TotalEnergies

Alwyn East

Environmental Statement

Doc Ref: BUS-191120-160440

Distribution:

BEIS, JNCC, Marine Scotland, MCA, CEFAS

<table>
<tr><td colspan="2" rowspan="2">Authorisation Record</td><td>Principal Environmental Consultant</td><td>Senior Environmental Engineer</td><td>NNS HSE Manager</td></tr>
<tr><td colspan="3" rowspan="2">[redacted]</td></tr>
<tr><td>A05</td><td>23/09/2021</td></tr>
<tr><td>Rev</td><td>Date</td><td>Prepared by</td><td>Reviewed by</td><td>Approved by</td></tr>
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Rev	Date	Revision History
R01	09/03/2021	Draft – Issued for Review
R02	15/04/2021	Near-final Draft for Submission to BEIS for Review
R03	11/08/2021	Draft – Reissued for Review
A04	15/09/2021	Issued for Use
A05	23/09/2021	Re-Issued for Use

TotalEnergies E&P UK Limited

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ENVIRONMENTAL STATEMENT DETAILS

Section A: Administrative Information

A1 – Project Reference Number

Please confirm the unique ES identification number for the project

Number: **D/4264/2021**

A2 – Applicant Contact Details

Company name:	TotalEnergies Exploration and Production Ltd
Contact name:	[redacted]
Contact title:	[redacted]

A3 – ES Contact Details (if different from above)

Company name:	As above
Contact name:	As above
Contact title:	As above

A4 – ES Preparation

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

Name	Company	Title	Relevant Qualifications/Experience
[redacted]	TotalEnergies E&P UK Ltd	[redacted]	All personnel involved in undertaking the impact assessment hold relevant environmental qualifications from recognised academic institutions and include those holding accreditation from the Institute of Environmental Management and Assessment (IEMA).
	TotalEnergies E&P UK Ltd		
	Xodus Group		
	Xodus Group		
	Xodus Group		
	Xodus Group		

A5- Licence Details

a) Please confirm licence(s) covering proposed activity or activities

Licence number(s): P90

b) Please confirm licensees and current equity

Licence Number: P1970	
Licensee	**Percentage Equity**
TotalEnergies Exploration and Production UK Ltd	100%

Section B: Project Information

B1 – Nature of Project

a) Please specify the name of the project

Name:	Alwyn East Environmental Statement

b) Please specify the name of the ES (if different from the project name)

Name:	As above

c) Please provide a brief description of the Project

As part of the field life-extension strategy in the Alwyn Area, it is planned to produce hydrocarbons from the Alwyn East field. Alwyn East will be developed using extended reach drilling, executed from the existing Alwyn North Platform. If successful, this would result in an increase in production from a new field (Alwyn East) from the Alwyn platform. The production estimates are above 500,000 m^3 of gas and above 500 tonnes of oil per day based on the future production baseline.

B2 – Project Location

Please indicate the offshore location(s) of the main project elements.

Quadrant number(s):	3
Block number(s):	9a
Latitude: 60° 48’ 33.33" N	Longitude: 01° 44’ 14.77" E
Distance to nearest UK coastline (km):	136
Which coast?	Scotland
Distance to nearest International median line (km):	9
Which line?	UK/Norway

B3 – Previous Applications

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

Name of project:

Date of submission of ES:

Identification number of ES:

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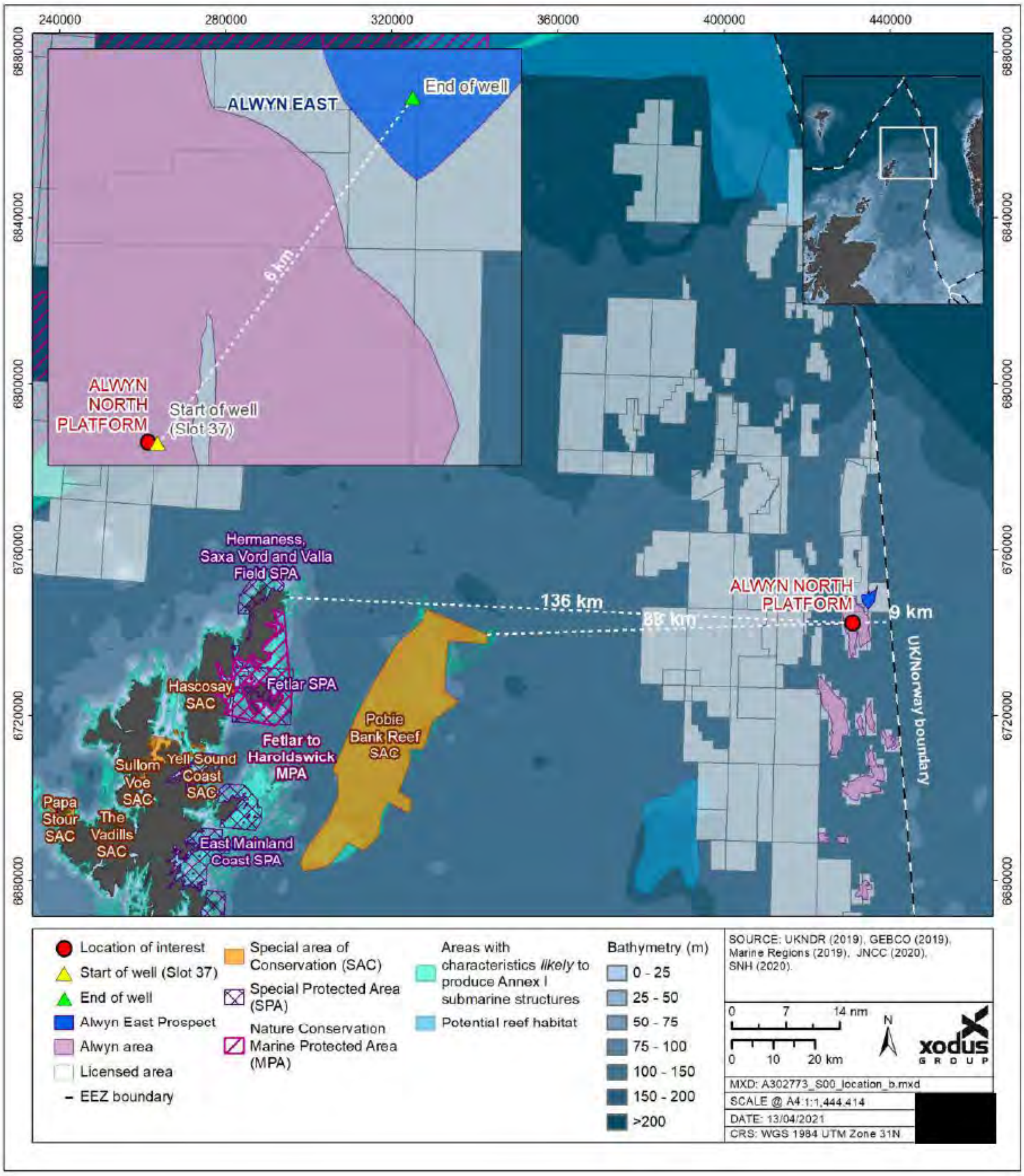
NON-TECHNICAL SUMMARY

INTRODUCTION

This Environmental Statement (ES) presents the findings of the Environmental Impact Assessment (EIA) conducted by TotalEnergies Exploration and Production UK Ltd (herein referred to as TEPUK) for the development of the Alwyn East Field. The Alwyn East field, which is operated by TEPUK, is located in the Northern North Sea (NNS) in United Kingdom Continental Shelf (UKCS) Blocks 3/04b, 3/04g and 3/05a. The field is located approximately 5.8 km north east of the Alwyn North platform (situated in Block 3/09). The Alwyn field is located approximately 136 km east of Shetland and 9 km from the UK/Norwegian median line in a water depth of 130 m (Figure 0-1).

Figure 0-1 Location of the Alwyn East Field



The Alwyn Area development in the NNS is comprised of 8 producing fields: Alwyn North, Dunbar, Ellon, Grant, Nuggets, Forvie North, Jura and Islay. The Alwyn North platform, located in UKCS Block 3/9a (Figure 0-1), is the hub and support centre for these fields, supplying them with power and water injection support while simultaneously receiving produced water, oil and gas via a network of subsea cables and pipelines. Alwyn North (Alwyn) consists of two platforms, North Alwyn Alpha (NAA) and North Alwyn Bravo (NAB), which are linked by a bridge. The Dunbar platform processes fluids from the Dunbar, Grant and Ellon fields and is tied back to Alwyn by pipeline. The Alwyn Area is therefore produced by a mix of platform wells (Alwyn and Dunbar) and subsea tie-backs (other fields). Alwyn East will be drilled from the NAA platform and will be produced directly into the Alwyn North platform facilities; therefore no seabed infrastructure is associated with the drilling and production from Alwyn East.

Production from these fields is combined at Alwyn and processed to produce gas and oil for export. Gas is exported into the Frigg UK gas pipeline (FUKA) to the St Fergus Terminal, in Aberdeenshire. Oil is exported to the Cormorant Alpha platform and then onto the Sullom Voe Terminal (SVT), in Shetland via the Brent System pipeline.

As stipulated in the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020, consent for the extraction of 500 tonnes or more per day of liquid hydrocarbons (e.g. oil, condensate) or 500,000 cubic metres (m^3) per day of gas must be supported by a full EIA and submission of a statutory Environmental Statement (ES). It is expected that production from the new Alwyn East field will be above these thresholds and an EIA is therefore required. This ES reports the findings of the EIA conducted by TEPUK to support the Alwyn East application for the drilling and associated production of a new well at Alwyn East.

ALTERNATIVES

The Alwyn East project sits within a portfolio of Alwyn Area development opportunities, which may be subject to future applications for development. Should they be developed, these projects are expected to yield a positive benefit by unlocking further hydrocarbon reserves in the area, enabling an extension of economic Cessation of Production (CoP). Constraining production to the currently consented levels could compromise efforts by TEPUK to maximise economic recovery of hydrocarbons from the Alwyn Area. TEPUK have thus considered two options for the future of the Alwyn area, which involve either continuing production at the consented levels or maximising economic recovery of this area, initially by drilling a new well into the Alwyn East field.

If the Alwyn East well is not drilled and therefore production is constrained to the presently approved values for the fields in the Alwyn Area, then the short-term forecast revenue from the field would be limited. Although the production could be realised in the longer-term, the short-term restriction in cash flow could make the field a less economically attractive proposition to maintain, and there exists the possibility that the decision could be taken to bring forward Cessation of Production (CoP). Although this is by no means a likely outcome, the alternative to increased production (to limit production to current consented values) is not the preferred option for TEPUK to pursue.

Two methods were considered for drilling the Alwyn East well: drilling a new subsea well using a mobile offshore drilling rig and drilling an extended-reach drilling (ERD) well from the Alwyn NAA platform. The latter option (ERD) makes use of an existing well slot (N43) to drill a sidetrack, which means that the project will occur within the physical footprint of the existing development and no additional subsea infrastructure is required. Drilling from the existing platform is also the safest, fastest and most economical method to develop the available resources. From the platform, production would be able to begin almost immediately (in the success case) as no new subsea facilities would be required (such as for a subsea well) and minimal topsides modifications on Alwyn are required to process Alwyn East production.

The other drilling option considered (drilling a new subsea vertical well from a new location via a standalone drilling rig) involved mooring a drilling rig at the new well location, installing a new subsea wellhead, drilling the well and installing new pipelines to tie-back the well to the existing platform. Whilst the duration to drill a subsea vertical well is likely to be shorter than that to drill a deviated well from Alwyn, this option would have a greater environmental impact with regards to seabed disturbance and atmospheric emissions.

Drilling via extended reach methods also allows all cuttings generated from the well to be either returned to the platform and recovered to shore or re-injected, whereas for a new subsea vertical well it would not be possible to retrieve the cuttings from the first two well sections (as there would be no riser in place); these would be discharged at the seabed during drilling. The chosen ERD option will not generate any discharges of drill cuttings to sea and therefore no seabed impacts are expected.

PROJECT DESCRIPTION

TEPUK plans to drill a new well at Alwyn East. Alwyn East is located approximately 5.8 km from the existing Alwyn NAA platform. The Alwyn East well will be drilled from the existing N43 wellbore, located at the NAA platform as a deviated secondary wellbore with a different target to the original wellbore (also known as a sidetrack). The deviated well will have a horizontal offset of 5.7 km and a planned maximum depth of approximately 4,836 m. This directional drilling technique used to drill the deviated well is called ERD. The existing wellhead at NAA will be utilised and consequently, no new subsea facilities will be required within the Alwyn East field. The drilling campaign is planned for 2022 and will take up to 175 days (this is a worst-case estimate and includes contingency for weather downtime). First oil is expected by September 2022.

Once the Alwyn East well is brought online, it is expected that production will exceed the thresholds as provided in the EIA Regulations. The proposed additional production from the Alwyn East field (oil and/or gas) does not exceed historic production levels from the Alwyn platform. The maximum achievable forecast production for Alwyn East would result in a peak in gas production over six consecutive years from 2023 to 2028 with 1,500,946 m^3/day of gas being produced. Peak forecasted oil production for Alwyn East is estimated over four consecutive years from 2023 to 2026, with 1,161 m^3/day (equivalent to 928 tonnes/day) produced. In the most optimistic forecast scenario the Alwyn East field remains potentially able to flow until 2040 although overall production values for Alwyn East are expected to decrease from 2030 onwards. The economic recovery of Alwyn East reserves will be determined by the overall minimum production rate of the Alwyn Area that can sustain economic operation of the Alwyn Area facilities.

The N43 well has previously been plugged and abandoned by placement of a cement plug in the wellbore at the 13⅜" casing shoe. The Alwyn East sidetrack is planned to consist of two sections that will be drilled with Oil-Based Mud (OBM). The first section will be started below the previously drilled 17½" section, above the cement plug. A new 12¼" section will then be drilled using OBM. Following the drilling of this section, a 9⅞" casing will be cemented in place to provide stability to the well and prevent any flow of fluids from the wellbore into the surrounding rock formation. An 8½" section will then be drilled, again using OBM. Based on the results from measurements and samples, a decision will be made to either complete or abandon the well. If the well is found to have economically recoverable hydrocarbons, it will be completed as a production well. Once the Alwyn East well has been completed, a compact housing and an assembly of valves, spools, pressure gauges and chokes (known as a Xmas tree) will be fitted to the existing wellhead at the NAA platform. The well will then be cleaned up (see below) and kept as a producing well on the NAA platform.

If the 8½" section fails to penetrate the reservoir, a 7" liner will be cemented within the 8" section. The planned contingency 6" section will then be drilled to a length of 760 m (2,493 ft) and 4½" liner will be cemented in place. However, in the event that the well is a dry hole and there is no flow of reservoir fluids, the well will be abandoned.

Mud and cuttings from all three OBM sections will be returned to the Alwyn platform and will either be shipped to shore for treatment and disposal (base case) or injected into the cuttings re-injection (CRI) disposal well. As this well is a sidetrack of an existing well starting below the previously drilled 17½" section there will be no deposit of excess cement on the seabed around the wellhead, as is often the case with a new subsea well. Following cementing operations there may be a small discharge of very diluted residual cement slurry from the cement unit on the platform following cleaning.

The specific chemicals and additives used during drilling and cementing will be dependent upon the drilling mud and cement packages, which will be designed specifically for the well. Use will also vary depending on the exact down-hole conditions experienced during drilling.

After the well has been drilled and completed, it will be cleaned up and tested via the test separator. Drilling mud will be displaced from the well. The wastewater generated will be routed to a test separator to allow hydrocarbons to be separated from the water, which will be re-injected or discharged overboard if the produced water re-injection system is unavailable. Hydrocarbons will be routed to the production train. Seawater returns will be sampled in line with permit conditions. Once the seawater returns are within specification for discharge, they will be routed directly overboard to sea. Samples of discharged water will be taken at regular intervals for analysis in accordance with Oil Pollution Prevention and Control (OPPC) Regulations.

