where present, they present a valuable habitat, however.

Rocky shores can be very varied in structure, ranging from exposed vertical walls to flat bedrock, or stable boulder fields to aggregations of cobbles. These shores can support a variety of sessile animal and plant communities which live attached to the rock surface, as well as a range of associated mobile invertebrates and fish. More exposed rocky shores are generally dominated by sessile animals and smaller more robust seaweeds, while the more sheltered shores are characterised by the large brown kelps.

Rocky shores are generally high energy beaches and, while hydrocarbons may have an impact on the animals and plants which live on them, stranded oil is often quickly removed by wave action and water movement. The vulnerability of rocky shore habitats to oiling is dependent on the type of rocky shore and its exposure. The action of the waves may start to remove the oil from an exposed vertical wall almost immediately, but the oil may remain for longer in more sheltered, kelp dominated areas.

Many of the animals and small seaweeds found on rocky shores would be killed by exposure to fresh and light oils, but much of the condensate potentially reaching the shore from a large spill from the Blythe and Elgood wells would have been at sea for several days and the majority of that oil would have lost most of its toxic constituents. Various shoreline species have been observed to survive shoreline oiling and continue feeding in oiled areas, suggesting that the toxic impacts would be minimal (Clark, 2001). However, even if the beached oil is relatively non-toxic, heavily weathered oil may still cause damage due to its physical properties. Large amounts of stranded oil may impact upon shoreline animals by smothering them. Those animal species that are large enough to protrude above the oil or can move away quickly may survive, but smaller species would be killed by inhibition of their feeding and respiration mechanisms. Many of the larger brown seaweeds which dominate the more sheltered rocky shores secrete mucus which would prevent oil adhering to them. However, if oil does adhere to the seaweed fronds, instead of killing the seaweeds directly, the oil will increase their overall weight causing them to be pulled from the rocks by the wave action. In the event of a condensate spill, such impacts would be very unlikely due to the very light nature of this oil.

The rate of recovery and the form it takes will depend upon the type of rocky shore and the animals and plants that live on it. The general pattern of hydrocarbon spills on rocky shores is that substantial recovery can be achieved within two years, but biological factors may intervene and cause a prolonged change. Rocky shores are high energy, highly productive environments, where the physical and biological factors exerted upon them lead to intense competition between the species which live there. The physical factors, such as desiccation, extremes of temperature and changes in salinity, can cause mortalities in rocky shore communities, while the severe winter storms can dislodge many animals and plants from the shore each year (Little & Kitching, 1996). As a result, these communities have the capability to regenerate quickly in order to take advantage of the newly available space.

9.5.3 Impacts on Other Users of the Sea

Commercial Fisheries

The effects of hydrocarbon spills on commercial fish and shellfish, and the indirect impacts on their habitats, are described above. Fish and shellfish exposed to hydrocarbons may become tainted which could prevent an entire catch from being sold (Clark, 2001). There is evidence that fish are able to detect and avoid oil-contaminated waters, therefore tainting is more a concern for immobile shellfish which cannot swim away. This is more common in filter feeding shellfish, such as scallops, as they could take up fine hydrocarbon droplets from the water column. Shellfish make up the vast majority of landings from ICES rectangle 35F1 where the Blythe and Elgood wells are located particularly crabs, scallops and whelks (Section 3.4.1).

If fishing in the area of a hydrocarbon spill, nets may become fouled with floating oil. This not only causes damage to the nets themselves, but contact with fouled fishing gear may also contaminate subsequent catches. Fishing activity in the area immediately around Blocks 48/22 and 48/23 for non-shellfish species is very low and very few if any pelagic species such as herring are landed from ICES rectangle 35F1 (Section 3.4.1.2; Scottish Government, 2016).

Demersal fish catches around the proposed location are slightly higher than landings for pelagic species but still significantly lower than landings of shellfish species. due to over exploitation of fish stocks in the area. Static gill and trammel nets are used to catch both cod family species (gadoids) and flatfish such as plaice.

Major spills may also result in loss of fishing opportunities with boats unable or unwilling to fish due to the risk of fouling causing a temporary financial loss to commercial fishermen. If a major spill were to occur from the Blythe and Elgood wells it would be anticipated that shellfish landings would most likely be affected.

Aquaculture

There are few active mariculture sites situated along the Humber and Norfolk coasts as the coastline generally does not provide appropriate conditions for cultivation. However, there are a few sites in the Humber and more extensively the Wash which culture shellfish, mostly mussels and some pacific oysters. The probability of an oil spill from the Blythe or Elgood wells reaching any aquaculture sites is considered to be low based on the results of the modelling undertaken (OSRL, 2018).

9.6 Potential for a Major Environmental Incident

The Offshore Safety Directive (2013/30/EU) came into force via UK Regulations on 19 July 2015. These Regulations require that a Safety Case defining Major Accident Hazards (MAH) with the potential to cause Major Accidents (MA) must be in place to cover all drilling operations. The potential for MAs to cause a Major Environmental Incident (MEI) must also be defined in the Safety Case. For the Blythe and Elgood wells, three MA scenarios with the potential to cause a MEI have been identified (Section 9.1):

- Spillage of hydrocarbons in the event of an uncontrolled well blow-out;
- Rupture of fuel oil storage tanks;
- Uncontrolled release from a pipeline.

Section 9.4 details the oil spill modelling carried out for these three scenarios. For each scenario, the results show that the majority of condensate or diesel would be expected to move to the north and east however some movement to the west is also predicted at certain times of the year with very small amounts of hydrocarbons considered to have the potential to beach on the Norfolk coastline.

Figure 9.11 shows the maximum extent of sea surface and shoreline oiling according to the condensate (a), pipeline (b) and diesel (c) modelling results, overlain with protected sites in the area affected by the modelling. Each image is presented as a composite, representing the maximum area oiled over the four seasons which were modelled. Table 9.11 lists the protected sites that have been shown by the modelling to have the potential to be affected by a condensate, pipeline or diesel spill from the proposed Blythe and Elgood operations.

There is no defined threshold for the minimum hydrocarbon concentration that would cause an impact to the protected features described in Table 9.11. Therefore, a precautionary approach has been used in this assessment with regards to coastal protected areas, with the assumption that any beached volume would have the potential to cause an impact to the highlighted conservation objectives for each protected site. Using this approach, it cannot be ruled out that either a well blow-out resulting in an uncontrolled condensate release, an instant pipeline inventory release or a diesel tank rupture resulting in a large diesel spill, would have the potential to cause a MEI, although the likelihood of a MA occurring is very low indeed.

However, as discussed in Section 9.3, any condensate slick on the sea surface would be expected to move predominantly north and east from the proposed development, so protected areas designated for the protection of seabird species and sandbank habitats (such as the Wash and North Norfolk Coast SAC), would not be expected to be affected. In addition, diesel spilled from the jack-up rig would be expected to spread out over the sea surface, and would not be expected to significantly impact the benthos at the water depths present at the site such as protected sites like the North Norfolk Sandbanks and Saturn Reef SAC.

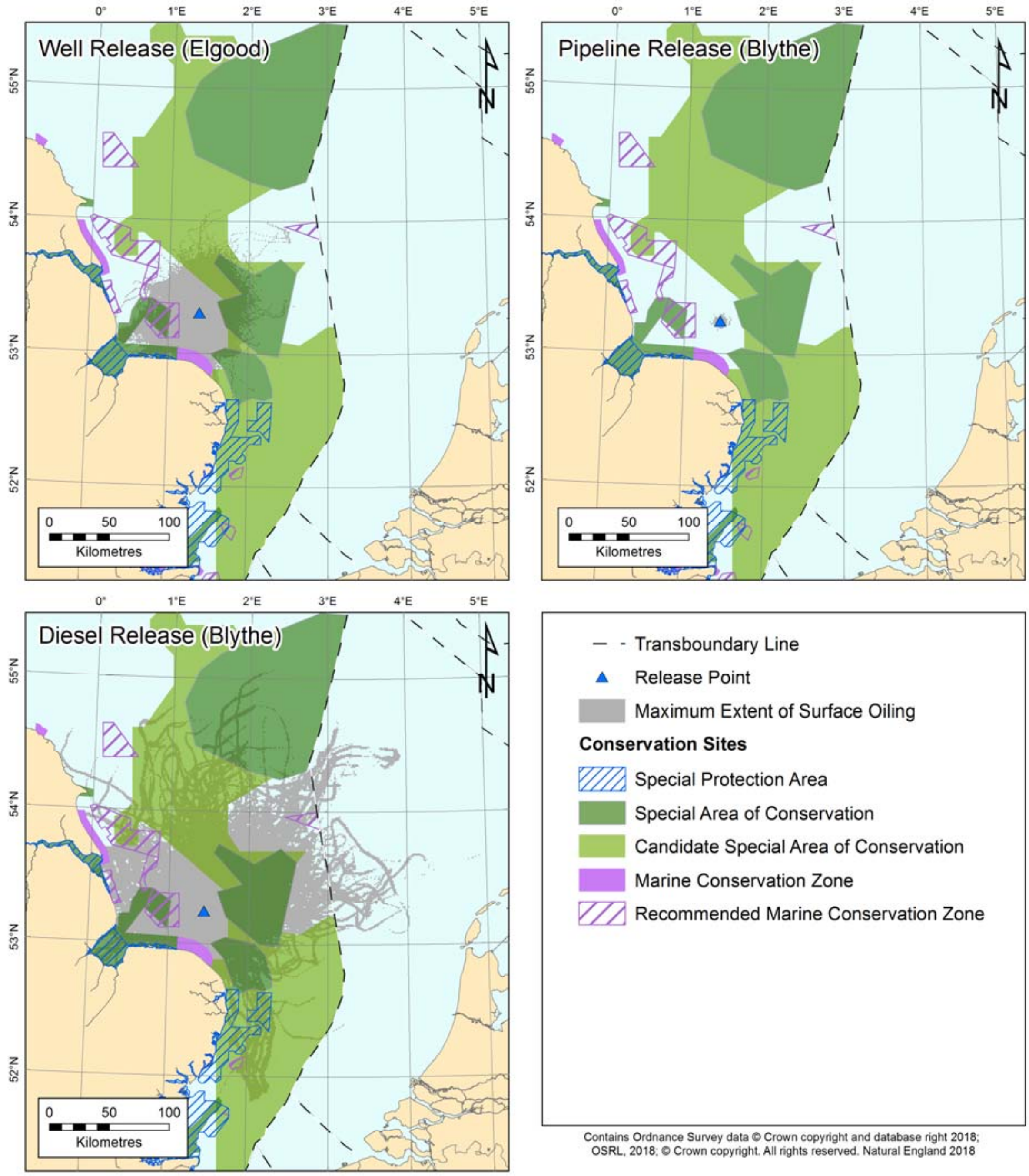

Figure 9.10: Maximum potential surface or shoreline oiling from a condensate spill, pipeline release and diesel spill overlain with protected sites

Source: OSRL, 2018.