After the well has been cleaned up, the well will be tested for a period of approximately 24 hours, during which time approximately 128 tonnes of gas will be flared. No extended well test will be conducted.

A number of the platform wells on Alwyn have "live annuli" in which they are subject to hydrocarbon ingress over time. Assuming the Alwyn East well also has live annuli, it will be necessary to maintain the annuli in their correct operating windows for well integrity, by performing periodic bleed offs during well start up to remove excess gas from the annuli to vent. It is anticipated that there will be a maximum of 4 annuli bleeds per day and a total of 2.2 tonnes of gas vented. There is no venting expected during production phase, as no leak off testing will be required.

A drilling package upgrade will be undertaken on the NAA platform, as part of enabling works for upcoming drilling campaigns, including Alwyn East and other potential wells. A new top-drive system (TDS) and variable frequency drive (VFD) will be installed on NAA to support ERD. The upgraded TDS will be installed on North Alwyn's drilling derrick. Since the upgraded TDS is not compatible with the existing VFD, a new suitable VFD will be installed as a standalone unit on the main pipe deck. The only other modifications required on the existing topside facilities are minimal.

If hydrocarbons are encountered at Alwyn East, oil will be mixed with fluids from the other fields producing into Alwyn and processed through the separation facilities on the NAB platform before being exported via the Cormorant Alpha pipeline to SVT. Gas will be processed though the gas separator on NAB prior to export to St Fergus via the St Fergus Terminal pipeline system.

Alwyn has a produced water re-injection system (PWRI). Discharges of produced water to sea occur at Alwyn only during periods when the PWRI system is unavailable. The increase in produced water associated with the proposed Alwyn East well will be within the capacity of the existing produced water handling facilities at Alwyn. PWRI facilities normally operate at worst-case 90% efficiency, and therefore, as a worst-case it is considered that 10% of the produced water is discharged overboard.

Power generation at Alwyn consists of four gas turbine driven generators, located on the NAB platform. These generators provide power generation for both NAA, NAB and Dunbar platforms. The Alwyn Area fields and associated NAA and NAB platforms were originally designed for greater production, hence the original need for four generators. In the second half of 2020, an initiative commenced to facilitate the running of only two gas turbine generators as much as possible during normal operations as part of long-term carbon footprint reduction plan. Two generator operation is now the base case.

However, due to the requirement for very high reliability of additional power during critical drilling phases, a third generator will need to be run for some of the Alwyn East drilling campaign so that it can be completed safely. Once drilling is complete, the platform is expected to revert back to running on two generators as an optimum scenario again.

The types of chemicals used to treat produced fluids from the Alwyn East field are not anticipated to change compared to the existing chemicals on the Alwyn platform, therefore no new chemicals will be required. However, it is likely that increased volumes of some process related chemicals will be required in line with the additional production increase.

Total produced fluids on the Alwyn platform are forecast to remain within the capacity of the existing facilities. The current compressors have the capacity to handle the additional production and as such, no modifications will be necessary, and only one export compressor is expected to be required online for the duration of production.

The base flare, required for safe and efficient operation of the process facility and flare system under normal operating conditions, is approximately constant and is not significantly influenced by Alwyn East coming online. However, over the first two years of production from Alwyn East (2023/24) there are expected to be up to four well start-ups per year following planned or unplanned well shutdowns. During start-ups, it is estimated that there will be up to 25 tonnes of gas flared when methanol is being injected for hydrate management. After two years, it is expected that the well pressure will have depleted such that methanol is not required for hydrate management and thus flaring is not required for restarts.

During the production phase venting will only occur during *ad hoc* maintenance operations which will not increase in frequency as a result of Alwyn East, therefore no changes are expected.

During the drilling campaign, there will be a small number of additional flights for transferring personnel, though these will be minimised as far as possible. There will also be a small number of additional supply vessels to transport equipment to the platform and ship muds and cuttings back to shore. During the operational phase, there will be no requirement for additional vessel trips or helicopter flights to what is currently deployed at the platform.

The Alwyn East field is expected to be able to produce reliably out to 2040 and will likely continue producing until the end of life of the wider Alwyn Area development, with all the infrastructure being decommissioned as a whole. Some of the older Alwyn wells are due to be plugged and abandoned starting from around 2024. CoP has not been defined yet but is likely to be earlier than 2040. The Alwyn East well will eventually be plugged and permanently abandoned in accordance with relevant legislation and guidance. As the well will be drilled from the Alwyn platform there will be no additional subsea infrastructure to be decommissioned.

ENVIRONMENTAL SENSITIVITIES

Plankton	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The increase in phytoplankton productivity reaches its peak between May and August in the NNS. Levels fall in June but remain elevated during the summer months before a sharp decline in October. Zooplankton provide an important source of food for many fish and marine mammal species.												
Benthos	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Surveys within the greater Alwyn area showed two broad types of surficial sediment present; these were 'silty sand with shell fragments and pebbles' and 'coarse sand with pebbles, cobbles and boulders'. Species present include sea urchins, sea stars and hermit crabs, occasional squat lobsters, anemones, cup corals, brittle stars, worm tube worms, sea potatoes and polychaete worms. This is expected to be representative of the benthic habitat at Alwyn East. There are no known Annex II and Annex I seabed species or habitats, Priority Marine Features (PMFs) or OSPAR (Oslo Paris Convention) habitats and species in the greater Alwyn area.												
Finfish and shellfish	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The Alwyn East field is located within the nursery grounds for a number of commercially important fish species including anglerfish, blue whiting, haddock, European hake, herring, ling, mackerel, Norway pout, sandeels, spurdog and whiting. The area is also located in an area of spawning grounds for cod, Norway pout, whiting, haddock and saithe.												
Birds	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The following bird species have been recorded within the vicinity of Alwyn East: northern fulmar, northern gannet, Arctic skua, great skua, black-legged kittiwake, great black-backed gull, common gull lesser black-backed gull, herring gull, glaucous gull, Arctic tern, common guillemot, razorbill, little auk and Atlantic puffin. Seabird sensitivity in the region of the Alwyn East field is medium in May and June, then low throughout the rest of the year.												
Cetaceans	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Atlantic white-sided dolphins, harbour porpoise, minke whale, long-finned pilot whale and white-beaked dolphins have been recorded in the vicinity of the Alwyn East field. Sightings are in moderate densities in February, June and December, increasing to high in July, August and September.												
Conservation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
There are no designated sites or protected areas within 40 km of Alwyn East. Additionally, there were no Annex II species observed during the surveys in the Alwyn area. All species of cetaceans observed within the vicinity of the field are listed as European Protected Species (EPS) as well as PMFs. Several species of fish observed to be present in the International Council for the Exploration of the Sea (ICES) rectangle 50F1 are also considered to be PMFs. However, due to the mobile nature of these species and the nature of the operations, no impacts to these species are envisaged. Additionally, the proposed operations are remote from sensitive breeding areas on the coastline. Due to this distance (136 km) from the shoreline no onshore conservation sites are deemed to be at risk.												
Other sea users	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The waters surrounding Alwyn East are targeted for demersal species. Fish landings and effort are considered to be relatively low, comprising <1% of the UK total in 2020. The closest existing active oil and gas infrastructure to Alwyn East will be the NAA, and the Ninian and Strathspey fields (located approximately 15 and 11.4 km respectively from the Alwyn platform). There are no existing or planned renewable projects within the vicinity. While Alwyn East does lie within an area of concern to the Ministry of Defence (MoD), due to the nature of the operations, there is no requirement for additional notifications to the MoD. There is one wreck located in Block 3/04, although it is not considered to be at risk, nor is it a danger to the proposed activities, due to its distance and the nature of the operations.												

Air Quality			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Previous modelling assumed that each turbine was operated under maximum load. For both gas and diesel fuel combustion predicted NO_2, SO_2 and CO concentrations were lower than background concentrations and therefore did not approach local air quality thresholds for these pollutants used onshore. The current turbine load and the number of turbines operating is less than that previously modelled. Therefore, it is considered that the previous modelling will provide an over-estimate of ambient pollutant concentrations compared with current operation but sits within the operational envelope previously modelled with the existing modelling capturing the potential worst-case impacts on local air quality resulting from the platform.														
Key: Sensitivity level	High	Moderate	Low	Negligible										

ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

The EIA process requires an understanding of the proposed project and the environment upon which there may be an impact. Fundamental to the process is the systematic identification of issues that could impact the environment, including other users of the environment. Once identified, these issues have to be assessed to define the level of potential impact they present to the environment, so that if necessary, measures can be taken to remove or reduce such effects through mitigation.

TEPUK informed the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) of the new Alwyn East field in August 2019 and updates on the timing of the drilling campaign have been provided at regular intervals since then.

Identification of the potential implications from the proposed drilling campaign and additional production from Alwyn East has been undertaken and the issues requiring assessment as part of the EIA have been identified below. The potential impact sources that have been assessed in the EIA are:

- Discharges to sea;
- Atmospheric emissions; and
- Accidental events.

A number of other potential impacts were scoped out of the EIA due to the scope of the proposed operations and the limited potential for interaction with sensitive receptors. These include:

- Seabed disturbance;
- Physical presence and impacts on other sea users; and
- Underwater noise.

The potential for cumulative impacts has also been assessed, as was the potential for transboundary impacts. Information was provided to allow the Competent Authority to perform an Appropriate Assessment of the implications of the project on European sites (Special Areas of Conservation (SACs) and Special Protection Areas (SPAs)) in view of site conservation objectives and the overall integrity.

Environmental impact significance was assessed with reference to the following guidance:

- Institute of Ecology and Environmental Management (IEEM) guidelines for marine impact assessment;
- Marine Life Information Network (MarLIN) species and ecosystem sensitivities guidelines;
- Scottish Natural Heritage (SNH) handbook on EIA;
- Institute of Environmental Management and Assessment Guidelines for EIA; and
- OPRED EIA Guidance 'The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 – A Guide' (rev 03, July 2021).

The following supporting studies were used to inform the assessment:

- Accidental hydrocarbon release modelling.

ATMOSPHERIC EMISSIONS

Atmospheric emissions have the potential to impact air quality on a local and regional scale, increase the prevalence of acid rain and contribute to global greenhouse gas emissions and climate change. Primary sources of atmospheric emissions on Alwyn are fuel gas consumption and flaring. In 2020 these contributed 87% (82% from fuel gas and 5% from diesel) and 12% to overall atmospheric emissions, respectively. There will be additional energy requirements as a result of the drilling and commissioning of the Alwyn East well.

Atmospheric emissions will temporarily increase as a result of drilling the new well at Alwyn East, due to the need to run a third power generator, as well as emissions from supply vessels, helicopters, well annuli venting and flaring during well test and start-up. The requirement for a third generator will be managed to ensure emissions are optimised wherever possible.

Furthermore, the increase in production from Alwyn East will result in at most, very small additional power requirements due to certain process conditions during the production phase. Once drilling is complete, the platform is expected to revert to normal operations, running on two generators (generally at the same load as before). The electrical power requirements on the platform during routine operations are made up from the requirements of various sub-systems on the platform including life-support systems (HVAC, lighting, galley), navigation aids, process (e.g. pumps), export (e.g. gas compression) and PWRI. In addition, many of these systems run more efficiently above a minimal level of production. The addition of Alwyn East fluids to the platform will not increase the power requirements of the platform (and therefore atmospheric emissions) in an easily quantifiable extent above pre-Alwyn East requirements; whilst the load on the equipment (both GTGs and compressor) may increase at times, the increase in the efficiency of the equipment at these higher loads will mean that there is not a proportional increase in emissions. In addition, the recent change in routinely running 2-out-of-4 power generation turbines compared to 3-out-of-4 has made a major step change in emissions reduction on the platform in the last two years. Production will remain within the current capacity of the Alwyn platform, therefore no additional compressors or pumps are required.

The quantity of gas flared during operational load flaring events is not expected to change as a result of Alwyn East commencing production. Operational load flaring is not an approach used on Alwyn when a gas export route is not available, however from experience on other Alwyn wells, four additional well start-ups per year are expected to be required during the first two years of production as a result of planned or unplanned well shutdowns; a maximum of 25 tonnes of gas would be flared on each occasion.

Carbon intensity is commonly used in the oil and gas industry as a metric to compare the greenhouse gas emissions between developments. Carbon intensity is a ratio of the greenhouse gases emitted by the development per unit time (expressed as carbon dioxide equivalents) to the energy produced by the development per unit time (expressed as Barrels of Oil Equivalent). A lower carbon intensity indicates a more efficient production of hydrocarbons (energy) with respect to the release of greenhouse gases. The forecast carbon intensity of the Alwyn area clearly shows that the production of Alwyn East significantly reduces the carbon intensity of production from Alwyn over the short to medium term. This demonstrates that the inclusion of Alwyn East results in a more efficient use of energy to produce the hydrocarbons and operate this platform until CoP of the Alwyn area.

Overall, despite the increase, when compared to emissions on a UK-wide scale, the atmospheric emissions associated with Alwyn East are minimal and do not contribute significantly to the UK carbon emissions budget. Given the temporary and limited nature of the majority of the atmospheric emissions from the Alwyn East drilling campaign, as well as the limited additional emissions once production has started, it is not expected that atmospheric emissions will negatively impact local air quality or result in significant local cumulative impacts. In addition, there are no sensitive receptors with respect to local air quality in the vicinity of the Alwyn platform and the area of influence of any additional local air quality pollutants will be localised to this area.

In terms of global climate change (i.e. cumulative and transboundary impacts), the drilling of the Alwyn East well will add a relatively small increment to the overall offshore emissions of the UK and the release of greenhouse gases into the environment. Consequently, its contribution to global warming will be negligible in relation to those from the wider offshore industry and outputs at a national or international level.

DISCHARGES TO SEA

The detailed use and discharge of all chemicals to be used during the drilling of Alwyn East will be assessed (using the Chemical Hazard Assessment and Risk Management (CHARM) system where appropriate), with the results of the well-specific chemical risk assessments being submitted in an application for a Chemical Permit prior to drilling operations commencing. However, discharges to sea during the drilling of the Alwyn East well will be significantly lower than the discharges expected from drilling a new well due to the fact that it is a sidetrack from an existing well on the Alwyn platform. The OBM used to drill the well and the cuttings generated will not be discharged to sea as they will either be back loaded to shore or disposed of via CRI should poor weather not allow skip and ship. Cement will be used for the well casings and liner, however since it is a sidetrack from an existing well there will be no deposit of cement around the wellhead.

Produced water can contain small amounts of reservoir hydrocarbons (oil), dissolved organic and inorganic compounds present in the geological formation and chemicals added during the production process. These components have the potential, if they are not managed appropriately, to impact upon the quality of the water column. However, the discharge of produced water to sea as a result of the production from Alwyn East poses a limited environmental risk since the majority of produced water at Alwyn is re-injected via the PWRI system, which significantly reduces produced water discharges. Whilst the proposed additional production from the Alwyn East field will result in an increase in the volume of produced water processed and discharged from the Alwyn platform, and consequently a higher actual quantity of oil-in-water discharged to sea on an annual basis, the increase will be minimal; in 2022 the produced water from Alwyn East is predicted to be approximately 6,935 m^3/year, representing <0.5% of the overall Alwyn produced water volumes (2,054,220 m^3/year). In 2023, the predicted produced water production from Alwyn East is predicted to be approximately 23,360 m^3/year within a total volume from Alwyn of 2,594,055 m^3/year, representing 0.90% of the total produced water at the platform. There will be no change to the produced water handling strategy at the Alwyn platform as a result of the production from Alwyn East. As TEPUK will be maximising the use of the PWRI system, the volume of produced water actually discharged overboard will be significantly lower than this; estimated volumes for 2022 and 2023 are 38,340 m^3/year and 51,881 m^3/year respectively (these estimates were made in January 2021 for the annual permit revision and so may be subject to revision).