The modelling assessment above indicates that the following protected sites could be affected by one or more of the modelled hydrocarbon release scenarios:

- Flamborough Head SAC
- The Wash and North Norfolk Coast SAC
- Dogger Bank SAC
- North Norfolk Sandbanks and Saturn Reef SAC
- Haisborough, Hammond and Winterton SAC
- Inner Dowsing, Race Bank and North Ridge SAC
- Southern North Sea cSAC
- The Wash SPA
- North Norfolk Coast SPA
- Breydon Water SPA
- Outer Thames Estuary SPA
- Minsmere Walberswick SPA
- Holderness Shore MCZ
- Cromer Shoal Chalk Beds MCZ
- Lincs Belt Recommended MCZ
- Markham's Triangle Recommended MCZ
- Holderness Offshore Recommended MCZ
- Silver Pit Recommended MCZ
- Wash Approach Recommended MCZ
- Orford Inshore Recommended MCZ

Any potential impacts on these protected sites is predicated on a worst scenario for a hydrocarbon release where the greatest possible volume of condensate or diesel is released and no containment or protection action is taken. In the event of an accidental hydrocarbon release, IOG will deploy rapid containment and protection measures to control the extent of the spill.

9.7 Mitigation Measures

9.7.1 Preventative Measures

In order to prevent a condensate or diesel spill occurring, stringent safety and operational procedures will be followed throughout activities at the proposed Blythe and Elgood wells.

Training, Experience and Suitability of Equipment

IOG is aware of the risk of a hydrocarbon spill occurring during operations at the proposed Blythe and Elgood wells. Before offshore operations commence, the Well Operator, appointed by IOG, will fully assess the competence and experience of all contractors, and the suitability of all equipment to operate in the Southern North Sea. The jack-up drilling rig selected for the drilling operations will be one which has been designed to operate in relative shallow water conditions such as those found in the Southern North Sea region where the Blythe Hub is to be located and therefore will be well suited to the planned drilling operations. All offshore personnel will be appropriately trained, experienced and certified to carry out their specific duties. The crew of the jack-up drilling rig and other vessels will also undergo environmental awareness and safety training.

Well Design

The Blythe and Elgood wells have been designed to minimise the potential for well control problems and take into account all specific safety design parameters associated with production wells. The wells have been designed to be fully abandoned upon cessation of production.

A thorough and formal peer-review approach will be used to review all critical elements of the well design and the execution of drilling and completion of the wells. In addition, the Blythe and Elgood well designs will be independently reviewed by a Well Examiner, as is required for all wells in the UK. The Well Examiner will also monitor the actual construction and any modifications to the well.

Well Control

Well control procedures will be in place to prevent uncontrolled well flow to the surface and a full risk assessment will be performed as part of the planning phase of the well. Data on well pressure will be monitored throughout the drilling operations, to allow suitable mud composition and mud weights to be used.

A BOP will be put in place once the 17½" section has been drilled in order to prevent the uncontrolled release of hydrocarbons from the well. The BOP stack and associated well control equipment on the jack-up drilling rig are all rated to 15000 psi working pressure.

The BOP will be independently inspected and verified periodically. Regular testing of the BOP and its back up systems takes place onboard the jack-up rig at regular intervals.

Diesel Bunkering Procedures

The highest risk of a diesel spillage occurs during fuel bunkering operations between the jack-up drilling rig and supply vessels. It is expected that bunkering will only be required once per well during activities at each of the proposed Blythe and Elgood production wells. Vessel audits will be performed to confirm sea worthiness, and DP vessels only will be used for supply duties, thus reducing likelihood of collision and potential tank rupturing. Bunkering operations will only take place during hours of good visibility, in suitable weather conditions, and with a dedicated and continuous watch posted at both ends of the fuel hose. All hoses used during bunkering are segmented with pressure valves that will close automatically in the event of a drop in pressure, such as might be caused by a broken connection or a leaking hose. In addition, the bunkering hoses are stored on reels, to prevent wear and damage. These hoses will be visually inspected and their connections tested prior to every loading operation. Bunkering procedures will be followed throughout all bunkering operations.

Loss of Diesel Containment

The loss of diesel from one or all of the diesel tanks onboard the jack-up drilling rig is extremely unlikely, and would only be expected to occur during a major collision with another vessel, or similar event, whereby the integrity of the jack-up drilling rig itself would be compromised. Section 9.6.5, on the potential impacts in case of catastrophic loss of the jack-up drilling rig, describes further mitigation measures in place to prevent a serious collision event from happening.

All equipment used on the jack-up drilling rig will have safety measures built in to minimise the risks of any hydrocarbon spillage. The jack-up drilling rig will have open and closed drain systems in place that will route any operational spills onboard the rig itself to the slop tanks where they can be contained and recovered. There will also be a number of spill kits available to deal with (smaller) spillages that may occur onboard the rig.

9.7.2 Action to Stop a Blow-out

Initial Actions

If an unexpected inflow of hydrocarbons into the well occurs, there may be various methods available to control the flow of hydrocarbons to the surface. These include varying the pump rate and the use of various chemicals, such as weighting material (barite or calcium carbonate) and cement. Therefore, a contingency stock of cement and barite will be kept onboard the rig. Although the time required to kill the well will be dependent on the how and why it has failed, a standard well kill operation takes between 12 and 48 hours. Once control of the well has been regained, the well can be fully abandoned with cement plugs.

Capping the Well

In the event of a subsea blow-out, whereby the BOP has failed and condensate is freely flowing into the sea, the possibility of fitting a temporary capping device to the well will be considered. Once installed, this type of cap will completely seal off the well and stop condensate from spilling into the sea whilst a relief well is drilled, and the original well is killed. This is currently regarded as the most likely successful approach to containing an uncontrolled subsea blow-out.

IOG is a member of Oil Spill Response Ltd (OSRL), which allows IOG access to the OSPRAG (the Oil Spill Prevention and Response Advisory Group) Capping Device stored at the Cameron facility in Aberdeen. The OSPRAG well capping device is of a modular design which will allow installation at various points of the subsea wellhead or the blow-out preventer (BOP). IOG has reviewed the technical specifications of the cap and has confirmed that it is compatible with the subsea equipment proposed for use during the Blythe and Elgood wells. Further, during a modelled blow-out scenario, the Blythe and Elgood wells fall within the maximum technical specifications for well flow rate, pressure and temperature, confirming that this device is suitable for use with this well. This capping device would be IOG's primary option for sealing the well, if required.

At approximately 40 tonnes, the capping device is suitable for installation by a light intervention vessel. In the event that it is required, the device would be transported from Aberdeen to the Blythe Hub location, for deployment from a light well intervention vessel. Although no contract is in place for such a vessel, the type of vessel required to install the cap is relatively easy to procure and deploy. IOG is confident that it would be able to procure a suitable vessel at very short notice.

In the event of an uncontrolled well blow-out, it is anticipated that it would take approximately 35 days until the capping device could be deployed and the well contained. This timeframe would include sourcing of an appropriate vessel, mobilisation of the capping device to the proposed Blythe or Elgood well location, site preparation and clearance at the well location, deployment of the capping device and well containment. A full timetable for this procedure will be provided in the Well Operator's Temporary Operations Oil Pollution Emergency Plan (TOOPEP) for the planned Blythe Hub operations.

Securing Required Equipment

As a worst-case scenario, it is assumed that an additional suitable jack-up drilling rig, would be required to conduct the relief well operations. The availability of suitable drilling rigs will to be monitored throughout operations at the Blythe and Elgood production wells. It has been estimated that it would take between four and six weeks to source an alternative suitable drilling unit, for the current operations to be suspended, and to move the unit onto the well location.

In addition to the drilling unit, all of the required drilling equipment will also have to be sourced and mobilised. In order to minimise the time involved, equipment would be sourced from off the shelf supplies and borrowed from other operators. Throughout this planning and preparation process, it is assumed that other license holders, drilling rig contractors and the government agencies would co-operate, where necessary.

Planning for the relief well will include a review of the original well design and the reasons for the uncontrolled well blow-out, allowing any required changes to well design, equipment and operating procedures to be implemented. Preparation of equipment, procedures and consent applications will all be conducted in parallel with the activities required to gain access to a suitable replacement drilling unit.

Drilling the Relief Well

Alternative relief well locations around the Blythe and Elgood wells will be identified in the Relief Well Plan. A well path will be created to ensure that the suggested well surface locations are suitable and can be quickly tailored to the actual relief well programme if required in a blow-out situation. In order to optimise the relief well design, planning at the time of an incident will include a review of the current location and directional plans, along with the reasons for well failure and the resultant uncontrolled blow-out. This will allow any required changes to be made to relief well design and equipment, and additional operating procedures to be implemented if required.

Once a suitable jack-up drilling rig has been sourced and mobilised to location and a relief well design selected, it is anticipated that it would then take approximately 81 days to drill a relief well and kill the original well. This is slightly longer than the estimated time required to reach the reservoir within the Blythe or Elgood production wells, and is potentially required due to the ranging surveys and additional measurements necessary to ensure the relief well is positioned correctly and in close proximity to the original well. Once the relief well reaches the original well, well kill operations would be carried out to permanently abandon it.

A full timetable for the drilling of a relief well will be provided in the Well Operator's Temporary Operations Oil Pollution Emergency Plan (TOOPEP) for the planned operations at the Blythe Hub.

9.7.3 Oil Spill Response

If a large spill were to occur, it would be a priority to avoid spilled condensate impacting the coastline and, therefore, all available and suitable oil spill response techniques would be employed in the event of a spillage moving towards the shore.

Oil Pollution Emergency Plan

The jack-up drilling rig will have an TOOPEP in place conforming to the Merchant Shipping (Oil Pollution, Preparedness, Response and Co-operation Convention) (Amendment) Regulations 2015 and the Offshore Installations (Emergency Pollution Control) Regulations 2002. The TOOPEP will fully consider the oil spill response requirements of the Blythe and Elgood production wells, taking into account the location, the prevailing meteorological conditions and the environmental sensitivities of the area. It has been designed to assist the decision-making process during a hydrocarbon spill, indicate what resources are required to combat the spill, minimise any further discharges and mitigate its effects.

During the production phase a Field OPEP will be in place for the Blythe Platform, covering both Blythe and Elgood.

Training, Exercises and Experience

Offshore Personnel

Specific members of the jack-up drilling rig and standby vessel crew will have undertaken Oil Pollution Emergency Plan (OPEP) oil spill response training.