Additionally, whilst chemical management will not change as a result of the additional production at Alwyn East (i.e. there is not expected to be any requirement for the use of additional chemicals), there is likely to be a small increased volume of chemical use and discharge as a result of the production from Alwyn East.

These discharges will be managed in accordance with the relevant permitting system. The very small increases in oil-in-water and chemical discharges will be minimal and insignificant in the context of the UKCS. Considering the limited increase in oil and chemical discharge resulting from the proposed drilling campaign and additional production from Alwyn East, and the low sensitivity of the receiving environment, as well as the fact that any additional discharge will be dispersed rapidly and widely in the marine environment, the impact is considered minor and not significant.

ACCIDENTAL EVENTS

The potential impact of any accidental hydrocarbon or chemical release will be determined by the location of the release, characteristics and weathering properties of the released material, the direction of travel and whether environmental sensitivities lie in the path of the release. These environmental sensitivities will have spatial and temporal variations. Therefore, the likelihood of any accidental release having a potential impact on the environment must consider the likelihood of occurrence against the probability of that hydrocarbon or chemical reaching a sensitive area and the environmental sensitivities present at that time.

Sources of accidental events include blowouts and well releases, structural failure, accidental releases from support vessels (via bunkering or collision), dropped objects and natural disasters. Accidental events associated with dropped objects and natural disasters are highly unlikely due to the scope of work being undertaken on the Alwyn platform and the location of Alwyn East. However, a hydrocarbon major environmental incident (MEI) at Alwyn from a well blowout could have major consequences. Stochastic modelling for a well blowout determined that such an event could cause severe surface and shoreline oiling. However, this was in an unconstrained scenario where no mitigation measures were in place and no response initiated in the event of a blowout.

Although the probability of an unplanned event occurring at Alwyn East and resulting in a MEI is remote, even with comprehensive prevention measures in place, a potential impact to the marine environment remains. This is recognised to be true for the offshore oil and gas industry in general. TEPUK will ensure appropriate response plans and mitigation measures are in place to address these risks. All activities will be covered by the appropriate Oil Pollution Emergency Plans. The consequences associated with such an event would be significant and would affect a number of protected conservation areas within UK waters and along the coast. However, given the measures in place to prevent and mitigate such a scenario and the unlikely possibility of a MEI occurring, the environmental risk has been deemed minor. Overall, accidental events are not thought to be a significant impact associated with the drilling and production at Alwyn East.

ENVIRONMENTAL MANAGEMENT

TEPUK's overall aim is to minimise environmental impact wherever operations are carried out. It is also recognised that this has to be achieved alongside the need to meet increasingly rigorous environmental standards, both regulated and self-imposed. It is TEPUK's policy to comply with all legal requirements and TotalEnergies Company policies. TEPUK supports this overall aim with an environmental policy which encourages a positive Safety, Health, Environment and Integrity culture. TEPUK's Health, Safety, and Environment (HSE) Policy and UK legislation jointly impose responsibilities on management, supervisors and individual employees for which they will be held accountable. Various groups and processes are in place within TEPUK that support this.

Together with society, TotalEnergies is committed to achieving carbon neutrality - net zero - by 2050 across its global business. TotalEnergies' ambition to become a responsible energy major means it needs to meet growing energy demand whilst responding to the climate change challenge: reducing carbon emissions and minimising the environmental impact of operations. TotalEnergies is committed to reducing the greenhouse gas (GHG) emissions and improving the energy efficiency of its installations to meet Net-Zero ambitions by 2050. Whilst there are emissions associated with the drilling of the Alwyn East well, TEPUK is working with contractors to reduce emissions and optimise operations where possible. It is anticipated that there will be a very small increase in emissions on the Alwyn facility during the production phase of Alwyn East from the well start-ups in the first two years as well as potential additional power requirements at times due to certain process conditions. However, increases in power requirement caused by the increased fluids are expected to be very small and difficult to accurately quantify above current baseline requirements as the plant is expected to operate more efficiently with increased production. A worst-case assumption regarding the frequency of using a third power generator and the additional load has been used throughout the impact assessment to allow a worst-case assessment to be made. It should however be noted that, TEPUK will run the platform on two generators whenever possible and are also applying a range of carbon saving measures across the platform. It is therefore anticipated that in reality emissions will show no great change from those reported in recent years (i.e. 2020). Alwyn NAA has sufficient capacity within the current normal operation of plant that the carbon intensity of production is predicted to decrease with the increased production rates.

TEPUK's environmental policy is underpinned by the company Environment and Energy Management System (E&EnMS), embedded in which is the achievement of continuous improvement in environmental performance. The E&EnMS provides a framework to ensure compliance with environmental legislation, the prevention of pollution, and achievement of continuous improvement of environmental performance. It also provides the framework to promote an overall reduction in energy use, energy costs and greenhouse gas emissions. The E&EnMS has achieved third party certification against the internationally recognised EMS standards ISO 14001 and also ISO 50001; TEPUK is the first energy major in the UKCS to achieve this.

The mitigation and management measures that TEPUK commits to, through the EIA process, will be collated, and progress against them will be tracked. This will also include any further commitments that arise out of the regulatory review of this ES and the stakeholder consultation process.

CONCLUSIONS

The drilling of a new well at Alwyn East (drilled from the Alwyn platform) and the additional production of gas and oil as a result of this new well are associated with potential environmental impacts. The environmental issues identification process conducted for this EIA has identified potential impacts from increased atmospheric emissions, additional discharges to sea and accidental events from the proposed activities.

Drilling activities and new production from the Alwyn East reservoir will result in a limited quantity of chemicals being discharged to sea as part of the drilling operations. A small increase in water production will also occur, as well as potentially slightly greater volumes of produced water being discharged to sea, which has the potential to impact on water quality and the species that make use of the water column. Considering the limited increase in oil and chemical discharge resulting from the proposed drilling campaign and additional production from Alwyn East and the fact that any additional discharge will be dispersed rapidly and widely in the marine environment, the impact on the marine environment is considered minor and not significant. In addition, internal chemical management controls in place at TEPUK as well as the control of chemical use and discharge through the permit application and approval process, further reduces the potential for any significant impacts to the marine environment.

During drilling activities of the Alwyn East well, emissions are expected to increase due to the need to use a third power generator to complete the drilling phase safely. Additionally, there will be emissions from supply vessels and helicopters during this time as well as emissions from flaring during well start-up. During start-up a well test will be carried out where it will be flowed for a period of approximately 24 hours during which time gas will be flared due to pipeline export specification requirements. There may also be the need to bleed the annuli during start up to maintain well integrity which would result in gas being vented.

Once production starts, power will be generated from only two turbines whenever possible (as per the current base case at Alwyn). Flaring is not predicted to increase as current practice on Alwyn is not to use operational load flaring when no export route for gas is available, however there is an expectation that there will be an additional four well start-ups (25 tonnes of gas flared per occurrence) per year for the first two years of production from Alwyn East following planned or unplanned well shutdowns.

Given the temporary and limited nature of the majority of the atmospheric emissions from the Alwyn East development and taking into account the distance from any potentially sensitive receptors, it is not expected that atmospheric emissions will negatively impact local air quality or result in significant local cumulative impacts. Alwyn East’s contribution to global warming will be negligible in relation to those from the wider offshore industry and outputs at a national or international level.

The drilling of a new well and the increase in production associated with Alwyn East creates an opportunity for an accidental event to occur causing a MEI. However, the probability of a MEI occurring is considered remote, and TEPUK will ensure appropriate response plans and mitigation measures are in place to address the risks of an unplanned event occurring. Whilst the consequences associated with such an event would be significant and would affect a number of protected conservation areas within UK waters and along the coast, the remote likelihood of a MEI occurring, and considering the measures in place to prevent and mitigate such a scenario, the environmental risk has been deemed minor. Overall, the potential for an accidental event to result in significant impacts to the environment is not considered to be significant.

The Alwyn East EIA has considered the objectives and marine plan policies of the Scotland National Marine Plan across the range of relevant policy topics including natural heritage, air quality, cumulative impacts and oil and gas. TEPUK considers that the proposed drilling of the Alwyn East well is in broad alignment with such objectives and policies. TEPUK’s existing environmental management procedures and practises will ensure that any potential impacts are managed and controlled.

ABBREVIATIONS

"/in	Inch
µg/g	Microgram per gram
µg/kg	Microgram per kilogram
µm	Micrometre/micron
ACA	Action Coordinating Authority
BAT	Best Available Technology
bbl/day	Barrel of oil per day
BEIS	Department for Business, Energy and Industrial Strategy
BEP	Best Environmental Practice
BOE	Barrels of oil equivalent
CFR	Carbon footprint reduction
CHARM	Chemical Hazard Risk Management
CIEEM	Charted Institute of Ecology and Environmental Management
CNR	Canadian Natural Resources
CNS	Central North Sea
CO_2e	Carbon dioxide equivalent
CoP	Cessation of Production
CPR	Continuous Plankton Reader
CRI	Cuttings re-injection
cSAC	Candidate Special Area of Conservation
DECC	Department of Energy and Climate Change
DTI	Department of Trade and Industry
EAJ	Environmental Assessment Justification
EEA	European Economic Area
EIA	Environmental Impact Assessment
EEMS	Environmental Emissions Monitoring System
EMS	Environmental Management System
E&EnMS	Environment and Energy Management System
EPS	European Protected Species
ERD	Extended Reach Drilling
ES	Environmental Statement
ESD	Emergency Shut-down
EU	European Union
EU ETS	EU Emissions Trading Scheme
EUNIS	European Nature Information System
FRS	Fisheries Research Services
ft	Feet
FUKA	Frigg UK gas pipeline to the St Fergus Terminal
g/cm^3	Grams per cubic centimetre
GHG	Greenhouse gas
GRP	TEPUK Gas, Renewables & Power
GTG	Gas turbine generator
HMPA	Historic Marine Protected Area
HP	High pressure
HRA	Habitats Regulations Assessment
HSE	Health, Safety and Environment
HSE	Health and Safety Executive

HSSE	Health, Safety, Security and Environment
IAPP	International Air Pollution Prevention Certificate
ICES	International Committee for the Exploration of the Sea
IEMA	Institute of Environmental Management and Assessment
IOPG	International Association of Oil and Gas Producers
IP	Institute of Petroleum
IPCC	Intergovernmental Panel on Climate Change
ITOPF	International Tanker Owners Pollution Federation
JNCC	Joint Nature Conservation Committee
km	Kilometre
km^2	Kilometre squared
kW/m	Kilowatt per metre
LOT	Leak-off testing
LSE	Likely Significant Effect
m	Metre
m/s	Metres per second
m^3	Cubic metres
m^3/day	Cubic metres per day
MAH	Major Accident Hazard
MarLIN	Marine Life Information Network
MCZ	Marine Conservation Zone
MEI	Major Environmental Incident
mg/l	Milligrams per litre
MoD	Ministry of Defence
MPA	Marine Protected Area
MPD	Managed Pressure Drilling
Mt	Million tonnes
MW	Megawatt
NAA	North Alwyn Alpha
NAB	North Alwyn Bravo
NC MPA	Nature Conservation Marine Protected Area
NCP	National Contingency Plans
N/m^2	Nautical metres squared
NMP	National Marine Plan
NMPi	National Marine Plan interactive
NNP	Ninian Northern Platform
NNS	Northern North Sea
NOAA	National Oceanic and Atmospheric Administration
NORBIT	Norwegian/British oil spill response
OBM	Oil-Based Mud
OCGT	Open Cycle Gas Turbines
OGUK	Oil and Gas UK
OVI	Oil Vulnerability Index
OPEP	Oil Pollution Emergency Plan
OPPC	Oil Pollution Prevention and Control
OPRC	Oil Pollution, Preparedness, Response and Cooperation
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSCAR	Oil Spill Contingency and Response model
OSPAR	Oslo Paris Convention
OSCR	Offshore Safety Case Regulations

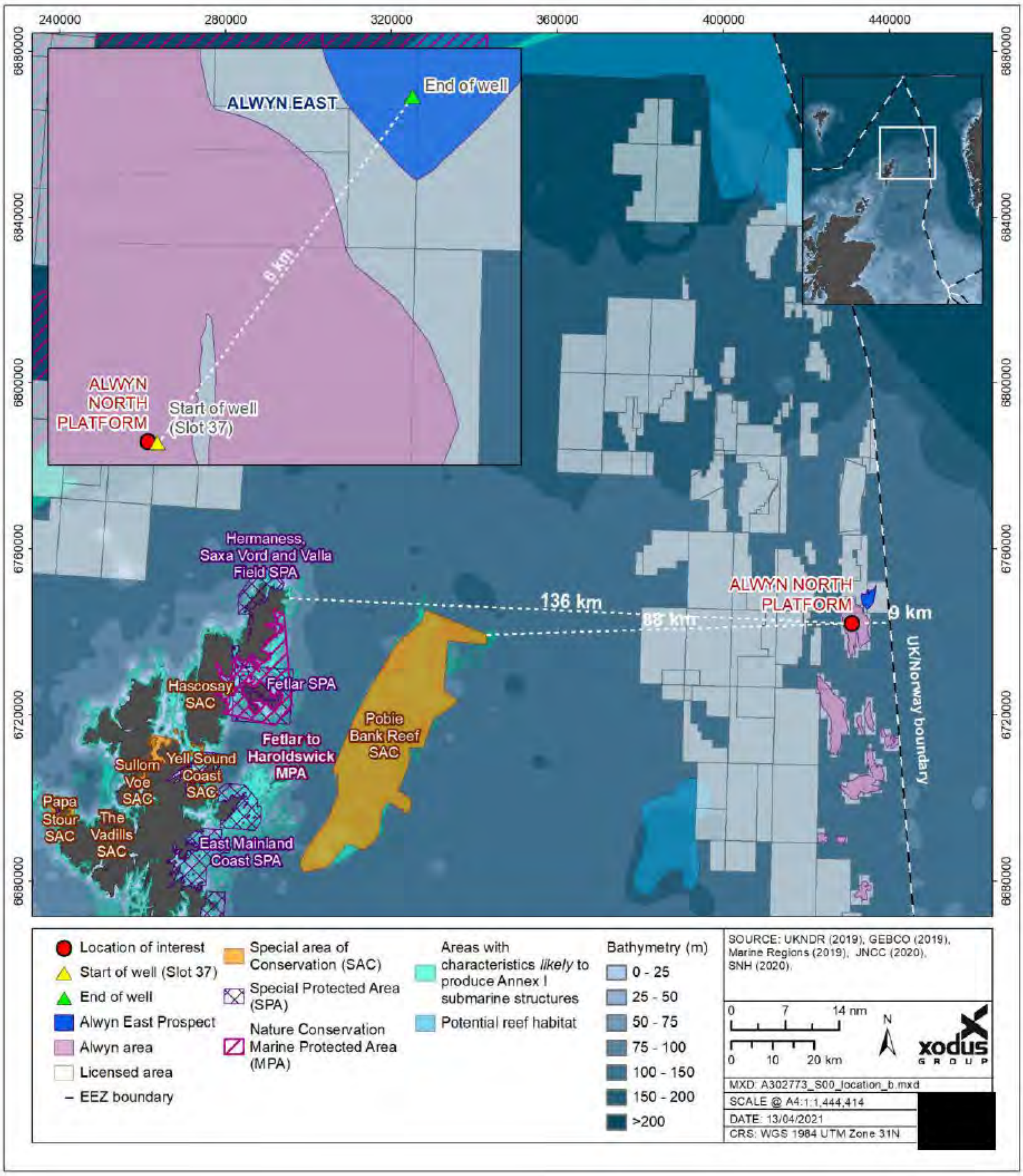
PAH	Polycyclic Aromatic Hydrocarbon
pMCZ	Proposed Marine Conservation Zone
PMF	Scottish Priority Marine Feature
PRA	Production Operations Application
pSPA	Proposed Special Protection Area
PWRI	Produced Water Re-Injection
RBA	Risk Based Approach
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SAT	Subsidiary Application Template
SAHFOS	Sir Alister Hardy Foundation for Ocean Science
SEA	Strategic Environmental Assessment
SECE	Safety and environment critical elements
SHE&I	Safety, Health, Environment and Integrity
SHEMS	Safety, Health and Environmental Management System
SIMOPS	Simultaneous operations
Sm^3/day	Standard cubic metres per day
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
SOSI	Seabird Oil Sensitivity Index
SPA	Special Protection Area
SVT	Sullom Voe Terminal
TDS	Top-drive system
Te	Tonnes
TD	Total depth
TEPUK	TotalEnergies Exploration and Production UK Ltd
THC	Total Hydrocarbon Concentration
TVDRT	True vertical depth rotary table
UK	United Kingdom
UKAPP	UK Air Pollution Prevention Certificate
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
UNECE	United Nations Economic Commission for Europe
VEC	Valued Ecosystem Components
VFD	Variable frequency drive
VMS	Vessel Monitoring System

1 INTRODUCTION

1.1 FIELD DEVELOPMENT

The Alwyn East field, which is operated by TotalEnergies Exploration and Production UK Ltd (herein referred to as TEPUK) is located in the Northern North Sea (NNS) in United Kingdom Continental Shelf (UKCS) Blocks 3/04b, 3/04g and 3/05a. The field is located approximately 5.8 km north east of the Alwyn North platform (situated in Block 3/09). The Alwyn field is located approximately 136 km east of Shetland and 9 km from the UK/Norwegian median line in a water depth of 130 m (Figure 1-1).