As a minimum, the TOOPEP/OPEP will be distributed to personnel with designated duties in the event that an oil spill response is required, and to the regulatory authorities and statutory consultees. On receipt of the TOOPEP/OPEP, personnel will undergo awareness training in oil spill response prior to the commencement of drilling and production operations. The aim of this training is to familiarise offshore personnel with the oil spill procedures, levels of response effort, equipment orientation and use, and communication and reporting during an oil spill of any size.

The jack-up drilling rig will regularly undertake training exercises, including vessel-based oil spill response exercises for the crew and an Offshore TOOPEP Exercise while on site, to ensure that offshore personnel are familiar with the TOOPEP and their responsibilities during a response.

Onshore Personnel

External oil spill response training will be organised for key onshore personnel, in line with the OPRED requirements. Relevant IOG, Well Operator and Installation Operator Duty Managers will, as a minimum, have attended the OPRED recommended course for Corporate Management oil spill response awareness (OPEP Level 2). IOG is a member of Oil Spill Response Ltd (OSRL), with activation rights being provided to key emergency response personnel. A response advisor with OPEP Level 4 training will also be provided by OSRL.

The appointed Well Operator will conduct an oil spill response exercise prior to drilling to ensure that all personnel are aware of their roles in an actual oil spill incident. These exercises will also familiarise personnel with the lines of communication between the jack-up drilling rig, offshore, the appointed Well Operator onshore and IOG. The exercise will also include familiarisation of the roles and responsibilities of the various interested parties, and the chosen response strategies. If necessary, the TOOPEP/OPEP will be updated to reflect any changes required as a result of the exercise.

9.7.4 Oil Spill Response Strategies

The most appropriate response to a hydrocarbon spill from the planned drilling operations will be determined by oil type, logistics and prevailing physical conditions. A precise response strategy, which may employ one or more of the response options described below, can only be decided at the time of the spill. Oil spill response personnel must be prepared to adapt their actions as the spill develops as changes in both the prevailing conditions and the oil properties dictate.

In general, there are several response strategies which could be deployed in the event of a spill:

- Natural dispersion and monitoring;
- Application of chemical dispersants;
- Containment and recovery (surface and subsea);
- Shoreline protection and clean-up.

Natural Dispersion and Monitoring

Condensate and diesel spills are often best monitored but otherwise left to naturally degrade. The natural evaporation and dispersion processes described in Section 9.3 will often be enough to successfully disperse condensate or diesel. These processes can be enhanced, where practicable, by physical agitation of the slick by the standby vessel and other vessels on site.

It is proposed that, in the event of a condensate or diesel spill incident from the either proposed Blythe or Elgood production well, the principal response strategy will be the monitoring and surveillance of the slick, where evaporation and natural dispersion will be the principle mechanisms for removal of oil from the sea surface.

On-site and Aerial Surveillance

A standby vessel will be on site throughout the drilling operations. In the early stages of the incident, the slick may be monitored by this onsite standby vessel, provided it can still meet its safety function. For larger, ongoing spills, aircraft may be mobilised to undertake aerial surveillance. However, in the short term, aerial surveillance may be undertaken by the helicopter contractor.

Dedicated aerial surveillance aircraft will be available through OSRL. The use of aerial surveillance in the monitoring of oil spills, as opposed to sea level vessels, allows for a more accurate picture of spill size and movement to be formed, especially in the monitoring of larger, more mobile spills. This would enable the development of various response options, including the decision to monitor the spill as it disperses naturally.

Oil Spill Modelling

Tracking and monitoring of the spilled oil would commence as soon as possible after the incident has occurred and continue for the duration of the response. This will be used to evaluate the extent of the slick, monitor its movement and dispersal, and decide on the appropriate response.

Initially, manual predictions can be used to estimate the movement of the oil on the sea surface as a function of the wind and current speed and direction. Oil spill modelling would also be employed to gain a more accurate indication of oil spill movement, using real time parameters to assist the predictions.

Chemical Dispersants

The use of chemical dispersants on a spill of condensate or of diesel is generally not recommended, and therefore dispersants are unlikely to be considered as a viable response strategy in the event of a spill at Blythe or Elgood.

The natural processes of evaporation and dispersion will usually remove light oils, such as condensate and diesel, from the sea surface rapidly, without the need for chemical treatment. The use of chemical dispersants on condensate or diesel will result in increased concentrations of toxic components within the upper water column. Many spawning species have pelagic eggs and larvae which are vulnerable to oil which is chemically dispersed into the water column. These eggs and larvae would become exposed to higher concentrations of oil if dispersants were used, than if the oil had been allowed to evaporate and disperse naturally. In addition, dispersants are generally less effective on very light oils, as the dispersants are thought to sink through the oil, reducing the contact time between the oil and water interface. As a result, chemical dispersants should generally not be used on these spilled light oils. However, the chemical dispersion of condensate or diesel spills, which are observed not to be dispersing naturally, may sometimes be necessary to protect vulnerable concentrations of seabirds. Although this may be an appropriate response, it will be necessary to balance the outcomes against each other, at the time of the spill.

Containment and Recovery

Booms may be used to contain a large slick on the sea surface, concentrating the oil for recovery by skimmers. The effectiveness of both booms and skimmers depends on the sea and weather conditions, with the most efficient containment and recovery of oil only achieved under calm conditions. In order to create a barrier with which to prevent the oil escaping, booms must move with the surface water. However, with the increasing flexibility required to achieve this in rougher seas, comes reduced boom rigidity and a corresponding reduction in its ability to contain oil. As skimmers float on the sea surface, they also experience many of the operational difficulties that apply to booms.

Recovery equipment requires the spilled oil to be of sufficient thickness to allow it to be lifted and sucked from the surface while disturbing the underlying water as little as possible. If the slick is too thin large quantities of water will be taken up by the process not only reducing the effectiveness of oil collection, but also causing additional issues for containment and disposal of the oily water. As the slick becomes increasingly spread out and broken up, the effectiveness of this response option decreases. Condensate is a very light hydrocarbon and would be expected to spread and disperse very quickly. A large condensate spill released near the seabed would spread out very thinly by the time it had risen through the water column to the sea surface. Therefore, it would not be expected that condensate from a subsea release from the Blythe or Elgood production well would be of appropriate thickness to allow for this recovery response option to be wholly effective.

<u>Shoreline Protection and Clean-Up</u>

Shoreline Protection

Where possible, the first priority should be to prevent spilled hydrocarbons from reaching coastal areas. As described above, a number of different response options are available to contain the spilled oil offshore or to limit the movement of the slick across the sea surface. However, there remains the potential for a large slick to threaten the shoreline communities.

The initial response to any spill will be onsite and aerial surveillance to track its movement, supplemented by modelling to predict which shorelines the spilled oil may threaten. With a better understanding of the shorelines at risk from the spill, information will be gathered on the coastal habitats present in these areas and their associated communities. Any coastal sensitivities, including vulnerable shoreline types, coastal and inshore protected areas (including those designated under the European Habitats and Birds Directives), areas of inshore fisheries or aquaculture, coastal tourist or recreational areas, and other coastal industries, will be identified. Throughout the well planning process, basic information has been gathered on the surrounding coastal sensitivities and this will be included within the TOOPEP and subsequent OPEP to assist in any required oil spill response. This will be supplemented by the OSRL GIS facility (which maps coastal sensitivities around the UK), local authority plans, strategy documents, maps, and other available resources. The closest coastline to the proposed Blythe Hub Development is the North Norfolk coastline. Broad-scale surveys, from vehicles, inshore vessels or helicopters, will be mobilised to gain an overview of the shoreline types and main sensitivities along the potentially affected stretch of coast, and consideration will be given to carrying out more detailed surveys of particularly environmentally sensitive or commercial important areas of shoreline prior to any oil beaching.

Once the coastal sensitivities under immediate threat have been identified, coastal protection resources will be deployed to protect priority areas. Although IOG and the Well Operator/Platform Operator will provide all necessary assistance as required, all shoreline protection strategies will be determined by the local authority in consultation with their environmental advisors. Details of local equipment suitable and available for shoreline booming will be available through coastal strategy documents. Additional response personnel and appropriate shoreline protection equipment will be provided by IOG and the Well Operator/Platform Operator, through their oil spill response contractor, OSRL.

Oil spill modelling has indicated that the coastlines of south-east England, specifically the Norfolk coastline would be under the greatest threat from beaching condensate or diesel (Section 9.3.3). These coastlines include a variety of coastal habitats including extensive intertidal sand and mud flats, saltmarshes, shingle and sand dunes as well as areas of freshwater grazing marsh and reedbeds. Containment and protection measures would be focused on these areas particularly ones which are designated as a protected site for their features such as the North Norfolk Coast SPA.

Shoreline Clean-Up

Every effort will be made to clean-up up any oil that reaches the shoreline. Depending on the type of coastline affected, various methods exist to remove oil from the shore. Sediment shores are generally more amenable to methods that will physically 'scoop' the oil from the beach, whereas appropriate washing and rinsing techniques are likely to be more effective on rocky substrata.

If a spill does reach the shoreline, aerial surveillance will be used to gain a broad overview of where it has beached, while vehicles or vessels will be used to make a more detailed, shore specific assessment. Stretches of shoreline will be surveyed, recording the type of shoreline (sediment type, slope, exposure etc), its use (tourism, recreation, etc), and any environmental sensitivities (protected areas, seal breeding sites, otter holts, etc), as well as the severity of any oiling (mobile oil, surface or subsurface oil, stranded oil, sheen etc). Information on access arrangements, parking and storage arrangements, and proximity to other facilities will also be recorded. This information will be used to determine where to focus the clean-up effort by making the optimum use of the available clean-up resources.

In certain circumstances the physical disturbances caused by some clean-up methods may be more damaging to shorelines and their associated communities than the direct effects of an oil spill. This is particularly true in more sensitive, less dynamic habitats, such as mudflats or saltmarsh. In addition, steeply sloping and unstable rocky shores or large soft mudflats are often difficult to access. Therefore, if oil does reach the shore, clean-up methods should be chosen carefully so as to not cause a greater degree of damage.

With all required assistance and information provided by IOG and the appointed Well Operator, the strategy for shoreline clean-up ultimately will be directed by the affected local authorities. Adequate trained personnel and clean-up equipment will be made available to assist any clean-up operations, through OSRL.

9.8 Catastrophic Loss of the Jack-up Rig, a Vessel or Helicopter

Under extreme circumstances, the jack-up drilling rig, the Blythe platform itself, a support vessel or a helicopter may sink. This could be caused by a variety of reasons, such as a serious blow-out situation, shallow gas release, a collision with another vessel or a freak weather event. These events are extremely rare, and happen so infrequently that no reliable statistics could be obtained to quantify them.

A raft of mitigation measures is in place for preventing such an event from happening. These include:

- The jack-up drilling rig will be inspected for sea worthiness and the drilling contractors audited prior to operations commencing;
- The Blythe Platform will be inspected for sea worthiness and the drilling contractors audited prior to operations commencing;
- A blow-out preventer will be installed after the 17½" section is drilled and the 13⅜" casing cemented in place;
- Well control procedures will be in place and an appropriate mud programme will be designed in order to maintain well control at all times;
- Personnel will be appropriately trained, experienced and certified;
- The competence and experience of all contractors will be assessed before they are contracted;
- All supply vessels will operate via DP, to reduce the likelihood of a collision;
- A digital site survey for drilling hazards has been carried out to confirm that there is no shallow gas in the area;
- A 500 m statutory exclusion zone will be enforced around the jack-up rig and subsequently around the Blythe platform for general shipping in the area;
- A standby vessel will be on site throughout operations to enforce the 500 m statutory exclusion zone during drilling operations;
- The jack-up drilling rig, Blythe Platform and associated vessels will use appropriate lighting;
- The suitability of supply, other support vessels and the helicopter will be assessed before they are contracted.
- The standby vessel will be equipped with radar and communication equipment so that any vessel in the area can be detected and contacted, if required;
- The United Kingdom Hydrographic Office (UKHO) and Ministry of Defence (MoD) will be kept informed of drilling activities.

In the event of the loss of the jack-up drilling rig, the Blythe Platform, a vessel or a helicopter it would is likely that the vessel or aircraft would be salvageable in this relatively shallow water environment. Attempts would be made to salvage any remaining hydrocarbons and other potentially harmful products onboard the wreck, although it should be noted that, in practice, these types of operations are prone to causing pollution incidents. The potential impact of the release of oil to the marine environment is described above in Section 9.4, and impacts of chemical discharge are reviewed in Section 5.3.1.

Should it not be possible or unsafe to recover a lost rig, platform, vessel or helicopter, the wreck would be marked on navigational charts to prevent the snagging of fishing nets and other towed equipment. Shipwrecks UK (2017) has identified more than 46,000 wrecks in the waters around the UK and Ireland. In general the presence of wrecks on the seabed is not considered to have any long lasting negative environmental effects. Therefore, given the remote chance of such an event happening due to appropriate mitigation measures in place, and minimal negative long term environmental impacts, the residual impact of a loss of rig is considered to be insignificant.

9.9 Conclusions

The risk of a large-scale condensate spill during drilling operations at the proposed Blythe Hub Development is very low. The condensate spill modelling scenario shows that a large spill, such as from a well blow-out, would, under the majority of meteorological circumstances, drift to the north and east of the proposed well location, although there is scope for the slick to drift to the west at certain times of the year (mainly in the spring months (March to May). This light hydrocarbon would be expected to break up and disperse very quickly. However, the modelling undertaken indicates that there would be a probability of a small amount of condensate (6 MT) landing on the Norfolk coastline during the spring months (March to May). These conclusions are based on modelling results that assume no intervention in the slick. In practice oil spill response resources would be mobilised immediately if a spill occurred. It would be a priority for IOG and the appointed Well Operator to ensure no spilled oil would impact the coastline, including the protected areas that exist along the Norfolk coastline, and, therefore, all appropriate oil spill response techniques would be employed in the event of a spillage moving towards the shore.

Historic data suggest small diesel spills of less than 1 tonne represent the most likely diesel spill scenario. Oil spill modelling scenarios show that a large diesel release would have a moderate potential to reach the Norfolk coastline during the spring months (March to May), a small chance of a spill reaching the same coastline in the summer months (June to August) and also the Lincolnshire coastline in spring. There is a very low probability that a diesel spill will cross over the Netherlands transboundary line for the majority of the seasons modelled with the exception of the summer months where it is considered there is a low potential for the UK/Netherlands median line to be reached.

The volatility of the diesel would, however, result in quick evaporation and dispersal of such a spill. The majority of diesel spills occur during bunkering operations and, therefore, bunkering will only take place under appropriate conditions and with equipment used that has been manufactured, maintained and operated in order to minimise the risk of any spillage and in the event of a spill immediate action would be taken to minimise the potential for any impact on the shoreline. Therefore, any potential diesel spill would have only a minor local environmental impact.

The potential loss of condensate from a pipeline failure is not considered likely to have any significant environmental impact owing to the highly localised spread of any condensate and the low potential for shoreline interaction. A robust operations and maintenance programme will be produced thereby ensuring any potential defects with the pipeline are identified before a failure occurs.

Throughout the proposed operations, the focus would be on the prevention of oil spills. Stringent safety and operational procedures will be adhered to throughout the operations. A robust well design has been developed to minimise the potential for well control issues, and all critical elements of this design and the execution operations will have been both peer and independently reviewed. Well pressure will be monitored throughout the operations, allowing suitable mud weights to be used throughout drilling. A blow-out preventer (BOP) will be put in place, in order to prevent the uncontrolled release of hydrocarbons from the well.

In the unlikely event of a well control incident, the BOP will be closed to prevent hydrocarbons from flowing to the surface. If all attempts to close the BOP fail, attempts would be made to temporarily seal the well using a capping device, while operations to drill a relief well and permanently abandon the well would commence as soon as possible. Any hydrocarbons spilled at sea would be closely monitored with information gathered on spill size and behaviour, the direction and speed of travel, how quickly the slick was being broken down, and the environmental sensitivities at risk.

There will be detailed operation specific TOOPEP/OPEPs in place to ensure that immediate and appropriate action is taken in the event of any hydrocarbon spillage, minimising any impact to the marine environment. A contract with OSRL is in place, allowing the rapid deployment of oil spill response equipment and personnel in the event of a large oil spill incident. Specific response equipment would be available including booms to contain surface spills at sea or protect sensitive shorelines. Ultimately, the type and size of spill, along with the metocean conditions at the time of the spill, will dictate which of these resources is most suitable for the spill event. Additional shore clean-up equipment is also available.

With the measures in place to prevent an oil spill incident from happening and the oil spill contingency planning and response resources available in the event of a large oil spill event, the residual environmental risk posed by the proposed Blythe and Elgood production well operations is judged to be reduced to an acceptable level.

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Section 10

Conclusions

10 Conclusions

IOG is proposing to construct the Blythe Hub Development in the Southern North Sea located approximately 35 km from the North Norfolk coast. The development will include the drilling of two production wells in the Blythe and Elgood fields in Blocks 48/23 and 48/22, as well as the installation of a minimum facilities platform and associated connecting flowlines. The project will connect to the existing Thames to Bacton pipeline. The two wells would be located at 53° 14' 31.35" N, 01° 26' 51.14" E (Blythe) and 53° 18' 19.88" N, 01° 23' 10.31" E (Elgood).

The wells will be drilled using a jack-up drilling rig. IOG proposes to appoint a Well Operator to drill and operate the wells on behalf of IOG. Drilling operations are proposed to commence in Q3 2019, starting at Blythe, before moving onto Elgood in Q4 2019. Drilling operations are planned to take 82.5 days for Blythe and 85.5 days for Elgood.

Both wells will be drilled using water base muds (WBM) and low toxicity oil base muds (LTOBM). All cuttings and associated WBM will be discharged to sea, as is normal practice on the UKCS. No LTOBM will be discharged to sea during the course of the operations. All spent LTOBM and associated cuttings will be skipped and shipped to shore for appropriate treatment and disposal. The expected hydrocarbons from the wells are gas and condensate.

The proposed activities and available options have been described (Section 2), together with a description of the local environment (Section 3). The interactions between the project and the environment have been identified (Section 4) and all potentially significant environmental impacts assessed (Sections 5 to 9). The key environmental concerns identified as requiring consideration for impact assessment were:

- Physical Presence (Section 5);
- Marine Discharges (Section 6);
- Noise generation and Wildlife Disturbance (Section 7);
- Atmospheric Impacts (Section 8); and
- Accidental Events (Section 9).

The main issues identified and conclusions on their residual impacts following the incorporation of mitigation measures are summarised below.

10.1. Physical Presence

Areas of the seabed affected by the development will not be able to fully recover until cessation of the development and removal of the associated infrastructure. However, the disturbance will be localised, and the area affected small in relation to the surrounding undisturbed areas. There is expected to be strong potential for the recovery of the seabed over time via re-sedimentation and re-colonisation of benthos from the surrounding areas. The development area is also largely featureless and supports no habitats of conservation concern.

The jack-up drilling rig may be just visible on clear days during the drilling operations but will be imperceptible to the human eye under most conditions. The Blythe platform itself will not be visible from the shore at sea level.

The close proximity of the Blythe and Elgood infrastructure to the Dudgeon Offshore Wind Farm (OWF) means the statutory 500 m safety zones will extend to a distance of approximately 500 m from the nearest turbine location. The Marine Traffic Survey and Navigation Assessment (NA) carried for the OWF showed that small vessels would be able to navigate through the OWF, however, larger vessels would need to transit around the outer extent of the OWF. The vast majority of this diverted traffic is likely to use the southern and western boundaries, as that minimises the disruption to existing routes. Only a very small proportion of traffic will therefore be directly affected by statutory safety zones around Blythe and Elgood.

During the life of filed (approximately 12 years), fisheries are expected to lose access to an area of 1.57 km^2 around the proposed Blythe and Elgood wells due to the enforcement of a 500 m statutory safety zone. This area is very small compared to the wider area available for fishing in ICES rectangle 35F1 with the excluded area representing approximately 0.04% of the total area of ICES rectangle 35F1. It is expected that the exclusion from this relatively small area will lead to the redirection of fishing effort to another area, rather than any loss of fishing effort in the general area around the well location. Very small amounts of demersal fish species are landed from this area with even fewer pelagic species caught. Shellfish species, such as crabs, lobsters and whelks, make up the majority of landings. The proportion of fishing grounds lost as a result of the statutory safety zones around Blythe and Elgood is a very small proportion of the available grounds with ICES rectangle 35F1. The proportion of area lost is 425 smaller that the smallest inter-annual variation of landings for shellfish between 2008 and 2013.

Impacts from the physical presence of the rig and infrastructure have been considered to be low to negligible, and thus not significant.

10.2. Marine Discharges

The drilling discharges from the proposed drilling operations at the Blythe and Elgood production wells have the potential to cause moderate effects in the immediate vicinity of the well location. There will be no production discharges, as all fluids will be produced to the onshore Bacton Terminal.

The effects of WBM and cuttings discharges on the benthic environment are related to the total quantity discharged and the oceanic energy regime encountered at the discharge site, particularly the currents close to the seabed itself. Any disturbance of the fauna typically only occurs within 50 m from single well locations, and the presence of drilling material on the seabed is often only chemically detectable at distances beyond this.