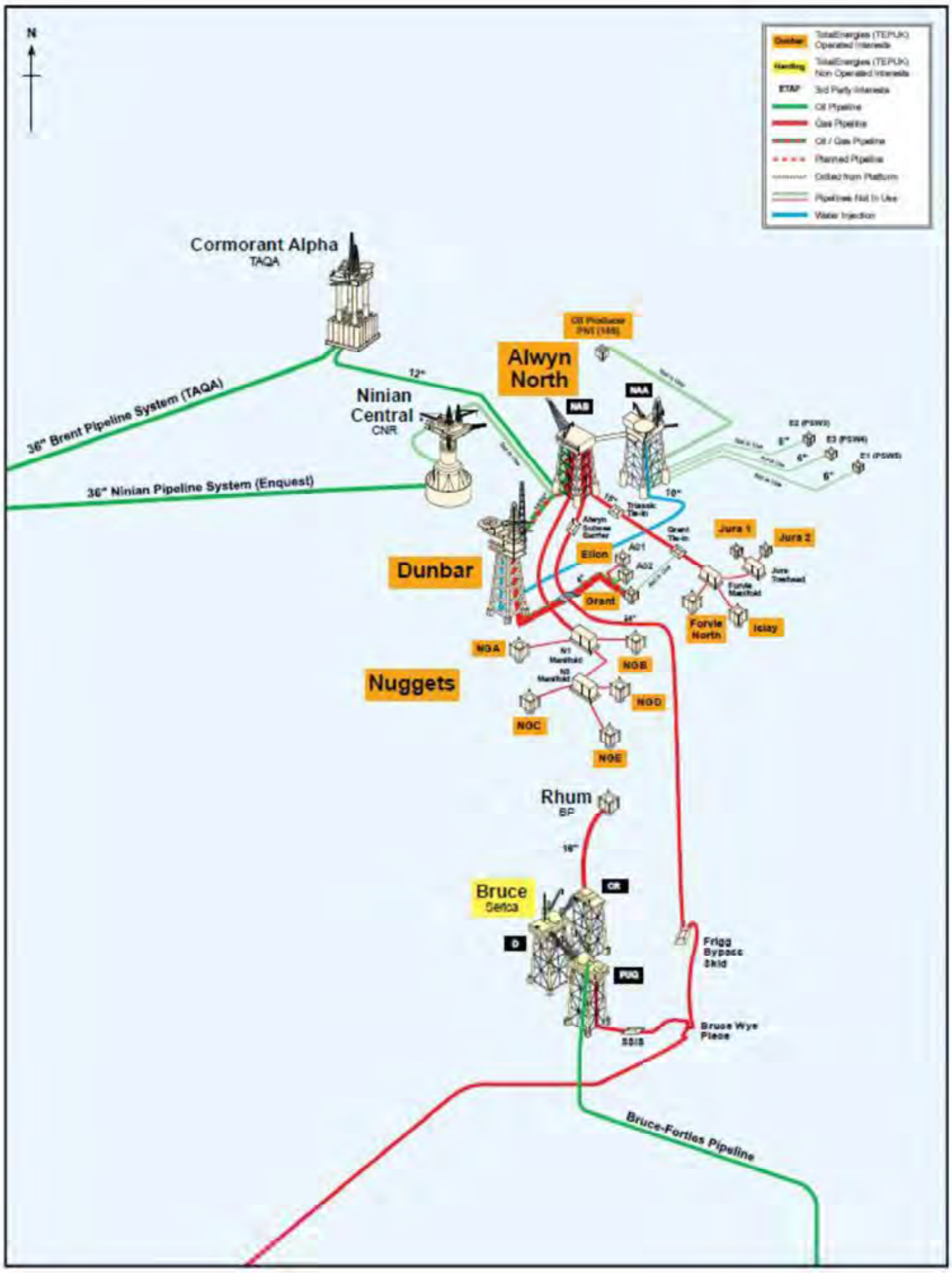
Figure 1-1 Location of the Alwyn East field



The Alwyn Area development in the NNS is comprised of 8 producing fields: Alwyn North, Dunbar, Ellon, Grant, Nuggets, Forvie North, Jura and Islay. The Alwyn North platform, located in UKCS Block 3/9a (Figure 1-1), is the hub and support centre for these fields, supplying them with power and water injection support while simultaneously receiving produced water, oil and gas via a network of subsea cables and pipelines (Figure 1-2). Alwyn North (Alwyn) consists of two platforms, North Alwyn Alpha (NAA) and North Alwyn Bravo (NAB), which are linked by a bridge. The Dunbar platform processes fluids from the Dunbar, Grant and Ellon fields and is tied back to Alwyn by pipeline. The Alwyn Area is therefore produced by a mix of platform wells (Alwyn and Dunbar) and subsea tie-backs (other fields). Alwyn East will be drilled from the NAA platform and will be produced directly into the Alwyn North platform facilities; therefore no seabed infrastructure is associated with the drilling and production from Alwyn East.

Production from these fields is combined at Alwyn and processed to produce gas and oil for export. Gas is exported into the Frigg UK gas pipeline system (FUKA) to the St Fergus Terminal, in Aberdeenshire. Oil is exported to Cormorant Alpha platform and then onto the Sullom Voe Terminal (SVT), in Shetland via the Brent System pipeline.

Figure 1-2 UKCS – NNS - Alwyn Area development



1.2 PURPOSE AND SCOPE OF THE ENVIRONMENTAL IMPACT ASSESSMENT

As stipulated in the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020, consent for the extraction of 500 tonnes or more per day of liquid hydrocarbons (e.g. oil, condensate) or 500,000 cubic metres (m^3) per day of gas must be supported by a full Environmental Impact Assessment (EIA) and submission of a statutory Environmental Statement (ES). This ES reports the findings of the EIA conducted by TEPUK to support the Alwyn East application for the drilling and associated production of a new well at Alwyn East.

Within this document, the maximum consent values submitted for Alwyn East are P10 figures. These represent the maximum achievable production currently forecast that have a 10% probability of being achieved.

The approved production consent figures for the Alwyn Area fields for 2019 onwards are provided in Appendix A as per the Alwyn Area Production Operations Application (PRA) PRA/15 and the Dunbar PRA (PRA/175). Production figures for Alwyn East are presented in Sections 2.2.2. and 2.5.3. For clarity, it is noted that this impact assessment considers only production from the future Alwyn East field; any changes in production associated with other fields in the Alwyn area are not relevant to this ES.

The Alwyn East project sits within the portfolio of Alwyn Area development opportunities of TNE-1 and potentially Brent Central, which may be subject to future applications for development. Should they be developed, these projects are expected to yield a positive benefit by unlocking further hydrocarbon reserves in the area, enabling an extension of economic CoP from approximately 2026, out to 2029[a]. Constraining production to the currently consented levels could compromise efforts by TEPUK to maximise economic recovery of hydrocarbons from the Alwyn area.

To give context to Alwyn East and its contribution to the overall production at Alwyn, the predicted production levels from Alwyn East have been compared to the currently consented Alwyn and Dunbar production figures, though these values may change in the future. In 2022, expected gas production from Alwyn East (499,000 m^3/day) will represent approximately 7% of the Alwyn Area production (6,845,000 m^3/day), whilst oil production from the Alwyn East field (387 m^3/day) will represent approximately 15% of the total production (2,625 m^3/day). In 2023, Alwyn East production increases whilst production from the other fields within the Alwyn Area is expected to decrease. As a result, Alwyn East gas production (1,501,000 m^3/day) will represent approximately 22% of the Alwyn Area production (6,841,000 m^3/day), whilst oil production from the Alwyn East field (1,161 m^3/day) will represent approximately 44% of the total production (2,625 m^3/day). A comparison of the produced water from Alwyn East with that of the overall Alwyn Area is provided in Section 6.4.1. If successful, new gas and oil production values will be consented for Alwyn East under the Alwyn Area PRA.

The EIA that is reported in this ES assessed the potential environmental and socio-economic impacts that could result from development of the Alwyn East field. The EIA process is integral to the proposed operations and involves: assessing the alternatives considered in Project design, identifying the possible impacts arising from Project activities and developing any control measures necessary to avoid, eliminate or minimise such impacts as far as reasonably practical. The process also provides for stakeholder involvement so that issues can be identified and addressed as appropriate at an early stage, and also ensures that the planned activities comply with environmental legislative requirements and with TEPUK's environmental policy.

The EIA considered the risks from both routine activities and accidental events with their possible environmental implications.

Key elements of this ES include:

- A non-technical summary of the ES;
- Description of the background to the Project; role of the EIA and legislative context (this chapter);
- Description of the Project and alternatives considered (Chapter 2);
- Description of the environment and identification of the key environmental sensitivities which may be impacted by the Project (Chapter 3);

[a] At current estimate. No decision has yet been taken on Alwyn CoP, but this is likely to be earlier than 2040, with phased Plug and Abandon of non-productive wells from around 2026.

- Description of the methods used to identify and evaluate the potential environmental impacts and scope of the EIA (Chapter 4);
- Detailed assessment of key potential impacts, including assessment of potential cumulative and transboundary impacts (Chapters 5, 6 and 7);
- Description of the environmental management that will be in place during the Project (Chapter 6); and
- Conclusions (Chapter 9).

The ES is submitted for review to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED), part of the Department for Business, Energy and Industrial Strategy (BEIS), to inform the decision on whether or not the Project may proceed. As part of the review process, the ES is also subject to formal public consultation.

1.3 *LEGISLATION AND POLICY*

The EIA Regulations 2020 require the undertaking of an EIA and the production of an ES for any offshore oil and gas development that is expected to produce more than 500 tonnes of oil per day or more than 500,000 m^3 of gas per day. The Alwyn East well is predicted to result in a P10 peak oil production rate exceeding 500 tonnes per day and must therefore be supported by an EIA.

As well as the requirement to carry out an EIA, there are also a number of other key regulatory drivers applicable to the proposed operations, with the key legislation being:

- The Petroleum Act 1998;
- The Petroleum Licensing (Production) (Seaward Areas) Regulations 2008;
- Energy Act 2008, as amended;
- Marine and Coastal Access Act 2009;
- The Conservation of Offshore Marine Habitats and Species Regulations 2017;
- Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001, as amended;
- The Offshore Chemical Regulations 2002, as amended;
- Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005, as amended;
- Pollution Prevention and Control (Scotland) Amendment Regulations 2017;
- The Merchant Shipping (Oil Pollution Preparedness, Response & Co-operation Convention) Regulations 1998;
- The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008 (as amended);
- The Offshore Installations (Emergency Pollution Control) Regulations 2002;
- Merchant Shipping (Prevention of Oil Pollution) Regulations 1996, as amended;
- Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008;
- International Convention for the Control and Management of Ships' Ballast Water and Sediments; and
- Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015.

1.4 *CONSULTATION*

Due to the very limited scope of the proposed Alwyn East drilling activities and resulting increased production on the Alwyn platform, consultation has been limited to one meeting with OPRED supplemented by email clarifications.

1.5 *DATA GAPS AND UNCERTAINTIES*

The ES has assumed the 'worst-case' scenario for impact assessment, and these assumptions are detailed within the Project Description (Chapter 2) and within the relevant assessment chapters. In addition, any gaps in the understanding of the receiving environment have been highlighted in each impact assessment chapter.

2 PROJECT DESCRIPTION

2.1 INTRODUCTION

The Alwyn field first started production in 1987. TEPUK now plans to drill a new well at Alwyn East. Alwyn East is located approximately 5.8 km from the existing Alwyn NAA platform. The Alwyn East well will be drilled from the existing N43 wellbore, located at the NAA platform as a deviated secondary wellbore with a different target to the original wellbore (also known as a sidetrack). The deviated well will have a horizontal offset of 5.7 km. This directional drilling technique used to drill the deviated well is called Extended Reach Drilling (ERD). The existing wellhead at NAA will be utilised with new compact housing, production casing and tubing hangers installed, as well as a new Xmas tree. No new subsea facilities will be required within the Alwyn East field. Further details of the drilling process are provided in Section 2.4.

Any drilling operations to be carried out within the Alwyn East field will be subject to a separate Drilling Application (DRA), which will include an Environmental Assessment Justification (EAJ), a Screening Direction Subsidiary Application Templates (SATs) and any other SAT which may be required for the planned operations. The drilling campaign is planned for 2022 and will take up to 175 days for drilling and completions operations (including hook-up, commissioning and perforation); this is a worst-case estimate and includes contingency for weather downtime. First oil is expected by September 2022[b].

This ES covers the drilling and production of the Alwyn East well. It is important in any EIA process that a clear description is provided of the project being assessed. In the case of additional production from an oil and gas field, it is first important to understand the reason for, and context of the additional production, including consideration of potential alternatives to an increase in production. This is described in Section 2.2. Following this, it is then important to understand the facilities through which the hydrocarbons are processed and highlight any changes that might be required to these facilities because of the additional production. The drilling operations are described further in Section 2.4. The processing facilities used to treat the Alwyn area hydrocarbons are described in Section 2.4.1. The platform topsides will require minimal modifications to allow production from the new well (described further in Section 2.5).

2.2 PRODUCTION OVERVIEW

2.2.1 Background to Production Increase

Once the Alwyn East well is brought online, it is expected that production will exceed the thresholds as provided in the EIA Regulations. It is currently unknown if oil and/or gas will be encountered at Alwyn East. Therefore, both oil and gas figures are presented below (Table 2-1 and Table 2-2).

The volume of oil and gas forecast to be produced from Alwyn East is shown in Table 2-1 and Table 2-2.

In the most optimistic (P10) case for Alwyn East available reserves, production from the field remains technically possible until 2040. Therefore it is possible that not all reserves will be recoverable because the supporting Alwyn infrastructure is likely to undergo CoP and decommissioning prior to this date, i.e. continued production from Alwyn East alone would be unlikely to extend economic CoP past 2030. However, the average (P50) reserves scenario would likely see all recoverable hydrocarbons from the field being produced within this timeframe.

It should also be noted that from around 2024, an alternative hydrocarbon export route will be required in order to continue producing from Alwyn North. This is because liquid export is currently via pipeline to the Cormorant Alpha facility, which is undergoing planning via a 3rd party operator for CoP and eventual decommissioning. An alternative means of liquids export is being investigated. The outcome of this project is not expected to have any specific impacts on the Alwyn East development.

[b] This is the current plan, but there is the potential that the schedule may change.

Table 2-1 Forecast gas production for the Alwyn East field

Year	Forecast Alwyn East gas production (1,000 m^3 /day)
2022	499
2023	1,501
2024	1,501
2025	1,501
2026	1,501
2027	1,501
2028	1,501
2029	1,401
2030	1,187
2031	954
2032	774
2033	647
2034	527
2035	434
2036	347
2037	294
2038	240
2039	193
2040	67

Table 2-2 Forecast oil production for the Alwyn East field[c]

Year	Forecast Alwyn East oil production (1,000 m^3 /day)	Forecast Alwyn East oil production (tonnes/day)
2022	0.38689	309
2023	1.1606	928
2024	1.1606	928
2025	1.1606	928
2026	1.1606	928
2027	1.1291	903
2028	0.9514	761
2029	0.7978	638
2030	0.6807	545
2031	0.5599	448
2032	0.4463	357
2033	0.3927	314
2034	0.3112	249
2035	0.2765	221
2036	0.2401	192
2037	0.1836	147
2038	0.0719	58
2039	0.0558	45
2040	0.0218	17

[c] A specific gravity of 0.8 g/cm^3 has been used for expected crude from Alwyn East.

2.2.2 *Production Profiles*

2.2.2.1 Gas production

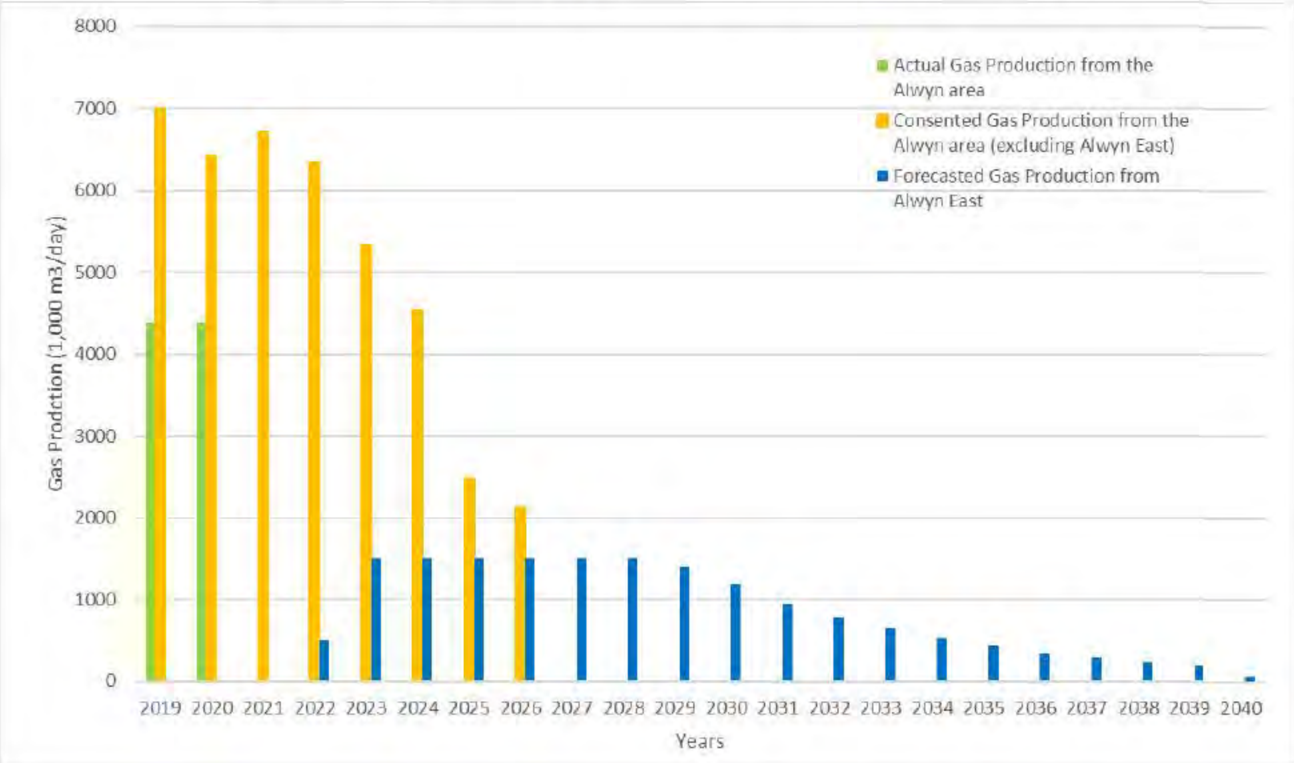
Figure 2-1 shows historical/existing gas production consent for the Alwyn field area and forecast production for gas from the Alwyn East well as detailed in this ES. Gas production at the existing Alwyn field area has greatly varied between 2010 and 2020. The peak production during that time was 2010 when an average of 2,791,846 m^3 of gas was produced per day. The lowest gas production levels were recorded in 2018 with an average of approximately 763,035 m^3/day being produced.

As discussed above, the production at Alwyn started in 1987. The proposed additional production from the Alwyn East field (oil and/or gas) does not exceed historic production levels from the Alwyn platform.

The forecast production for Alwyn East (P10 values) would result in a peak in gas production over six consecutive years from 2023 to 2028 with 1,500,946 m^3/day of gas being produced (Table 2-1).

Gas production values for Alwyn East are expected to decrease from 2030 onwards, however due to declining reserves in the fields that produce via Alwyn it is unlikely that Alwyn East will continue producing till 2040. Currently, production is anticipated from the majority of the Alwyn wells until 2024 at which time some wells would be plugged and abandoned. The Alwyn platform is expected to continue exporting fluids from the Dunbar field until around 2028.

Figure 2-1 Forecast gas production from the Alwyn East field[d]



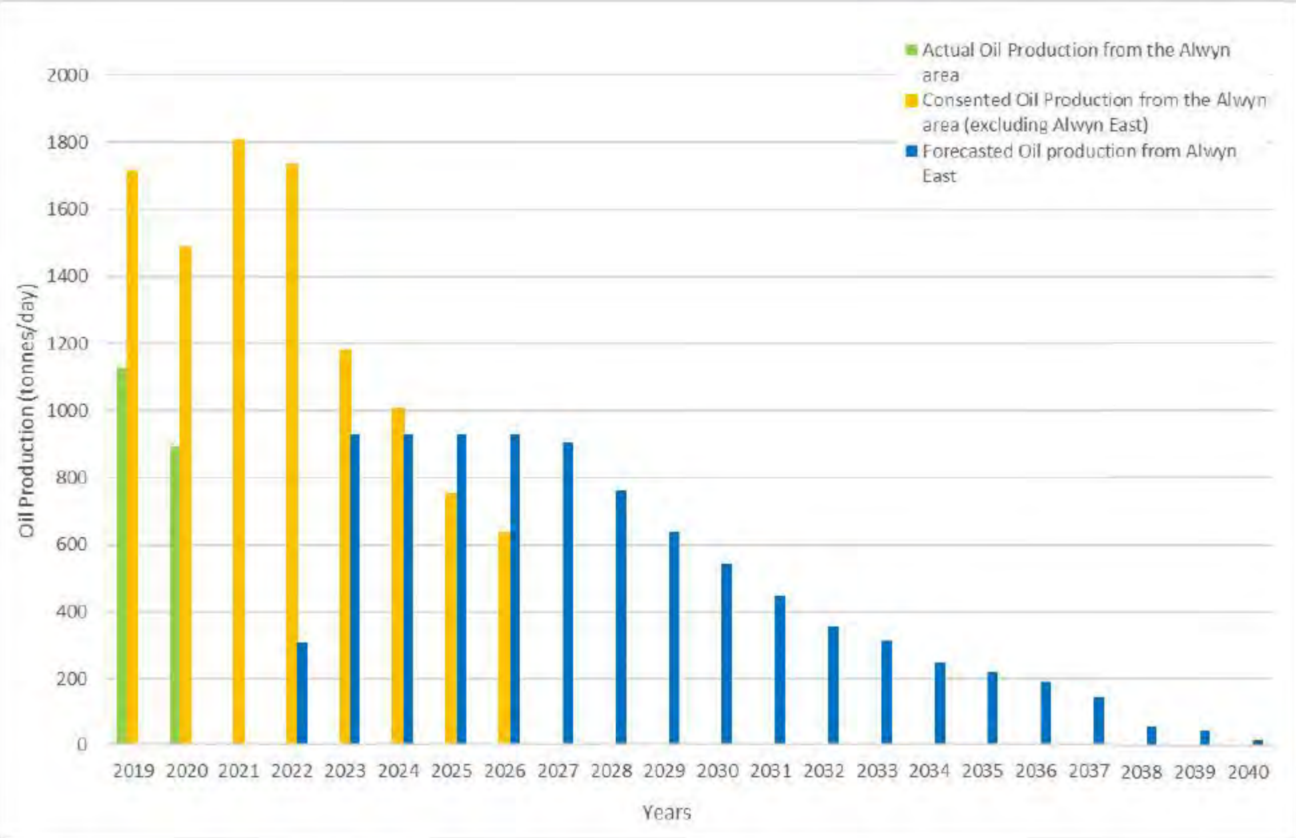
2.2.2.2 Oil production

Figure 2-2 shows historical/existing oil production consent for the Alwyn field area and forecast production for oil from the Alwyn East well as detailed in this ES. Peak production from the Alwyn field between 2010 and 2020 was in 2019 with an average of 1,128 tonnes/day of oil being produced. The lowest oil production levels for that period were recorded in 2018 with an average of approximately 461 tonnes/day produced.

[d] The value for Consented Gas Production is based on the latest consent for the Alwyn fields. Nugget N2- consented until 2021; Nugget N3, Nugget N4, Islay and Dunbar – consented until 2022; Nugget N1 - consented until 2023; Grant, Ellon, and Jura – consented until 2024; and Alwyn and Forvie fields – consented until 2026.

Peak forecasted oil production for Alwyn East is estimated over four consecutive years from 2023 to 2026, with 1,161 m3 / day (equivalent to 928 tonnes/day) produced (Figure 2-2).

Figure 2-2 Forecast oil production from the Alwyn East field[e]



2.3 *CONSIDERATION OF ALTERNATIVES*

As outlined in Section 1.2, constraining production to the currently consented levels could compromise efforts by TEPUK to maximise economic recovery of hydrocarbons from the Alwyn area. TEPUK have thus considered two options for the future of the Alwyn area, which involve either continuing production at the consented levels or maximising economic recovery of this area, initially by drilling a new well into the Alwyn East field.

If the Alwyn East well is not drilled and therefore production is constrained to the presently approved values for the fields in the Alwyn area, then the short-term forecast revenue from the field would be limited. Although the production could be realised in the longer-term, the short-term restriction in cash flow could make the field a less economically attractive proposition to maintain and there exists the possibility that the decision could be taken to bring forward cessation of production (CoP). Although this is by no means a likely outcome, the alternative to increased production (to limit production to current consented values) is not the preferred option for TEPUK to pursue.

Two methods were considered for drilling the Alwyn East well; drilling a new subsea well using a mobile offshore drilling rig and drilling an extended-reach drilling (ERD) well as a sidetrack of the original N43 well from the Alwyn NAA platform. This option makes use of an existing well slot (N43) to drill a sidetrack, which means that the project will occur within the physical footprint of the existing development and no additional subsea infrastructure is required. Drilling from the existing platform is also the safest, fastest and most economical method to develop the available resources. From the platform, production would be able to begin almost immediately (in the success case) as no new subsea facilities would be required (such as for a subsea well) and minimal topsides modifications on Alwyn are required to process Alwyn East production.

[e] The value for Consented Oil Production is based on the latest consent for the Alwyn fields. Nugget N2- consented until 2021; Nugget N3, Nugget N4, Islay and Dunbar – consented until 2022; Nugget N1 is consented until 2023; Grant, Ellon, and Jura – consented until 2024; and Alwyn and Forvie fields – consented until 2026.

The other drilling option considered for the Alwyn East well was drilling via a standalone drilling rig. However, this option involved drilling a subsea vertical well from a new location, mooring a drilling rig at the new well location, installing a new subsea wellhead and installing new pipelines to tie-back the well to the existing platform. Whilst the duration to drill a subsea vertical well is likely to be shorter than that to drill a deviated well from Alwyn, this option would have a greater environmental impact with regards to the installation of the seabed infrastructure and the anchoring of a drilling rig generating a greater seabed disturbance. Furthermore, there would be additional atmospheric emissions associated with the installation of new pipelines and subsea infrastructure and bringing a drilling rig to site, as well as drilling the well from a standalone rig which runs on diesel and thereby produce higher emissions than from the platform gas turbine generators (GTGs). Using the pre-existing well (N43) slot means there is no requirement for a standalone drill rig, or new seabed infrastructure.

Additionally, the cost of a new vertical well would be significantly greater due to the additional costs of a standalone drilling rig, as well as the seabed infrastructure required to tie-back the well to Alwyn since there is no in-service infrastructure to the north east of Alwyn that could be utilised.

Drilling via extended reach methods also allows all cuttings generated from the well to be either returned to the platform and recovered to shore or re-injected, whereas for a new subsea vertical well it would not be possible to retrieve the cuttings from the first two well sections as there would be no riser in place; these would be discharged at the seabed during drilling. The drill cuttings discharges that would be generated in the new subsea vertical well drilling method would thus result in additional seabed disturbance and introduce chemicals and heavy metals to the seabed environment, with potential impacts on seabed habitats and species. As part of the chosen ERD option, cuttings re-injection (CRI) was initially considered as the base case, but there is the potential that the injection wells may not have sufficient capacity for all the cuttings from the Alwyn East drilling operations. Therefore, skip and ship is now planned as the primary option, whilst CRI will be available as a contingency, should poor weather not allow skip and ship. No seabed impacts are expected from either the skip and ship or CRI methods. Confirmation on the cuttings disposal method will be provided within the Drilling Permit Application prior to drilling commencing.

2.4 *DRILLING OPERATIONS*

2.4.1 *Production Well*

The Alwyn East production well will be drilled as a deviated secondary wellbore away from the original N43 (donor) well, which is located at the existing Alwyn NAA platform. The proposed Alwyn East well has a planned maximum depth of approximately 4,847 m true vertical depth rotary table (TVDRT) (see Figure 2-3).

The original N43 well was drilled in five sections, with the top hole being the widest hole and each subsequent section being drilled with a successively reduced diameter.

The N43 well has previously been abandoned by cutting and removing the 9⅝" casing, and then setting a cement plug in the wellbore at the 13⅜" casing shoe, which will be the kick-off point for the Alwyn East wellbore.

Using ERD techniques, the secondary wellbore (or sidetrack) is planned to consist of two sections that will be drilled with Oil-Based Mud (OBM). The first section will be started below the previously drilled 17½" section, above the cement plug. A new 12¼" section will be then be drilled using OBM. This section will be 3,749 m (12,300 ft) in length. Following the drilling of this section, a 9⅞" casing will be cemented in place to provide stability to the well and prevent any flow of fluids from the wellbore into the surrounding rock formation.