Based on these factors, the discharge of cuttings and drilling fluids at the Blythe and Elgood well locations have the potential to cause temporary localised impacts to the benthic environment, primarily through direct physical changes to the seabed. This effect is expected to be chiefly limited to within 50 m of the well location. Recovery of the benthos is expected to begin soon after discharges cease. The areas of the seabed directly affected by drilling discharges are not protected, or potential Annex 1 habitat, and are typical and widespread in the Southern North Sea.

All chemicals used will be approved by Cefas, and will be in accordance with UK chemicals regulations. Wherever practicable and technically feasible, chemicals without substitution warnings will be prioritised over those that do have warnings.

Bearing these factors in mind, the magnitude of environmental effects is considered to be minor and thus not significant.

10.3. Noise Generation and Wildlife Disturbance

Anthropogenic noises from shipping are currently believed to be the main source of background noise in the area of the proposed well location. During the drilling operations at the Blythe Hub Development, noise will be generated by the jack-up drilling rig during drilling and also by support vessels (i.e. the standby vessel and supply vessels) and helicopters. However, the loudest anticipated sound source will be piling noise generated during platform installation.

An assessment of the requirement for a wildlife disturbance licence was undertaken for the Blythe Hub Development, in line with the Offshore Marine Regulations 2007 (amended 2009). This assessment concluded that it is extremely unlikely that piling operations at the Blythe Hub Development would cause a disturbance offence in relation to any Marine European Protected Species and, therefore, IOG believes it is unnecessary to apply for a wildlife disturbance licence.

The main impacts from the development of the Blythe Hub are expected to be limited to avoidance behavioural responses of individual animals within 9 km of the platform piling operations, for the duration of the piling activities, i.e. up to 4 days. More subtle effects may be noticed up to a distance of approximately 28 km from the platform. Given the intermittent nature and short duration of the piling operations, any effects are expected to only last for a short period of time and are, therefore, not considered to be significant.

Many species of fish use sound to find prey, to avoid predators, and for social interactions. In addition, the sensory systems used by fishes to detect sounds are very similar to those of marine (and terrestrial) mammals, and, as a consequence, sounds that damage or affect marine mammals could in other ways have similar consequences for fish. Adult and juvenile fish are rarely affected by piling operations because they are able to detect and physically avoid the area but fish eggs and larvae may be more vulnerable. Given the limited spatial extent of the anticipated impact and the limited (4 day) period over which the piling will take place, and the ability of fish to temporarily avoid areas of adverse noise, the proposed piling operations is not anticipated to cause any significant impacts on fish.

The piling operations during the installation of the Blythe platform will temporarily add to the ambient noise in the Southern North Sea which includes various sources of industrial noise such as shipping and fishing activity, windfarms, other oil and gas installations and aggregate extraction.

The long-term, synergistic and cumulative impact of sound sources is not known. However, the risks in this instance are considered to be low, for the following reasons:

- Noise generation associated with the proposed piling operations will be intermittent and transitory; occurring over a period of up to 4 days;
- Although the Southern North Sea can be regarded as important for certain species of cetacean, the highest densities of cetaceans present in the Blythe Hub Development area are classed as "mid-frequency" cetaceans, which are generally regarded to be more sensitive to higher sound frequencies than the dominant frequencies produced by the piling operations.

With regard to potential transboundary effects, the location of the Blythe Hub is 105 km east of the UK/Netherlands transboundary line. At this distance any underwater sound will have attenuated to a low level therefore no observable effects are expected to occur. Consequently, no significant cumulative and/or transboundary impacts from noise generated during the piling operations are anticipated.

Therefore, no significant cumulative and/or transboundary impacts from noise generated by the piling activities during the platform installation are anticipated.

10.4. Atmospheric Emissions

Atmospheric emissions will be produced during drilling and installation operations, as a result of power generation, flaring, supply vessels and helicopter activity. However, it should be noted that atmospheric emissions during the production phase will be minimal, as the power required onboard the Blythe platform will be mainly supplied by wind/solar energy, and therefore has not been considered further in the ES.

Emissions will contribute to local and global environmental effects. At a local level, impacts are mitigated by health and safety measures in place to control emissions and by the dispersive nature of the offshore environment. Emissions will also contribute to global environmental issues such as climate change. The contribution of the proposed drilling and installation programme is comparable to similar operations, and small in comparison to emissions at a national level. Therefore, the individual atmospheric emissions generated at the Blythe Hub Development and their resultant impacts are considered to be negligible and therefore not significant.

The ultimate cumulative global implications, such as the contribution to global climate change, are more difficult to assess, and the overall strategy to tackle such issues ultimately lies with national and international governance. As such, the mitigation of the potential cumulative impacts involved is considered to lie outwith the scope of this ES.

10.5. Accidental Events

The risk of a large-scale hydrocarbon spill occurring during drilling operations at the proposed Blythe Hub Development is very low. The only potential sources of a large spill would be an uncontrolled well blow-out leading to a release of condensate from the well, catastrophic failure of the MODU's diesel tanks or a release of condensate from pipeline failure.

Modelling undertaken indicates that a large spill from a well blow-out, would, under the majority of meteorological circumstances, drift to the north and east of the proposed well location though there is scope for the slick to drift to the west at certain times of the year (mainly in the spring months March to May). This light hydrocarbon would be expected to break up and disperse very quickly. The modelling indicates that there would be a probability of a small amount of condensate (6 MT) landing on the Norfolk coastline during the spring months (March to May).

However, these predictions assume no intervention in response to the slick. In practice oil spill response resources would be mobilised immediately if a spill occurred. It would be a priority to ensure no spilled oil would impact the coastline, including the protected areas that exist along the Norfolk coastline, and, therefore, all appropriate oil spill response techniques would be employed in the event of a spillage moving towards the shore.

Historic data suggest small diesel spills of less than 1 tonne represent the most likely diesel spill scenario. Oil spill modelling scenarios show that a large diesel release would have a moderate potential to reach the Norfolk coastline during the spring months (March to May), a small chance of a spill reaching the same coastline in the summer months (June to August) and also the Lincolnshire coastline in spring. There is a very low probability that a diesel spill will cross over the Netherlands transboundary line for the majority of the seasons modelled with the exception of the summer months where it is considered there is a low potential for the UK/Netherlands median line to be reached.

The volatility of the diesel would, however, result in quick evaporation and dispersal of such a spill. The majority of diesel spills occur during bunkering operations and, therefore, bunkering will only take place under appropriate conditions and with equipment used that has been manufactured, maintained and operated in order to minimise the risk of any spillage and in the event of a spill immediate action would be taken to minimise the potential for any impact on the shoreline. Therefore, any potential diesel spill would have only a minor local environmental impact.

The potential loss of condensate from a pipeline failure is not considered likely to have any significant environmental impact owing to the highly localised spread of any condensate and the low potential for shoreline interaction. A robust operations and maintenance programme will be produced thereby ensuring any potential defects with the pipeline are identified before a failure occurs.

Throughout the proposed operations, the focus would be on the prevention of oil spills. Stringent safety and operational procedures will be adhered to throughout the operations. In the unlikely event of a well control incident, the BOP will be closed to prevent hydrocarbons from flowing to the surface. If all attempts to close the BOP fail, attempts would be made to temporarily seal the well using a capping device, while operations to drill a relief well and permanently abandon the well would commence as soon as possible. Any hydrocarbons spilled at sea would be closely monitored with information gathered on spill size and behaviour, the direction and speed of travel, how quickly the slick was being broken down, and the environmental sensitivities at risk.

A detailed operation specific TOOPEP/OPEP will be in place to ensure that immediate and appropriate action is taken in the event of any hydrocarbon spillage, minimising any impact to the marine environment. A contract with OSRL is in place, allowing the rapid deployment of oil spill response equipment and personnel in the event of a large oil spill incident. Specific response equipment would be available including booms to contain surface spills at sea or protect sensitive shorelines.

With the measures in place to prevent an oil spill incident from happening and the oil spill contingency planning and response resources available to the appointed Well Operator in the event of a large oil spill event, the residual environmental risk posed by the proposed Blythe and Elgood production well operations is judged to be reduced to an acceptable level.

10.6. Overall Conclusion

The only potential significant impact identified in the environmental impact assessment is that of a large-scale condensate or diesel spill. However, the probability of such a spill is very low and mitigation and management procedures will be put in place to prevent this from happening, as well as adequate resources to deal with any such spill should it occur. All other impacts identified in the ES are expected to only have localised impacts with good recovery potential over time.

Overall, it is concluded that the environmental impacts of the proposed Blythe Hub Development will not incur any significant long lasting environmental effects.

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Section 11

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Section 12

Abbreviations

12 ABBREVIATIONS

AFEN	Atlantic Frontier Environmental Network
AMF	Automatic mode function
AONBs	Areas of Outstanding Natural Beauty
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
AUV	Autonomous underwater vehicle
BAC	Background assessment concentration
BAT	Best Available Techniques
BC	Background concentrations
BEIS	Department of Business, Energy and Industrial Strategy
BI	Birdlife International
BODC	British Oceanographic Data Centre
BOP	Blow-out preventer
CEO	Chief Executive Officer
CH_4	Methane
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CHARM	Chemical Hazard Assessment and Risk Management
CMAPP	Corporate Major Accident Prevention Policy
CO	Carbon monoxide
CO_2	Carbon dioxide
CP	Chemical Permit
CP-SAT	Chemical Permit Subsidiary Application Template
cSAC	Candidate Special Area of Conservation
DECC	Department of Energy and Climate Change
DOWFL	Dudgeon Offshore Wind Farm Limited
DP	Dynamic positioning
DPM	Diesel particulate matter
DST	Drill string test
DSV	Diving support vessel
EBS	Environmental Baseline Survey
EC	European Commission
ECD	Early Consultation Document
ECP	Environmental Care Policy
EDS	Emergency Disconnect System
EEMS	Environmental Emissions Monitoring System
EHD	European Habitats Directive
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
ENVID	Environmental Issues Identification Workshop
EPS	European Protected Species
ERRV	Emergency Response and Rescue Vessel
ES	Environmental Statement
EU	European Union
EUNIS	European Nature Information System
FEAST	Feature activity sensitivity tool
FEED	Front end engineering and design
FEPA	Food and Environment Protection Act 1985