Following the cementing of the 9⅞" casing, an 8½" section will then be drilled, again using OBM, with a length of 1,250 m (4,101 ft). Pressure samples will then be taken. Based on the results from measurements and samples, a decision will be made to either complete or abandon the well at this point.

If the well is found to have economically recoverable hydrocarbons, it will be completed as a production well. In this case, the 4½" casing will be suspended from the end of the previously cemented casing (also known as a liner) to complete the 8½" section. Once the Alwyn East well has been completed, a compact housing and an assembly of valves, spools, pressure gauges and chokes (also known as a Xmas tree) will be fitted to the existing wellhead at the NAA platform. The well will then be cleaned up and kept as a producer from the NAA platform.

If the 8½" section fails to reach the reservoir, a 7" liner will be run to approximately 100 m above the top of the Brent reservoir, i.e. to approximately 7,525 m (25,016 ft). The contingency 6" section would then be drilled to well total depth (TD) with a total 6" hole of approximately 760 m (2,493 ft) in length. A 4½" liner will be cemented in place at well TD. The same liner size will be used for both 8½" and 6" hole sizes to well TD.

However, in the event that the well is a dry hole and there is no flow of reservoir fluids, the well will be abandoned. A cement plug will be placed within the 8½" section and the well abandoned at this point in line with Oil and Gas UK (OGUK) Guidelines.

Figure 2-3 Alwyn East well sections

ALWYN EAST - Well Architecture

	WELL ARCHITECTURE	MD/RT	TVD/RT	TVD/MSL	Incl.	Az.	DLS (°/30m)	CASING
N43 WELL	Rotary Table	0	0	-47.6	0	0	0	
	MSL	47.6	47.6	0.0	0.5	264.9	0.2	Length: 262 m
	Seabed	177.6	177.6	130.0	0.9	263.3	1.0	Casing type 26" 388.6# X52 1" WT
	26" Casing shoe	262.0	262.0	214.4	0.7	273.3	1.5	
	23½" Open hole	265.0	265.0	217.4	0.8	285.7	1.7	Length: 667 m Casing type 18⅝" 87.5# X56 RL-4S
	18⅝" Casing shoe	667.0	654.5	606.9	23.6	342.0	1.3	
	23½" Open hole	670.0	657.2	609.6	23.5	342.1	1.2	Length: 3182 m
		1982.0	1517.4	1469.8	59.4	23.2	2.0	Casing type 13⅜" 68# P110 New Vam 13⅜" 68# P110 Buttress
	TOC	2732.0	1949.1	1901.5	57.0	25.9	0.8	
	13⅜" Casing shoe	3182.0	2158.9	2111.3	57.8	27.0	2.0	
ALWYN EAST	17½" Open hole	3192.0	2164.2	2116.6	58.6	27.1	4.2	Length: 6915 m Casing type 10-3/4" 85.3# VM110SS Vam 21 HW-NA SC70 9-7/8" 66.9# VM110SS Vam Top 9-7/8" 66.9# VM110SS Vam 21 9-7/8" 66.9# VM125SS Vam 21 9-7/8" 66.9# VM125CY Vam 21
	TOC	6415.0	3502.5	3454.9	65.9	47.6	0.0	
	9⅝"x4½" Top of Liner	6815.0	3668.0	3620.4	61.8	47.1	2.0	
	9⅝" Casing shoe	6915.0	3720.2	3672.6	55.2	46.2	2.0	
	12¼" Open hole	6935.0	3731.8	3684.2	53.9	46.0	2.0	Length: 1363 m Casing type 4-1/2" 18.9# VM25 125 Vam Top NA
	TOP RESERVOIR	7625.0	4304.7	4257.1	16.6	31.3	0.0	
	4½" Liner shoe	8178.0	4834.7	4787.1	16.6	31.3	0.0	
	8½" Open hole	8180.0	4836.6	4789.0	16.6	31.3	0.0	

2.4.2 *Muds and cuttings discharges*

Drilling fluid (mud) fulfils a number of functions such as lubrication and cooling of the drill bit, suspension and transport of rock cuttings to the surface, and the provision of 'weight' (hydrostatic pressure) to counter-balance formation pressure and prevent uncontrolled reservoir fluid flow.

Mud and cuttings from all three OBM sections will be returned to the Alwyn platform and either be shipped to shore for treatment and disposal (base case) or injected into the CRI disposal well.

Details of the mud system to be used and the volume of cuttings to be produced from the Alwyn East well are presented in Table 2-3.

Table 2-3 Well design and Mud Programme for the Alwyn East production well

Well Section Diameter (inches)	Length of Section (m)	Mud Type	Estimated weight of cuttings (tonnes)	Discharge Method
12¼"	3,749	OBM	2,180	Cuttings skipped and shipped to shore or re-injected.
8 ½"	1,250		350	
6" (contingency)	760		106	
Total	**4,999[f]**		2,530[f]	

2.4.3 *Cementing and other chemicals*

The 12¼", 8½" and 6" hole sections will be cased with 9⅞" production casing and a 7" and 4½" liner strings respectively and cemented in place. As this well is a sidetrack of an existing well starting below the previously drilled 17½" section there will be no deposit of excess cement on the seabed around the wellhead as is often the case with a new subsea well. However, during cementing, excess cement may be produced and consequently need to be discharged overboard to the marine environment. This could be either a left-over job volume of cement or residual volume from tank/unit cleaning. To limit this discharge of cement, it is anticipated that all cement will be mixed as required. However, any excess cement, typically less than 10% of the total cement slurry, may be discharged to sea.

The specific chemicals and additives used during drilling and cementing will be dependent upon the drilling mud and cement packages, which will be designed specifically for the well. Use will also vary depending on the exact down-hole conditions experienced during drilling. There will be contingency chemicals available to deal with any predictable contingencies including stuck drill pipe and lost circulation (where drilling mud is lost into a porous formation). Typical chemicals that are used during drilling, cementing and completions operations are provided in Appendix D and impacts from chemical discharges to sea are assessed in Section 6.4.

All chemicals will be selected on their technical specifications as well as for their potential environmental impacts, which will be assessed using the Chemical Hazard Risk Management (CHARM) system where appropriate. The results of the well-specific chemical risk assessments will be submitted in a Chemical Permit SAT at least 28 days before the re-entry of the N43 well, in line with the Offshore Chemical Regulations 2002 (as amended).

2.4.4 *Well clean-up and testing*

After the well has been drilled and completed, it will be cleaned up and tested via the test separator. Drilling mud will be displaced from the well by circulating cleaning pills and seawater at a fast pumping rate. The wastewater generated will be routed to a test separator to allow hydrocarbons to be separated from the water, which will be re-injected or discharged overboard if the produced water re-injection system is unavailable, as described in Section 2.5.3. Separated hydrocarbons will be routed to the production train.

[f] 6" contingency length not included in this total

If the produced water re-injection system is unavailable during the drilling campaign and discharge overboard is needed, any seawater returns will be sampled in line with permit conditions and the average oil in water concentration will not exceed 30mg/l. Once the seawater returns become visibly clean, they will be routed directly overboard to sea. Samples of discharged water will be taken at regular intervals for analysis in accordance with Oil Pollution Prevention and Control (OPPC) Regulations.

Once the well is clean it will be filled with a completion fluid comprising chloride brine (NaCl / CaCl / KCl) containing small quantities of chemicals to protect the well. Added chemicals will include a corrosion inhibitor, an oxygen scavenger and a biocide. The exact chemicals to be used will be included in the detailed chemical risk assessment within the chemical permit SAT which will be submitted to BEIS at least 28 days prior to commencement of drilling activities.

After the well has been cleaned up, the well will be tested. It will be flowed for a period of approximately 24 hours, during which time approximately 128 tonnes of gas will be flared; this has been assessed in Section 5.4. No extended well test will be conducted. The requirement to flare the gas during the initial well clean-up is due to the fact that methanol for hydrate prevention will be injected during the initial start-up and because of commercial constraints, the gas must be flared until the well has been warmed up. The commercial constraint includes a strict gas export specification for methanol, which TEPUK must meet to allow exporting the produced gas. Injection of methanol at the proposed Alwyn East is likely to be required to inhibit the well fluids for hydrate prevention. This constraint stems from a specification for exported natural gas liquids (NGLs) at St Fergus Terminal where there are no means to remove methanol from the incoming gas and subsequent NGLs. If the Terminal receives high methanol content gas, there is a risk of having to shutdown NGL exports, which is not considered as an acceptable risk.

Alternative hydrate inhibitors such as MEG do not typically provide the right level of protection/mitigation, which is why methanol is used on these wells by exception.

2.5 *FACILITIES DESCRIPTION*

2.5.1 *Overview*

As described in Section 1.1, the Alwyn North installation consists of two fixed steel jacket platforms (NAA and NAB), connected by a 72m long steel bridge. The bridge provides personnel access between the platforms, and also carries various process lines and utilities. The topsides on each platform are supported by a conventional eight-legged, piled steel jacket and module support frame. Both topsides are of modular construction with solid boundary walls.

A drilling package upgrade will be undertaken on the NAA platform, as part of enabling works for upcoming drilling campaigns, including Alwyn East and other potential wells. A new upgraded top-drive system (TDS) and variable frequency drive (VFD) shall be installed as part of the North Alwyn drilling package, unlocking capability to drill to the “extended reach” Alwyn East targets. The existing hang-off plate, service loops, gooseneck and redundant steelworks in the derrick structure shall be dismantled. A, new hang-off plate, and upgrade to the dolly rail tracks shall be assembled to support the installation of the new TDS. Since the upgraded TDS is not compatible with the existing VFD, a new VFD will be installed as a standalone unit on the main pipe deck. Other rig upgrades involve a standpipe upgrade and updating the interface of Managed Pressure Drilling (MPD). Updates to the current flowlines will also take place on the platform topsides; new HP/LP flowlines and valves/connections to the methanol, corrosion inhibitor (CI), and scale injection lines will be installed. There will be no new subsea infrastructure or subsea modifications required to accommodate production from Alwyn East.

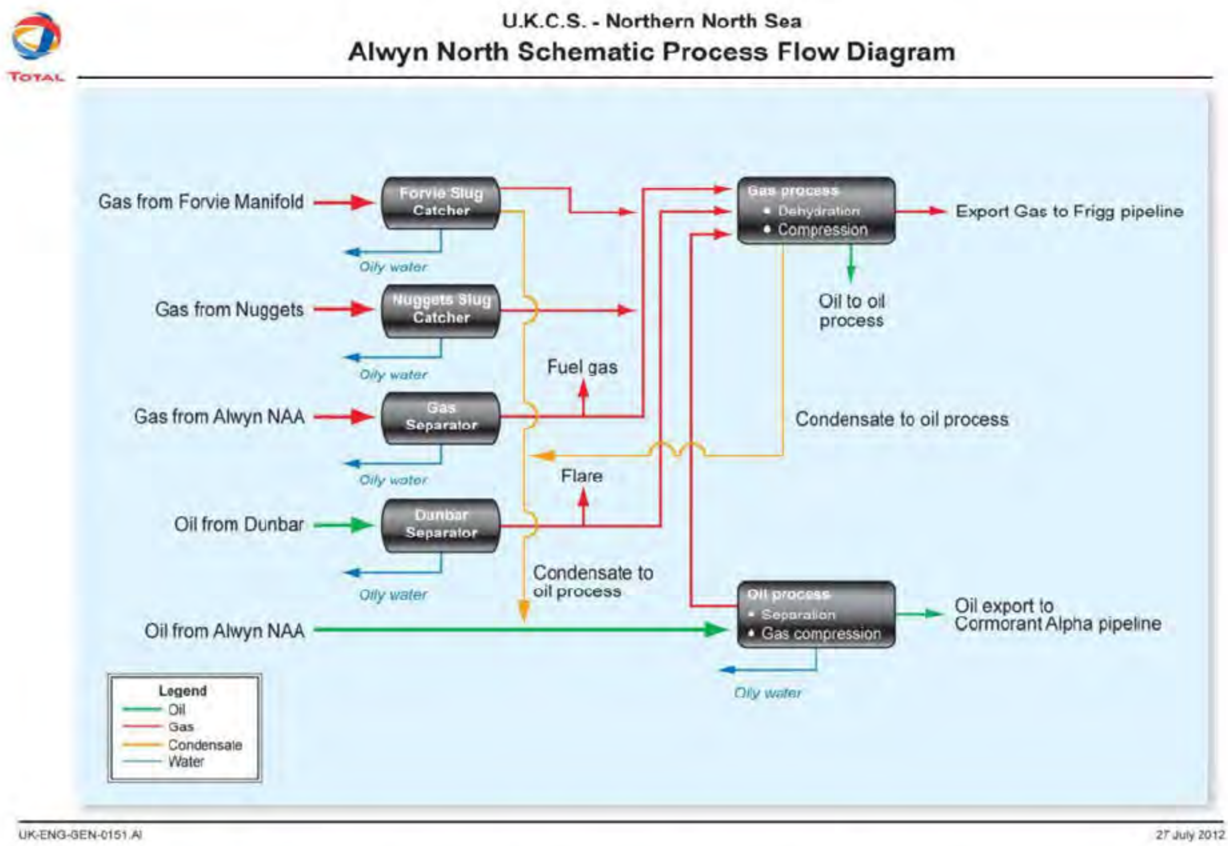
The following sections provide a summary of the facilities which support production from the Alwyn area fields to help understand the potential implications of an additional production well at Alwyn East.

2.5.2 *Separation Process*

Figure 2-4 provides an overview of the separation facilities at Alwyn. Oil from low pressure wells at Alwyn is collected by an oil production manifold at NAA and is routed to the Alwyn three stage separation process on the NAB platform. Before arriving in the first stage separator oil is mixed with oil from other adjacent fields, Dunbar, Ellon and Grant which is collected in the Dunbar separator. Following processing, oil is exported via the Cormorant Alpha pipeline to SVT and the gas is exported via the FUKA gas pipeline to the St Fergus Terminal. If oil is encountered at Alwyn East, it will be processed through the separation facilities described above.

Gas from high pressure (HP) Alwyn wells is collected into the gas separator after which it is mixed with the gas from Dunbar, Grant, Ellon, Forvie, Jura, Islay and Nuggets. The gas is dehydrated and compressed prior to export to St Fergus via the FUKA pipeline system. If gas is encountered at Alwyn East, it will be processed though the gas separator, as described above.

Figure 2-4 Separation process at Alwyn



The Alwyn platform was built to process a greater volume of oil and gas than currently proposed following production from the Alwyn East field. However, as described above there will be alterations made to the current Alwyn infrastructure to support ERD and subsequent production.

2.5.3 *Produced Water Processing*

Produced water may contain residues of reservoir hydrocarbons as well as chemicals added during the production process, along with dissolved organic and inorganic compounds that were present in the geological formation. Alwyn has a produced water re-injection system (PWRI). Discharges of produced water to sea occur at Alwyn only during periods when the PWRI system is unavailable. Produced water from Alwyn is discharged at the outlet of the C405 vessel through the produced water discharge caisson on the Alwyn NAB platform. The produced water discharge caisson opens at 18 m below mean sea level. The increase in produced water associated with the proposed Alwyn East well will be within the capacity of the existing produced water handling facilities at Alwyn.

On Alwyn there are several routes for the handling of produced water; Phase 1 or Phase 2 PWRI or overboard disposal to sea. These routes are detailed below:

- Phase 1 PWRI facility consists of two injection wells N25 and N27. It handles the produced water from the Dunbar separator, Forvie slug catcher and Nuggets slug catcher. Produced water from these vessels is injected to N25 and N27 using the differential pressure between the separator and the formation;

- Phase 2 PWRI facility consists of one injection well N30. It handles produced water from the Alwyn wells and any carry over from the Phase 1 PWRI. Produced water is injected using two pumping trains to achieve the required pressure; and
- When neither Phase 1 nor 2 PWRI is available on Alwyn, the produced water is routed overboard to sea via the produced water caisson. Any oil that separates out in the produced water caisson can be skimmed to the closed drains by means of normally closed manual valves.