FLO	Fisheries Liaison Officer
ft	Imperial feet
FWL	Free water level
GWP	Global warming potential
HIPPS	High-Integrity Pressure Protection System
HMCS	Harmonised Mandatory Control System
HOCNS	Harmonised Offshore Chemical Notification System
HSEQ	Health, Safety, Environment and Quality
ICES	International Council for the Exploration of the Seas
IOG	IOG North Sea Limited
IPPC	Integrated Pollution Prevention and Control
IUCN	International Union for Conservation of Nature
kHz	Kilohertz
KIS-ORCA	Kingfisher Information Service- Offshore Renewable and Cable Awareness Project
km	Kilometre
KP	Kilometre post
LAT	Lowest Astronomical Tide
LMRP	Low marine riser package
LTOBM	Low-Toxicity Oil Based Mud
LWD	Logging While Drilling
m	Metre
MA	Major Accident
MAH	Major Accident Hazard
MARPOL	International Convention for the Prevention of Pollution from Ships
MAT	Master Application Template
MBES	Multibeam echo sounder
MCAA	Marine and Coastal Access Act
MCZ	Marine Conservation Zone
MEG	Monoethylene glycol
MEI	Major Environmental Incident
MMO	Marine Management Organisation
MoD	Ministry of Defence
MODU	Mobile drilling unit
MPA	Marine Protected Area
ms^{-1}	Metre per Second
MS	Marine Scotland
MSS	Marine Scotland Science
N_2O	Nitrous Oxide
NA	Marine Traffic Survey and Navigation Assessment
NADL	North Atlantic Drilling UK Limited
NAP	National Allocation Plan
ncMPA	Nature Conservation Marine Protected Area
nm	Nautical Mile
NMHC	Non-Methane Hydrocarbons
NMP	National Marine Plan
NMPI	National Marine Plan Interactive
NNR	National Nature Reserve
NO_x	Nitrogen Oxides
O_3	Ozone

OGA	Oil and Gas Authority
OIM	Offshore Installation Manager
OMR	Offshore Marine Regulations
OPEP	Oil Pollution Emergency Plan
OPF	Organic Phase Fluids
OPPC	Oil Pollution Prevention and Control
OPOL	Offshore Pollution Liability Association Limited
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSCAR	Oil Spill Contingency and Response
OSD	Offshore Safety Directive
OSDSCR	Offshore Safety Directive (Safety Case etc) Regulations 2015
OSPAR	The Convention for the Protection of the Marine Environment of the north-east Atlantic
OSPRAG	Oil Spill Prevention and Response Advisory Group
OSRL	Oil Spill Response Limited
OWF	Offshore Wind Farm
PETS	Portal Environmental Tracking System
PEXA	Practice and Exercise Areas
PLONOR	Pose Little or No Risk (to the environment)
PMF	Priority Marine Feature
POBM	Pseudo Oil Base Muds
PON	Petroleum Operations Notice
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SAC	Special Area of Conservation
SAT	Subsidiary Application Template
SAST	Seabirds at Sea Team
SBM	Synthetic Oil Base Mud
SFF	Scottish Fishermen’s Federation
SEA	The Strategic Environmental Assessment
SEMS	Safety and Environment Management System
SG	Specific Gravity
SIMOPS	Simultaneous Operations
SMP	Shoreline Management Plan
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
SNS	Southern North Sea
SO_2	Sulphur Dioxide
SoS	Secretary of State
SOTEAG	Shetland Oil Terminal Environmental Advisory Group
SPE	Siccar Point Energy Limited
SSS	Sidescan sonar
SSSI	Sites of Special Scientific Interest
TD	Total depth
TVDSS	Total depth subsea
TDBRT	Total depth below rotary table
TOOPEP	Temporary Operations Oil Pollution Emergency Plan
UK	United Kingdom
UKBAP	UK Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf
UKHO	United Kingdom Hydrographic Office

UKOOA	United Kingdom Offshore Operators
TWT	The Wildlife Trust
VMS	Vessel Monitoring Systems
VOC	Volatile organic compounds
VSP	Vertical seismic profile
WBD	Wild Birds Directive
WBM	Water base mud
WONS	Well Operations Notification System
ZSS	Zero discharge, skip and ship

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Section 13

Glossary

13 GLOSSARY

Abandonment	To cease work on a well which is non-productive, to plug off the well with cement plugs and salvage all recoverable equipment. Also used in the context of field abandonment.
Acid rain	Precipitation of acidic pollutants, chiefly sulphur dioxide and nitrogen oxide, released into the atmosphere by the burning of fossil fuels such as oil.
Acidification	The decrease in pH of the oceans, caused by their uptake of atmospheric carbon dioxide.
Annex I Habitat	A rare or characteristic habitat which is affords protection under on the EU Habitats Directive.
Annex II Species	A rare, threatened or endemic species (not including birds), which is affords protection under on the EU Habitats Directive.
Annulus	The space between well bore and casing.
Atmospheric emissions	A collective term for gases and particulates released to the atmosphere.
Baleen whales	Whales of the suborder Mysticeti. They have plates of whalebone (a baleen) along the upper jaw for filtering plankton from the water.
Barite	Barium sulphate ($BaSO_4$).
Bathymetry	The measurement of underwater depth in ocean, seas or lakes.
Benthic	Of or relating to the seabed.
Benthos	Animals that occur on or in the seabed.
Biogenic reef	This reef may be composed almost entirely of the reef building organisms and their tubes or shells, or may include sediments, stones and shells bound together by the organism.
Block	Sub-division of territorial seas for the purpose of licensing to a company or group of companies for exploration and production rights. A UK block is approximately 200 to 250 km^2.
Blow-out	A blow-out occurs when gas, oil or saltwater escapes in an uncontrolled manner from a well.
Blow-out preventer (BOP)	A hydraulically operated wellhead device that can be actuated to close a well in order to prevent an uncontrolled release of fluids (a blow-out).
Casing	Steel lining inserted into a well as drilling progresses to prevent the wall of the hole from caving in during drilling, to prevent the inflow of unwanted fluids from surrounding formations and to provide a means of extracting oil (and gas) if a well is productive.
Cetacean	Aquatic mammals of the order Cetacea, which comprise porpoises, dolphins, and whales.
Conductor	First string of casing to be inserted and cemented into the borehole. Its purpose is to prevent the soft formations near the surface from caving in and to conduct drilling mud from the bottom of the hole to the surface when drilling starts.
Continental shelf	The Continental shelf refers to the extension of the continent into the ocean.
Copepods	Small free-living or parasitic crustaceans of the subclass Copepoda, living in marine and fresh waters. The free-living forms are an important constituent of plankton.
Cuttings	Rock chips produced by chipping and crushing action of the drill bit.
Cuttings pile	An accumulation of rock chips or formation debris, produced by the action of the drill bit, and deposited on the seabed.
dB re 1µPa-m	The sound source level measured on the decibel (dB) logarithmic scale at 1 m from the source.
Demersal	Living in the water column at or near seabed. Usually in relation to fish.
Diatoms	Unicellular planktonic algae with silica shells.
Dinoflagellates	Unicellular planktonic organisms often bearing a tough cellulose shell (theca).
Dispersant	A chemical that breaks up concentrations of oil in water, reducing the oil to small droplets (an emulsion).

Drilling mud/fluid	A mixture of base substance and additives used to lubricate the drill bit and to counteract the natural pressure of the formation.
Epifauna	Benthic organisms that live on the surface of the seabed, either sessile or free moving.
European protected species	Species listed in Annex IV of the Habitats Directive.
Field	An accumulation of hydrocarbons in the subsurface. Consists of a reservoir in a shape that will trap hydrocarbons and that is covered by an impermeable, sealing rock.
Gadoids	Fish belonging to the family Gadidae, which includes cod, haddock and whiting.
Global warming potential	A measure of how much a given mass of gas is estimated to contribute to global warming, relative to the same mass of carbon dioxide.
Greenhouse gas	Gas that contributes to the greenhouse effect. Includes gases such as carbon dioxide (CO_2) and methane (CH_4). The greenhouse effect results in a rise in temperature due to incoming solar radiation being trapped by carbon dioxide and water vapour in the Earth's atmosphere.
Hydrocarbon	A compound containing only the elements hydrogen and carbon. May exist as a solid, a liquid or a gas. The term is mainly used in a catch-all sense for crude oil, natural gas, condensate and their derivatives.
Important Bird Areas	A global network of sites for the conservation of birds and bird habitats, set up by BirdLife International.
Infauna	Animals living within seabed sediments mostly within the top 10 to 15 cm.
Macrobenthos	Animals that occur on or in the seabed and are large enough to be retained on a 500 µm or 1 mm mesh.
Nautical mile	Nautical measurement of distance, equivalent to 1.852 km or 1.15 miles.
Nephrops	Burrowing crustacean also known as Norway lobster, Langoustine, Dublin Bay prawn or scampi.
Odontocetes	Toothed whales, a suborder of cetaceans. Examples include sperm whales, beaked whales and dolphins.
Oil base mud	Drilling mud with oil as the fluid continuous phase.
Ozone	Atmospheric gas which acts as a pollutant creating smog at ground level, and in the upper atmosphere filters out ultra violet light from reaching the earth.
Pelagic	Inhabiting the water column of the sea.
Phytoplankton	Free floating microscopic plants.
Plankton	Free floating organisms found in the oceans and other aquatic systems.
Pockmarks	Craters in the seabed formed by fluids such as liquid and gas, erupting and streaming through the sediments. They can be classed as Annex 1 habitats "Submarine structures made by leaking gasses", by the Joint Nature Conservation Committee.
Polychaete	A class of marine annelid worms.
Pseudo-oil/synthetic based mud	Synthetic alternative to oil based mud, created from esters or vegetable oil.
Ramsar sites	Wetlands of international importance.
Reservoir	The underground formation where oil and gas has accumulated. It consists of a porous rock to hold the oil or gas, and a cap rock that prevents its escape.
Riser	A pipe which connects an offshore installation to a subsea wellhead or pipeline during drilling or production operations.
Site of Special Scientific Interest	Sites designated by Natural England, Scottish Natural Heritage, or the Countryside Council for Wales as being of conservational importance because of their flora, fauna, or geological and physiographical features.
Spawning	The production and release of gametes (eggs or sperm) by animals.

Special Area of Conservation	Protected sites designated under the EC Habitats Directive in order to conserve important habitats and species (excluding birds).
Special Protection Area	Sites designated by the UK Government under the EC Birds Directive to protect certain rare, vulnerable, and regularly occurring migratory species of birds.
Water base mud	A type of drilling fluid (mud) consisting mainly of water, which has additives to modify it and make it more effective.
Zooplankton	Animals which drift in the water column along with prevailing currents, mostly microscopic.

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Appendix A

Summary of Legislation

APPENDIX A SUMMARY OF LEGISLATION

The main environmental legislation regulatory requirements relevant to the proposed field development at Blythe and Elgood.