PWRI facilities normally operate at worst-case 90% efficiency and therefore as a worst-case it is considered that 10% of the produced water is discharged overboard.

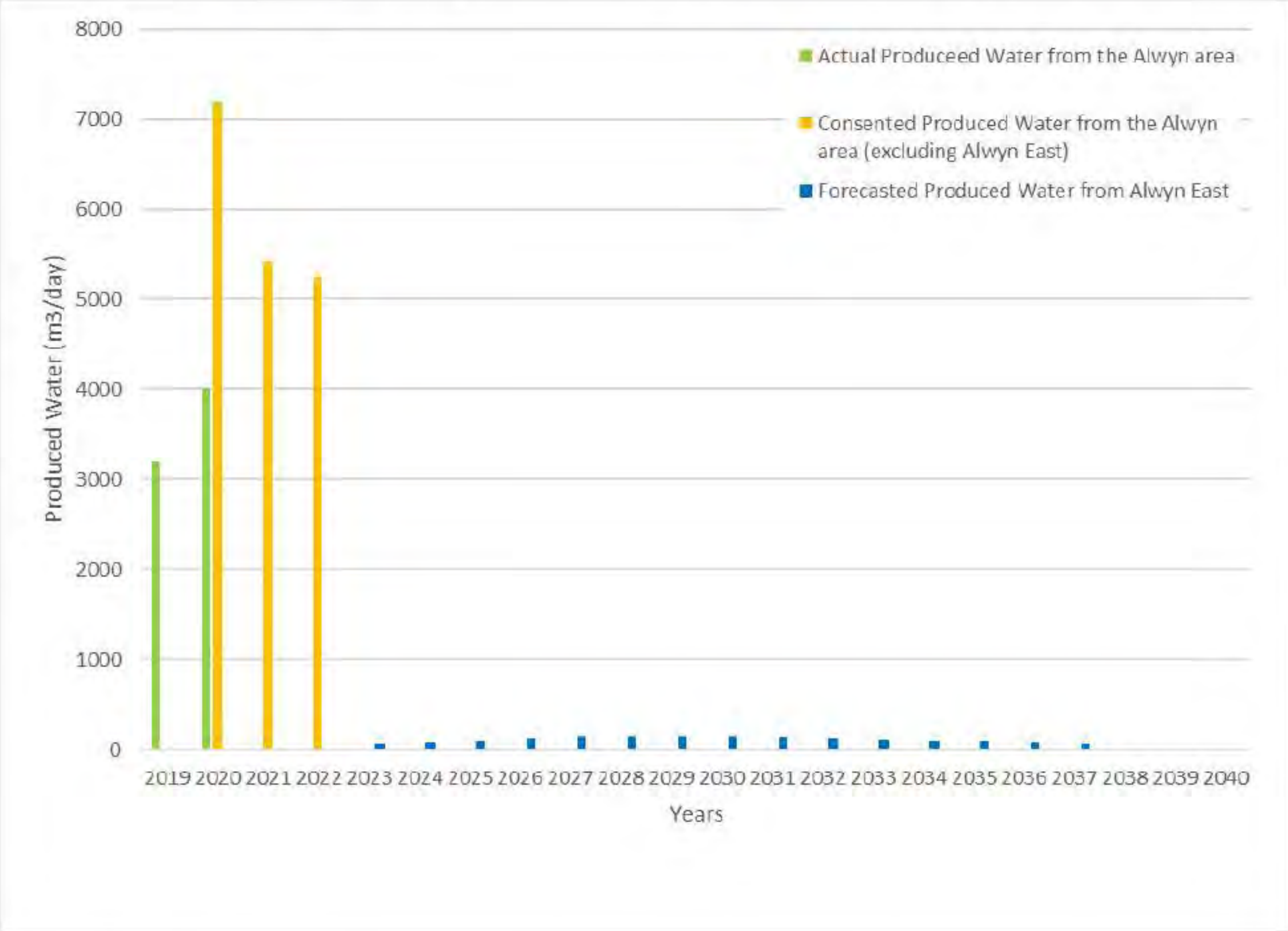
Produced water discharge during the production phase is consented under the Alwyn Oil Discharge Permit SAT (Ref. OLP/144) and impacts from produced water discharges to sea are assessed in Section 6.4.

Table 2-4 shows the produced water discharge volumes expected from the Alwyn East field. Figure 2-5 shows historical produced water volumes from Alwyn and historical/existing consent for the Alwyn field area and forecast produced water from the Alwyn East well.

Table 2-4 Forecast produced water data for Alwyn East

Year	Forecasted daily production (m^3 / day)
2022	19
2023	64
2024	80
2025	101
2026	126
2027	153
2028	156
2029	154
2030	150
2031	138
2032	121
2033	115
2034	97
2035	91
2036	83
2037	74
2038	18
2039	15
2040	5

Figure 2-5 Forecast produced water production from the Alwyn East field[g]



2.5.4 *Power Generation*

Power generation capacity at Alwyn consists of four GTGs, located on the NAB platform. These generators provide power generation for both NAA, NAB and Dunbar platforms. The Alwyn area fields and associated NAA and NAB platforms were originally designed for greater production, hence the original need for four generators. In the second half of 2020, an initiative commenced as part of a long-term carbon footprint reduction plan to target the running of only two GTGs during normal operations. Before the initiative commenced, the platform typically ran three GTGs, but this generally meant that an excess electrical load was available due to reduced levels of production. In a drive to reduce atmospheric emissions TEPUK identified efficiencies and, when operating conditions permit, has cut the number of generators down to two. In 2019 Alwyn ran three or more generators for 92% of the year, in the first half of 2020 this fell to 50% and to 33% by the second half of 2020. Two generator operation is now the base case. However, due to the requirement for very high reliability of additional power during critical drilling phases and the risk of one generator becoming unavailable during drilling, the third generator will be run for the majority of the Alwyn East drilling campaign duration. Atmospheric emissions as a result of additional power demand during drilling operations are quantified in Table 5-2. Once drilling is complete, the platform is expected to revert back to running on two generators as a base-case optimum scenario again.

2.5.5 *Flow Assurance and Chemical Treatment*

As Alwyn operates as a process hub for a number of fields, different fluid types are processed on the platform. The main issues associated with the production at Alwyn and associated fields are scale formation and corrosion (particularly from Dunbar and Ellon fluids), and hydrate formation as a result of the production of gas and condensate from subsea tie-ins. There are also routine chemicals that are necessary within a number of

[g] Consented Produced Water values for the Alwyn area have been forecasted until 2022.

the systems on the Alwyn, including the oil and gas process systems, seawater injection system and various utility systems. A number of chemicals are therefore required to mitigate these issues:

- Corrosion
  - Corrosion inhibitor is applied on a continuous basis to the Alwyn process. Corrosion inhibitor is also applied as a batch treatment to the displacement seawater for the diesel system and also as a mothballing treatment for the diesel leg D10 to ensure long term integrity of the system. Corrosion control is undertaken through a system of corrosion inhibitor injection; monitoring and chemical residue analysis.
- Emulsions
  - A process demulsifier is continuously dosed into the Alwyn separation system. Demulsifiers are required to assist with dehydration of produced water from crude oil. The main priority is to ensure that the platforms overboard oil in water figures remain within the defined limit for discharge. It is also a priority to ensure that the sales specification on the export crude oil is achieved.
- Bacterial growth
  - Biocides are required at Alwyn to prevent microbial growth and induced corrosion. This is required in particular for seawater injection system and closed loop systems.
- Hydrate formation
  - Hydrate formation is controlled via injecting a gas hydrate inhibitor during gas processing at Alwyn.
- Scale
  - Due to the high water cut at Alwyn, producing wells require treatment to ensure that the build-up of scale is controlled both topsides and within the subsea infrastructure. Scale inhibitor is continually injected at Alwyn to prevent the deposition of calcium and barium salts.
- Gas dehydration / glycol system
  - Gas produced at Alwyn is saturated with water vapour, which must be removed prior to export. The glycol system is used to dehydrate process gas through contact with glycol in the glycol contactor vessel. Rich glycol is treated and recovered in the glycol regeneration unit where solids are removed by separation and electrical heat is used to boil off the water. The collected liquids are returned to the closed drains drum while the gas vapours from the glycol regeneration are sent to the flare. The collected liquids are routed through the produced water system. Glycol levels are monitored and topped up when required.
- Hydrogen sulphide
  - There is an export pipeline gas specification for Hydrogen sulphide (H2S). A chemical scavenger is injected on a continuous basis to ensure that the pipeline entry limit is maintained. Liquid scavenging of H2S, is often necessary on safety and/or materials grounds to maintain the levels experienced in the downstream process at a safe level when wells with high H2S levels are produced to the topsides process.

All chemicals currently used on the Alwyn platform have been risk assessed and permitted under the Chemical Permit SAT (CP/69). The types of chemicals used to treat produced fluids from the Alwyn East field are not anticipated to change compared to the existing chemicals on the Alwyn platform; i.e. no new chemicals will be required. The treatment rate, or dosage level, for the batch chemicals is anticipated to remain unchanged. However, the volume of continuously applied chemicals, such as corrosion inhibitor, scale inhibitor and demulsifier, may increase due to higher production, though according to initial estimation the increase is not expected to be higher than 5% as a result of Alwyn East. Other chemical treatment volumes are expected to remain largely unchanged. It should be noted that the actual chemical management will be assessed and adjusted accordingly after the start-up. Any changes in required chemical volumes will be further risk assessed and a variation to CP/69 submitted at the appropriate time.

All chemicals to be used will be selected based on their technical specifications and environmental performance. Chemicals subject to substitution warnings under the Harmonised Mandatory Control Scheme, which are recognised as being hazardous to the marine environment, will be avoided where technically possible. The chemicals to be used during drilling have not yet been determined but will be selected following TEPUK's chemical management and selection system.

2.5.6 *Flaring and Venting*

2.5.6.1 Flaring

There are three separate flare systems on the Alwyn NAB platform; they operate at High Pressure, Low Pressure and Low-Low-Pressure. Gases from the three systems are burned at dedicated flare tips located adjacent to each other at the end of the flare boom. Flaring consents are granted on an installation basis and annually where production consents allow.

Flaring is classified as Base Load, Operational Load and Emergency Shut-down (ESD) Load at Alwyn. Flaring categorised as Base Load includes all the gas flared in order to maintain safe and efficient operation of the process facility and flare system under normal operation. It includes any gas that has to be discarded as part of the installation's processes and is discharged to flare. Base Load flaring will not be affected by the operations from Alwyn East.

Flaring categorised as Operational Load includes the following:

- flaring resulting from the planned start-up and shutdown of equipment;
- flaring resulting from planned maintenance activities and equipment outage; and
- flaring resulting from wells stimulation activity.

ESD Load Flaring includes any gas flared as a result of a process trip or an emergency shutdown. It also includes gas flared during restart of the process plant following a trip / ESD event. From experience on other Alwyn wells, as a result of producing from Alwyn East it is anticipated that there will be up to four additional well shutdowns and subsequent start-ups per year over the first two years (2023/24), during which a maximum of 25 tonnes per start-up will be flared when methanol is being injected for hydrate management. After two years, it is expected that the well pressure will have depleted such that methanol is not required for hydrate management and thus flaring is not required for restarts.

Alwyn's 2021 flare consent allows an average daily rate of 40.8 tonnes per day[h]. Consequently, the anticipated four additional flaring events per year as a result of production from Alwyn East represent approximately 0.7% of the approved Alwyn flare consent cumulative annual allowance. This figure does not include the volume flared during the initial well test and start-up.

2.5.6.2 Venting

In 2020, venting contributed <1% to overall Alwyn atmospheric emissions. Venting only occurs during ad hoc maintenance operations which will not increase in frequency as a result of Alwyn East. Hence, there will be no changes to venting as a result of additional production from Alwyn East.

A number of the platform wells on Alwyn have "live annuli" in which there are subject to hydrocarbon ingress over time. Assuming the Alwyn East well also has live annuli, it will be necessary to maintain the annuli in their correct operating windows for well integrity, by performing periodic bleed offs during well start up to remove excess gas from the annuli. The annuli would be bled off into a temporary liquid / gas separation package with the gas being routed into the drilling derrick vent stack for disposal. For conservatism, it has been assumed that the Alwyn East well will use a temporary vent for 30 days (to allow for completion and start-up) at a rate of 75 kg/day gas (based on experience with similar Dunbar wells). This equates to a maximum of four annuli bleeds per day. There is no venting expected during production phase, as no leak-off testing (LOT) is anticipated.

Alwyn's 2021 vent consent allows for an average daily rate 0.163 tonnes of vented gas. Based on the potential need to vent up to 75 kg/day for 30 days during well completions and start up, venting from the Alwyn East well represents approximately 3.8% of Alwyn's cumulative annual allowance.

[h] Equivalent rate, as allowance issued through two short-term consents.

2.6 *DECOMMISSIONING*

In the event that the Alwyn East well is successful, the well will be produced from the Alwyn platform. Consequently, no additional subsea infrastructure is required. The Alwyn East field is expected to be able to produce reliably out to 2040 as shown in Table 2-1 and Table 2-2 above, but overall production at Alwyn East may be constrained by other fields that are tied back to the Alwyn platform. Some of the older Alwyn wells are due to be plugged and abandoned starting from around 2024. CoP has not been defined yet but is likely to be earlier than 2040. The Alwyn East well will likely continue producing until the end of life of the wider Alwyn area development, with all the infrastructure being decommissioned as a whole.

All production wells will be plugged and permanently abandoned in accordance with the OGUK guidelines for suspension and abandonment of wells (or applicable legislation or guidance at that time). Additionally, all well programmes will be reviewed by the Health, Safety and Environment (HSE) Offshore Safety Division as required under The Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996.

Closer to the time of CoP, a full Decommissioning Plan will be developed in consultation with the relevant statutory authorities. Decommissioning options and the final method will be discussed and agreed with them, and will adhere to government policy and regulations in force at the time. The plan will be designed to ensure that potential effects on the environment resulting from the decommissioning of the facilities are considered and minimised.

2.7 *VESSEL REQUIREMENTS*

During the drilling campaign, there will be a small number of additional flights for transferring personnel (though these will be minimised as far as possible) and supply vessels to transport chemicals and ship muds and cuttings back to shore. The additional flights will be minimised as far as practical. During the operational phase, there will be no requirement for additional vessel trips or helicopter flights to what is currently deployed at the platform (Table 2-5).

Table 2-5 Vessel requirements

Operation type	Vessel type and number	Number of days/trips
Shipment of cuttings/muds Transport of chemicals	2 x Supply vessels	2 x supply vessels per week for 175 days 56 hours per return trip
Transfer of personnel during drilling	1 x Helicopter	4 trips per week for 175 days 5 hours return flight

3 ENVIRONMENTAL DESCRIPTION

3.1 INTRODUCTION

It is important in any impact assessment process that the main physical, biological and socio-economic sensitivities of the receiving environment are well understood. As such, this section describes the main characteristics of the environment in and around Alwyn East and highlights the key sensitivities.

This section draws on a number of information sources including published papers, relevant Strategic Environmental Assessments (SEAs), associated online mapping resource (NMPi, 2021) and site-specific investigations undertaken commissioned by TEPUK. Key studies used to inform this environmental description include:

- Habitat assessment and environmental monitoring survey at Alwyn in 2011 (Fugro, 2012).