Topic	Legislation
Consenting	
Environmental Statement	Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999, as amended; Offshore Petroleum and Pipelines (Environmental Impact Assessment and other Miscellaneous Provisions) (Amendment) Regulations 2017; Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001, as amended; Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2017 (SI 2017/588); Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007, as amended; Pollution Prevention and Control (Fees) (Miscellaneous Amendments) Regulations 2016 (SI 2016/529); Pollution Prevention and Control (Fees) (Miscellaneous Amendments) (No. 2) Regulations 2016 (SI 2016/1042); Pollution Prevention and Control (Fees) (Miscellaneous Amendments) Regulations 2017 (SI 2017/404) Convention on Environmental Assessment in the Transboundary Context (Espoo Convention) 1991.
Well Consent	The Petroleum Act 1998; Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999, as amended; Well Operations Notification System (WONS); Offshore Petroleum Licensing (Offshore Safety Directive) Regulations 2015 (2015 licensing regulations); Drilling Operations MAT (DRA), Chemical Permit SAT (CP), and EIA Direction for Drilling Operations SAT (DR).
Well Test Consent	Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999, as amended; Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005, as amended; Petroleum Licensing (Exploration & Production) (Seaward and Landward) Regulations 2004; Petroleum Licensing (Production) (Seaward Areas) Regulations 2008; Convention on the Protection of the Marine Environment of the North East Atlantic 1992 (OSPAR Convention); Drilling Operations MAT (DRA), Chemical Permit SAT (CP), EIA Direction for Extended Well Test SAT (EWT).
Pipeline Consent	Petroleum Act 1998; Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999, as amended; Pipeline Safety Regulations 1996, as amended; Marine and Coastal Access Act 2009; Pipeline Works Authorisation (PWA) and consent to deposit of materials on the Seabed (DEPCON); Pipeline Operations MAT (PLA), Chemical Permit SAT (CP), EIA Direction for Pipeline Operations SAT (PL), and EIA Direction for Deposits SAT (DEP).
Consent to Locate	Marine and Coastal Access Act 2009 (MCAA); Energy Act 2008 Part 4.

Topic	Legislation
Consenting	
Platform Consents	Petroleum Act 1998; Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999, as amended; Offshore Petroleum Licensing (Offshore Safety Directive) Regulations 2015 (2015 licensing regulations); Production Operations MAT (PRA) and EIA Direction for Commencement of Production SAT (SP).
Production Consent	Petroleum Act 1998; Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999, as amended; Offshore Petroleum Licensing (Offshore Safety Directive) Regulations 2015 (2015 licensing regulations); Production Operations MAT (PRA) and EIA Direction for Commencement of Production SAT (SP).
Produced Water	Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005, as amended; Production Operations MAT (PRA) and Oil Discharge Permit (Life) SAT (OLP);
Routine Drilling Operations	
Sewage from drilling rig	MARPOL 73/78 Annex IV Prevention of Pollution by Sewage from Ships; Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008; Food and Environment Protection Act 1985 (FEPA), as amended Deposits in the Sea (Exemption) Order 1985; Convention on the Protection of the Marine Environment of the North East Atlantic 1992 (OSPAR Convention).
Oil contaminated discharges	Offshore Chemical Regulations 2002, as amended; Offshore Petroleum Activities (Oil Pollution Prevention and Control) (OPPC) Regulations 2005, as amended; Food and Environment Protection Act 1985 (FEPA), as amended; Convention on the Protection of the Marine Environment of the North East Atlantic 1992 (OSPAR Convention); OSPAR Decision 2000/3 on the Use of Organic-phase Drilling Fluids (OPF) and the Discharge of OPF-Contaminated Cuttings; OSPAR Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles.
Water based mud (WBM) cuttings	Offshore Chemical Regulations 2002, as amended; Offshore Petroleum Activities (Oil Pollution Prevention and Control) (OPPC) Regulations 2005, as amended; Food and Environment Protection Act 1985 (FEPA), as amended; Deposits in the Sea (Exemptions) Order 1985; OSPAR Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles.

Topic	Legislation
Routine Drilling Operations	
Chemical use	Pollution Prevention and Control Act 1999; Offshore Chemicals Regulations 2002, as amended; The REACH Enforcement Regulations 2008, as amended; Convention on the Protection of the Marine Environment of the North East Atlantic 1992 (OSPAR Convention); OSPAR Recommendation 2006/3 on Environmental Goals for the Discharge by the Offshore Industry of Chemicals that are, or which contain Substances Identified as Candidates for Substitution; OSPAR Recommendation 2005/2 on Environmental Goals for the Discharge by the Offshore Industry of Chemicals that Are, or Contain Added Substances, Listed in the OSPAR 2004 List of Chemicals for Priority Action; OSPAR Recommendation 2000/2 on a harmonised mandatory control system for the use and reduction of the discharge of offshore chemicals as amended by OSPAR Decision 2005/1; Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005, as amended (OPPC); Food and Environment Protection Act 1985 (FEPA), as amended; Deposits in the Sea (Exemptions) Order 1985.
Rig drainage water	Offshore Petroleum Activities (Oil Pollution Prevention and Control) (OPPC) Regulations 2005, as amended; Convention on the Protection of the Marine Environment of the North East Atlantic 1992 (OSPAR Convention); PARCOM Recommendation 86/1 of a 40 mg/l Emission Standard for Platforms; Merchant Shipping (Prevention of Oil Pollution) Regulations 1996, as amended; Merchant Shipping Act 1995; International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78; Merchant Shipping (Prevention of Oil Pollution) (Amendment) Regulations 1994.
Atmospheric Emissions from the Rig	
Turbine/combustion emissions	MARPOL 73/78 Annex VI Prevention of Air Pollution from Ships; The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008, as amended; Offshore Combustion Installations (Prevention and Control of Pollution) Regulations 2001, as amended; Climate Change Act 2008; National Emission Ceilings Regulations 2002; Pollution Prevention and Control Act 1999.

Topic	Legislation
Atmospheric Emissions from the Rig	
Halocarbons (halons, CFCs)	Ozone Depleting Substances Regulations 2015; Fluorinated Greenhouse Gases Regulations 2015; MARPOL 73/78 Annex VI Prevention of Air Pollution from Ships; The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008, as amended.
Flaring and venting	Energy Act 1976, as amended; Petroleum Act 1998, as amended; Petroleum Licensing (Exploration & Production) (Seaward and Landward) Regulations 2004; The Petroleum (Current Model Clauses) Order 1999; Climate Change Act 2008; Greenhouse Gas Emissions Trading Scheme Regulations 2005; National Emission Ceilings Regulations 2002; Waste and Emissions Trading Act 2003.
Chemical Transport	
Bulked chemicals	Environmental Protection Act 1990; Merchant Shipping (Dangerous or Noxious Liquid Substances in Bulk) Regulations 1996, as amended.
Dangerous goods	Environmental Protection Act 1990; Controlled Waste Regulations 1992, as amended; The Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997; The Waste (England and Wales) Regulations 2011.
Hazardous chemicals	Environmental Protection Act 1990; Controlled Waste Regulations 1992, as amended; Chemicals (Hazard Information and Packaging for Supply) Regulations 2009; The Waste (England and Wales) Regulations 2011.
Wildlife Protection (Offshore)	
Habitats and species	Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007, as amended; The Conservation of Habitats and Species Regulation 2010, as amended; The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001; The UK Marine and Coastal Access Act 2009.
Cetaceans	The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001, as amended; Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas 1991 (ASCOBANS); Wildlife and Countryside Act (1981); Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007, as amended.

Topic	Legislation
Waste Handling	
Transfer of oil contaminated wastes	Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005, as amended; Merchant Shipping (Prevention of Oil Pollution) Regulations 1996; Prevention of Pollution (Reception Facilities) Order 1984; Merchant Shipping and Maritime Security Act 1997.
Garbage	Food and Environment Protection Act 1985, as amended; Deposits in the Sea (Exemptions) Order 1985; Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008.
Transfer of waste/garbage from installations	Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008; Food and Environment Protection Act 1985, as amended; Deposits in the Sea (Exemptions) Order 1985; The Waste (England and Wales) Regulations 2011.
Transfer of special waste	Environmental Protection Act 1990; Controlled Waste Regulations 1992, as amended; Special Waste Regulations 1996, as amended; The Waste (England and Wales) Regulations 2011.
Radioactive waste	Radioactive Substances Act 1993 (RSA 93), as amended; Environmental Permitting (England and Wales) Regulations 2010; Radioactive Substances (Phosphatic Substances, Rare Earths etc.) Exemptions Order 1962; Radioactive Substances (Substances of Low Activity) Exemption Order 1986, as amended; Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997.
Support Vessels	
Machinery space drainage from shipping	The Merchant Shipping (Prevention of Oil Pollution) Regulations 1996, as amended; Merchant Shipping Act 1995; International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78.
Sewage from vessels	MARPOL 73/78 Annex IV Regulations for the Prevention of Pollution by Sewage from Ships; Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008; Deposits in the Sea (Exemption) Order 1985; Food and Environment Protection Act 1985, as amended.
Garbage from vessels	Food and Environment Protection Act 1985, as amended; Deposits in the Sea (Exemption) Order 1985; Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008.

Topic	Legislation
Support Vessels	
Atmospheric emissions from vessels	The Merchant Shipping (Prevention of Air Pollution from Ships) Order 2006; MARPOL 73/78 Annex VI - Prevention of Air Pollution from Ships, the regulations in this annex set limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibit deliberate emissions of ozone depleting substances; The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008.
Accidental Events (Installations)	
Oil pollution emergency planning	Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998, as amended; Offshore Installations (Emergency Pollution Control) Regulations 2002; Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995; The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005, as amended.
Spill reporting	Model Clauses of Licence; Petroleum Operations Notice no 1.
Accidental Events (Vessels)	
Spills, release or possible escape of oil, noxious substance or marine pollutant	Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998, as amended; Merchant Shipping (Reporting of Pollution Incidents) Regulations 1987; Merchant Shipping (Reporting Requirements for Ships Carrying Dangerous Polluting Goods) Regulations 1995; Petroleum Operations Notice no 1.
Decommissioning	
Well suspension and abandonment	Petroleum Act 1998, as amended; Energy Act 2008, as amended; The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005, as amended; Offshore Chemicals Regulations 2002, as amended; Offshore Chemicals (Amendment) Regulations 2011; Marine and Coastal Access Act 2009 (MCAA); Marine Scotland Act 2010; Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001, as amended; The Offshore Petroleum Activities (Conservation of Habitats) (Amendment) Regulations 2007; Petroleum (Production) (Seaward Areas) Regulations 1988, as amended; Offshore Installations and Wells (Design and Construction etc) Regulations 1996; Food and Environment Protection Act 1985, as amended; Well intervention Permit via the UK Oil Portal, FEPA licence may be required, or a Marine Licence for deposits on the seabed. A MCAA licence via the UK Oil Portal.

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Appendix B

ENVID Matrices

Appendix B – ENVID Matrices

B.1 Impact Scoping Matrix (Blythe Hub Development)

	Operational Activity	Environmental Aspects (or Sub-operational Activity)	Environmental Impacts	Receptor	Magnitude of Effect (1 to 10)	Receptor Value (1 to 5)	Significance	Comments
General Operations	**Platform and Vessel Use** (drilling rig, platform, support vessels and helicopters)							
	Fuel consumption	Fuel use by the drilling rig, platform, support vessels and helicopters	Climate change	Marine environment; coastal environment; terrestrial environment; Society as a whole	n/a	n/a	Scoped in	
			Resource use	Society as a whole (potential future users of given resource)	2	3	6	
			Air pollution	Other users of the sea (passing vessels); marine environment (birds and marine mammals)	2	4	8	
	Vessel noise (rig, platform, vessels and helicopters)	Production of sound below sea level (thrusters, propellers, engines etc)	Noise (under water)	Marine environment (marine mammals and fish)	4	5	20	
		Production of engine and machinery noise on the surface (including transfer routes)	Noise (in air)	Marine environment (seabirds and marine mammals)	2	3	6	
	Other rig/vessel activities	Use and discharge of other chemicals (e.g. rig wash)	Marine pollution	Marine environment (water column)	2	3	6	
		Resource by the crew (consumables such as furniture, electrical equipment, stationery, food, etc)	Resource use	Society as a whole (potential future users of given resource)	2	2	4	
		Generation of artificial light from drilling rig, platform and support vessels	Light pollution	Marine environment (seabirds)	2	3	6	
	Waste Management							
	Waste generation and disposal	Disposal of wastes to marine environment (macerated sewage and food waste, and bilge water)	Marine pollution	Marine environment (water column)	2	3	6	
		Disposal of general wastes onshore (non-hazardous)	Waste generation	Landscape (landfill sites)	2	1	2	Strict planning regulations prevent waste disposal sites being located in sensitive ecological locations.
			Resource use	Society as a whole (potential future users of given resource)	2	2	4	
		Disposal of hazardous wastes onshore (e.g. chemical containers)	Waste generation	Landscape (landfill sites)	2	1	2	As per comment above for onshore general waste disposal.
			Resource use	Society as a whole (potential future users of given resource)	2	2	4	

	Operational Activity	Environmental Aspects (or Sub-operational Activity)	Environmental Issue	Receptor	Magnitude of Effect (1 to 10)	Receptor Value (1 to 5)	Significance	Comments
Drilling Operations	**Mooring the Drilling Rig**							
	Installation and removal of spud cans	Disturbance to seabed	Seabed impacts	Marine environment (seabed communities)	4	4	16	Value is assumed to be 'high' until survey confirms otherwise.
	Physical presence of the rig	Physical Presence of the rig	Socio-economic impacts	Other users of the sea (shipping and fisheries)	4	4	16	
	Drilling Activities							
	General drilling activities	Use of steels, pipes, drill bits, etc	Resource use	Society as a whole (Potential future users of given resource)	4	2	8	
	Drilling of the tophole sections	Deposition of drill cuttings and associated muds directly to the seabed	Marine pollution	Marine environment (seabed communities)	4	4	16	
		Deposition of excess cement directly to the seabed	Marine pollution	Marine environment (seabed communities)	4	4	16	
	Drilling of deeper well sections	Discharge of drill cuttings and associated base mud at the surface	Marine pollution	Marine environment (seabed communities and water column)	2	4	8	
		Discharge of waste cements at the sea surface	Marine pollution	Marine environment (seabed communities and water column)	1	4	4	
	Drilling of reservoir sections	Discharge of oil contaminated pay zone cuttings and muds at the sea surface	Marine pollution	Marine environment (seabed communities, water column and seabirds)	2	4	8	Based on high angle and near vertical wells (i.e. shorter pay zone sections).
		Backloading of oil contaminated pay zone cuttings and muds for onshore treatment and disposal	Waste generation	Landscape; Local communities	2	1	2	Strict planning regulations prevent waste disposal sites being located in sensitive ecological locations.
		Containment and onshore disposal of oil base muds and contaminated drill cuttings	Waste generation	Landscape; Local communities	2	1	2	Strict planning regulations prevent waste disposal sites being located in sensitive ecological locations.
		Discharge of base oil residues during well bore clean up	Marine pollution	Marine environment (seabed communities and water column)	2	4	8	Very small amounts may be discharged.
	Wireline, logging while drilling etc	Generation of electromagnetic fields, acoustic waves, microwaves, etc	Electromagnetic radiation	Resource use	2	3	6	No ecological effects anticipated as tools will only be used deep down in the borehole.
		Use of radioactive sources	Electromagnetic radiation	Resource use	2	3	6	

	Operational Activity	Environmental Aspects (or Sub-operational Activity)	Environmental Issue	Receptor	Magnitude of Effect (1 to 10)	Receptor Value (1 to 5)	Significance	Comments
Installation and Commissioning	**Laying of Flowlines and Associated Infrastructure**							
	Laying of flowlines (pipelines, flowlines and umbilicals)	Trenching and laying of flowlines (including any backfilling)	Seabed impact	Natural environment (seabed communities)	4	4	16	The requirement of new pipeline laying operations is strongly mitigated by the re-use of the Thames pipeline (PL370).
	Installation of template, manifolds and other seabed infrastructure	Positioning of infrastructure on the seabed	Seabed impact	Natural environment (seabed communities)	4	4	16	
	Stabilisation and protection of infrastructure	Rock dumping protection of flowlines or other infrastructure	Seabed impact	Natural environment (seabed communities)	4	4	16	
			Socio-economic impact	Other users	2	4	8	
		Laying of concrete mattresses, grout bags etc for protection of flowlines or other infrastructure	Socio-economic impact	Other users	4	4	16	
			Seabed impact	Natural environment (seabed communities)	4	4	16	
	Installation of the Platform							
	Installation of platform	Installation of the platform	Seabed impact	Natural environment (seabed communities)	4	4	16	
		Underwater noise associated with piling operations	Noise	Natural environment (marine mammals)	6	5	30	
	Commissioning of Production Facilities							
	Testing and commissioning of flowlines and facilities	Use and discharge of chemicals during testing and commissioning of flowlines	Marine pollution	Natural environment (water column, plankton)	2	3	6	All chemicals related to installation to be included.
		Discharge of oily fluids during testing and commissioning of flowlines etc	Marine pollution	Natural environment (water column, plankton)	2	3	6	

	Operational Activity	Environmental Aspects (or Sub-operational Activity)	Environmental Issue	Receptor	Magnitude of Effect (1 to 10)	Receptor Value (1 to 5)	Significance	Comments
Production Operations	**Physical Presence of Development Infrastructure and Standby Vessels**							
	Physical presence of the installation and infrastructure	Ongoing presence of the installations	Socio-economic impact	Other users of the sea (wind farm, shipping and fisheries)	4	5	20	
		Ongoing presence of the flowlines and other seabed infrastructure	Socio-economic impact	Other users of the sea (fisheries)	6	4	24	
	Ongoing Production Activities							
		Deck discharges to sea	Marine pollution	Marine environment (plankton and water column)	2	3	6	Open drain system.
		Discharge of hydraulic fluids at wellhead	Marine pollution	Marine environment (seabed communities and water column)	1	3	3	
	Maintenance, Shutdown and Well Intervention Activities							
	Discharges to sea	Use and discharge of chemicals during maintenance and well intervention	Marine pollution	Marine environment (plankton and water column)	2	3	6	
		Discharge of reservoir oil contaminated fluids during maintenance and well intervention	Marine pollution	Marine environment (plankton and water column)	2	3	6	

	Operational activity	Environmental aspects (or sub-operational activity)	Environmental issue	Receptor	Magnitude of effect (1 to 10)	Receptor Value (1 to 5)	Significance	Comments
Accidental Events	**Small to medium oil or chemical spills**							
	Spillage of diesel or other oils	Diesel spill during bunkering	Marine pollution	Marine environment (All marine biota present)	4	5	20	
		Condensate spill	Marine pollution	Marine environment (All marine biota present)	4	5	20	This has been scored on an **undetected** subsea leak.
		Hydraulic fluid, lube, helifuel, waste oil spill	Marine pollution	Marine environment (All marine biota present)	2	5	10	
	Chemical spills	Wet or dry chemical spill	Marine pollution	Marine environment (All marine biota present)	2	5	10	
		Chemical spill during bulk transfer to rig or platform (e.g. mud systems)	Marine pollution	Marine environment (All marine biota present)	4	5	20	
	Large hydrocarbon spill /release							
	Diesel spill	Rupture of a diesel storage tank or associated system	Marine pollution	Marine environment (All marine biota present)	10	5	50	
			Marine pollution	Coastal environment (All coastal biota present)	10	5	50	
			Socio-economic impact	Other users of the sea (Fishing and shipping)	10	4	40	
			Marine pollution	Other users of the sea (Other industries)	6	5	30	
	Gas/Condensate spill	Well blow-out or pipeline failure	Marine pollution	Marine environment (All marine biota present)	10	5	50	
			Marine pollution	Coastal environment (All coastal biota present)	10	5	50	
			Air pollution	Other users of the sea (passing vessels); marine environment (seabirds and marine mammals)	6	4	24	
			Marine pollution	Other users of the sea (Fishing and shipping)	10	4	40	
			Marine pollution	Other users of the sea (Other industries)	10	5	50	

	Operational Activity	Environmental Aspects (or Sub-operational Activity)	Environmental Issue	Receptor	Magnitude of Effect (1 to 10)	Receptor Value (1 to 5)	Significance	Comments
Accidental Events (continued)	**Other Accidental Events**							
	Loss of vessel	Catastrophic loss of rig, platform, various vessels or helicopter	Resource use	Society as a whole (Potential future users of given resource)	4	2	8	
			Socio-economic impact	Other users of the Sea (Fishing and shipping)	4	4	16	
			Marine pollution	Marine environment (Seabed communities)	4	3	12	
	Collision	Collision between rig, platform or vessels and passing vessel	Socio-economic impact	Other users of the Sea (Fishing and shipping)	4	4	16	
	Dropped objects	Loss of objects overboard (e.g. containers or pipes)	Marine pollution	Other users of the sea	2	4	8	
	Damage caused to infrastructure	Potential damage to flowlines, cables and other subsea infrastructure	Socio-economic impact	Other users of the sea	4	5	20	
	Fire	Fire on platform, drilling rig or vessel	Air pollution	Other users of the sea (passing vessels); marine environment (birds and marine mammals)	2	4	8	
			Resource use	Society as a whole (Potential future users of given resource)	2	2	4	
		Use of firefighting equipment including fire water run off	Marine pollution	Marine environment (water column)	2	3	6	