Due to the close proximity of the Alwyn East field to the Alwyn field (approximately 5.8 km away), it is thought that the environmental observations from this survey are suitable to be used to infer the habitat at Alwyn East. This survey provides the most recent and comprehensive information on the benthic habitat in the area. Visual inspections are carried out around the Alwyn platform legs to monitor the condition of the jacket on an annual basis, and any seabed anomalies or environmental features of interest would be communicated to the environmental team as required for further analysis. However, there have not been any significant changes in the seabed around the Alwyn platforms and consequently, there is no specific survey reports to reference in this instance. As the Alwyn East well will be drilled from the Alwyn NAA platform using an existing well, there will be no disturbance to the seabed associated with the proposed Alwyn East drilling campaign. Consequently, TEPUK consider that this data source, combined with additional detail described below, provides sufficient information on which to base a robust impact assessment. Given the scope of the project, further environmental sampling is not thought to be required.

3.2 PHYSICAL ENVIRONMENT

3.2.1 Wind and Currents

The anti-clockwise movement of water through the North Sea and around the NNS region originate from the influx of Atlantic water, via the Fair Isle Channel and around the north of Shetland, and the main outflow northwards along the Norwegian coast (DECC, 2016). Against this background of tidal flow, the direction of residual water movement in the NNS is generally to the south or east (DTI, 2001; DECC, 2016). The peak flow for mean spring tide ranges between low velocities of 0.01 m/s in open water to 2.5 m/s in the narrow sounds around Orkney (Pentland Firth) (DECC, 2016). The mean residual currents surrounding the proposed Alwyn East field is approximately 0.163 m/s.

The NNS is seasonally stratified, and the strength of the thermocline is determined by solar energy, tidal and wave forces (DECC, 2016). Distinct density stratification occurs in the NNS region in summer at a depth of around 50 m and the thermocline becomes increasingly distinct towards deeper water in the north of the region (DECC, 2016). This stratification breaks down in September as the frequency and severity of storms increases causing mixing in the water column (DECC, 2009).

The prevailing winds in the NNS are from the south-west and north-north-east. Wind strengths in winter are typically in the range of Beaufort scale force 4-6 (6-11 m/s) with higher winds of force 8-12 (17-32 m/s) being much less frequent. Winds of force 5 (8 m/s) and greater are recorded 60-65% of the time in winter and 22-27% of the time during the summer months. In April and July, winds in the open, central to NNS, are highly variable and there is a greater incidence of north-westerly winds (DECC, 2016).

The annual mean wave height in the NNS region follows a gradient increasing from the southern point in the Fladen/Witch Ground to the northern area of the East Shetland Basin. In the south, the mean wave height ranges from 2.11 - 2.40 m whilst in the north it ranges from 2.41 - 3.00 m (NMPi, 2021). McBreen *et al.*, (2011) shows wave energy at the seabed to range between 'low' (less than 0.21 N/m^2) and 'moderate' (0.21 – 1.2 N/m^2) for most of the NNS region, increasing to 'high' (more than 12 N/m^2) close to shore. The wave height within the greater Alwyn area ranges from 2.41 - 2.7 m and the annual mean wave power is 36.1 – 42 kW/m (NMPi, 2021).

3.2.2 *Air Quality*

The Alwyn North platform currently has four GTGs, three are RR Avon GT and one is Alstom GT-35c. Air quality modelling performed in 2007 assumed that three out of four GTGs were operated under maximum load. Table 3-1 compares this worst-case scenario with current operational configuration (ITPEnergised, 2020).

Table 3-1 Operational Scenarios (ITPEnergised, 2020)

Scenario	Gas Turbine Generator Model	Output	Purpose
2007 Modelling (worst-case) whilst running on 3 out of 4 GTGs and running 2 export compressors	RR Avon 1535 Alstom GT-35c RR Avon 1535	1 x 17 MWe, 1 x 15.9 MWe 1 x 18.4 MWe 2 x 17 MW	Power Generation Power Generation Compression
Current Operations whilst running on 2 out of 4 GTGs and running an export compressor	RR Avon 1535 / Alstom GT-35c RR Avon 1535	2 x 10.5 MWe 1 x 11 MW	Power Generation Compression

Previously, it had been normal practice to run three out of four power generation turbines to meet the power requirements of the Alwyn North platform with one of the RR Avon turbines on standby.

Operations changed in 2020 as part of a series of energy improvement projects for the Alwyn North platform. The platform switched to two out of four Open Cycle Gas Turbines (OCGTs) operating, comprising one of the three RR Avon power generation turbines and the single Alstom GT-35c turbine. This approach is used to meet a power requirement of approximately 21 MWe.

Note that the extra power required for enhanced power reliability when undertaking critical phase drilling operations is met by the operation of three power generation turbines. Whilst the scenario modelled in 2007 is different to the current set-up, it overestimates the electrical output required from each generator, and therefore, any predicted concentrations for current operations are likely to be lower than those predicted by the 2007 modelling.

The maximum impacts, including background concentrations, are less than the air quality standards (AQS) for all of the operational scenarios considered in the 2007 modelling. All maximum predicted concentrations occur within 1.9 km or less of the Alwyn North location, several kilometres from any receptors. It was therefore concluded that the impact of combustion emissions and subsequent sea level NO_2, SO_2 and CO concentrations on the environment around the Alwyn North platform are not significant based on the lack of receptors and low percentages of the AQS values predicted by the modelling.

Emissions from current typical operation of two generators with a maximum of 21 MWe are expected to be less than those modelled in 2007. Emissions during drilling, when three power generation turbines are operating, are also expected to be less than modelled in 2007.

Worst-case modelling in 2007 concluded that the emissions from the Alwyn North platform did not pose a significant impact on the environment and therefore emissions from the reduced number of GTG currently in operation will not pose a significant impact on the environment.

3.2.3 *Bathymetry and Seabed Conditions*

The North Sea is a large shallow sea with a surface area of around 750,000 km^2. Water depths gradually deepen from south to north (DTI, 2001; DECC, 2016). The NNS region has a depth ranging from 100 m at the southern point in the Fladen/Witch Ground to as deep as 1,500 m in the Faroe-Shetland Channel.

In the NNS, and indeed across the North Sea, seabed sediments generally comprise a veneer of unconsolidated terrigenous and biogenic deposits, generally much less than 1 m thick, although areas of outcropping rock occur in coastal waters around and between Shetland, Orkney and the Scottish mainland. Sediments in the area are predominantly sand and muddy sand, although the deeper areas within the Fladen Ground consist of mud or sandy mud off the edge of the continental shelf to the north of the region, the slope is characterised by areas of mixed and coarse sediments, while the floor of the Faroe-Shetland Channel is classified as mud (Joint Nature Conservation Committee (JNCC), 2019; DECC, 2016).

3.2.3.1 Sediment types and Seabed features

According to the SEA2, the bulk of modern seabed sediments comprises substrates that are more than 10,000 years old and have been reworked from strata by currents that have been generated by tides and sea waves. Soft muds typically cover wide areas in the deeper waters of the continental shelf, while the three main types of hard substrate (rock, gravel and hard cohesive gravel) commonly occur together in the nearshore western margins of the North Sea. (DTI, 2001).

A habitat assessment and environmental monitoring survey was undertaken by Fugro Survey Ltd of the Alwyn area during 2011 (Fugro, 2012). The survey was located in the area surrounding the Alwyn platform and the associated pipeline towards the Dunbar platform. As Alwyn East is located 5.8 km northeast from the NAA platform at Alwyn North, the results of this survey are thought to provide an accurate representation of the benthos at Alwyn East.

The seabed around the Alwyn platform is relatively flat, varying little from 126 – 129 m, and even moving further from the platform into the wider area, depths are not often found out with the 125 – 150 m range (Fugro, 2012).

Seabed photography around the Alwyn platform showed two broad types of surficial sediment present; these were 'silty sand with shell fragments and pebbles' and 'coarse sand with pebbles, cobbles and boulders'. For the most part, photographic data showed majority of the stations within the Alwyn area and the infill area to be a consistent covering of silty sand with only small variations in the proportion of shell fragments between stations, although some locations (various areas to the south, north and east of Alwyn) showed a greater covering by pebbles, cobbles and boulders (up to 40% cover) (Fugro, 2012).

Sediment sampling supported the findings of the photographic data analysis that two different sediment types exist in the Alwyn field. According to the NMPi (2021) the sediments in the vicinity of the Alwyn field consists of sand, muddy sand, gravelly sand and slightly gravelly sand. The habitat at Alwyn East is also expected to be predominantly sand (Figure 3-1). Seabed sediments in the vicinity of the Alwyn platform are therefore considered to be typical of the NNS. Two habitats within the survey area were able to be identified according to the European Nature Information System (EUNIS): 'Deep circalittoral sand' (A5.27) and 'Deep Circalittoral mixed sediment' (A5.45) (Fugro, 2012).

Considerable scarring and disturbance of the seabed in the form of trawl scars, anchor scars and drilling mud related to previous fishing and drilling activity is apparent in the vicinity of Alwyn. Persistence of these features indicates the relatively low sediment mobility in the area (Fugro, 2012).

3.2.3.2 Sediment contaminants

The Alwyn platform is located in a region known as the East Shetland Basin. This area has been studied by the Fisheries Research Services (FRS; now Marine Scotland) as it has been subject to an intensive oil and gas exploration programme due to the possibility of cumulative hydrocarbon contamination (Russell *et al.*, 2005). Near-field Forties oil equivalent hydrocarbon concentrations determined in pre-2000 surveys were all above background levels of less than 50 µg/g dry weight (Baxter *et al.*, 2008). Mean Forties oil equivalent hydrocarbon concentrations in the far-field were lower than in the near-field, suggesting that contamination had originated from the oil field developments themselves (Baxter *et al.,* 2008).

Contamination of sediments may occur from discharges of drilling wastes and spills. Produced water is now the major ongoing source of hydrocarbons, with hydrocarbon input from drill cuttings essentially eliminated due to replacement of diesel and OBM discharges with alternative mud systems and disposal methods. The concentration of contaminants in sediment is found to be high within the immediate vicinity of installations, however, concentrations generally fall to background levels within a very short distance from discharge. Additionally, the levels of certain metals (Lead, Vanadium, Copper and Iron) appear higher in the southern North Sea compared to the northern North Sea. (DTI, 2001).

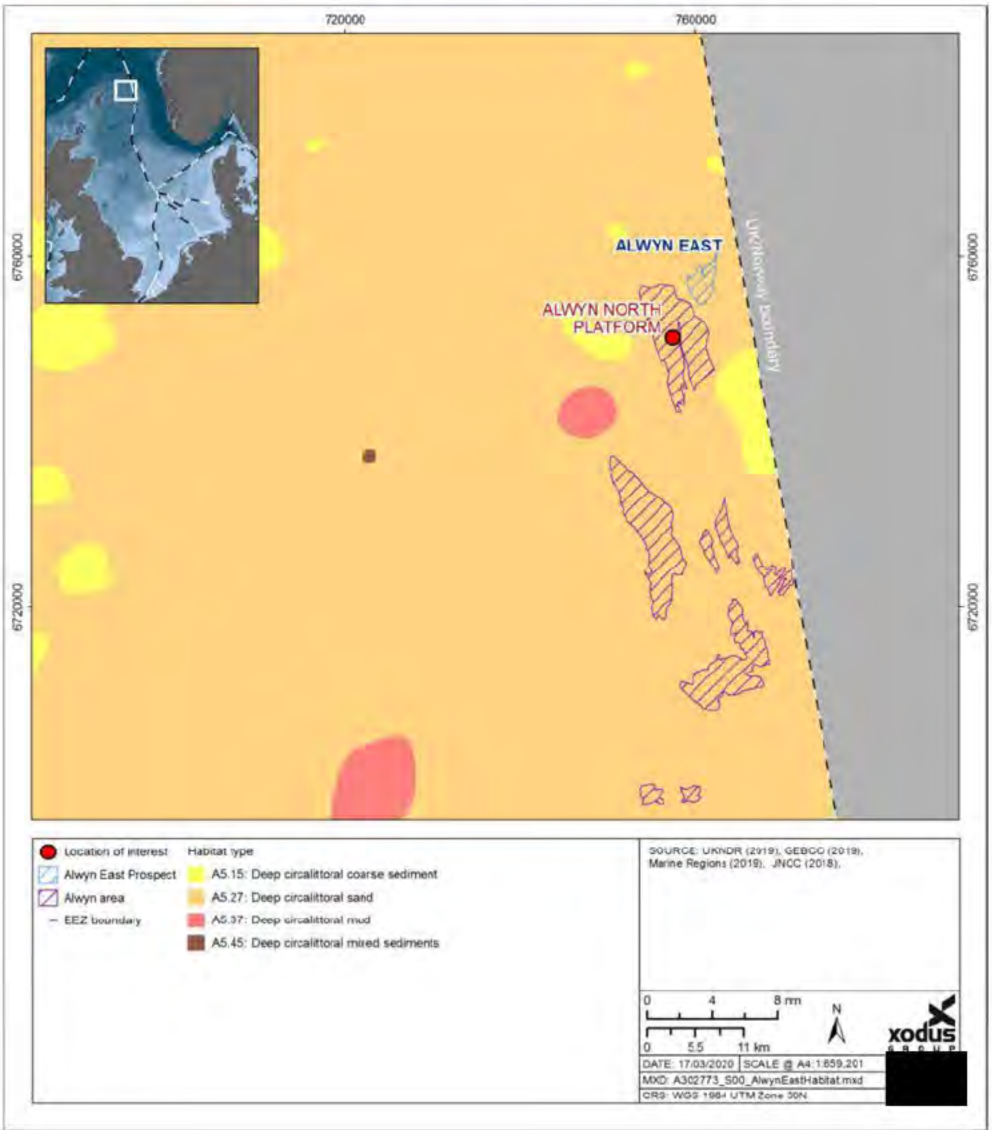
However, surveys since 2000 in the area have shown that oil contamination of near-field sediments has progressively declined over time, and that far-field mean concentrations have dropped below background levels. In the East Shetland Basin, survey work undertaken from 2002 reported a mean Polycyclic Aromatic Hydrocarbons (PAH) concentration of below 150 µg/kg dry weight (Baxter *et al.,* 2008). Analysis of the compounds suggests the source of these hydrocarbons to be diffuse combustion-related fallout from the atmosphere (Baxter *et al.*, 2008). The same survey notes some evidence of petrogenic input, but this was of mixed North Sea and Middle Eastern origin and thus is likely to be attributable to general shipping activity (Baxter *et al.*, 2008).

Hydrocarbon concentrations in 2001 and 2002 are therefore classed as low or close to background, with significant decreases observed when compared to earlier surveys (Baxter *et al.*, 2008). It is probable that hydrocarbons present at this time will have degraded further (Baxter *et al.*, 2008). This is confirmed by site-specific survey work undertaken at Alwyn (Fugro, 2012) which found that total hydrocarbon concentrations (THC) ranged from 5.3 µg/g to 23.6 µg/g, with the higher concentrations found in close proximity to the Alwyn platforms. However, the majority of values were comparable to UKOOA background values and substantially lower than in surveys undertaken prior to 2000.

PAH concentrations around Alwyn field showed a similar pattern to that related for THC above, being considerably lower than in pre-2000 surveys but still slightly elevated above background within 800 m of the Alwyn North platform (Fugro, 2012).

According to CNR's Ninian Northern Platform (NNP) Decommissioning Programme, total hydrocarbon levels surrounding NNP ranged from 8.0 µg/g to 1,390 µg/g (mean 137 µg/g), while those within the drill cutting pile ranged between 24,700 µg/g to 96,300 µg/g (µg/g = microgram (one millionth of a gram) per gram). Within 250 m of NNP, the values exceed the background concentrations for THC in Northern North Sea (CNR, 2019). The NNP was installed in 1978, while North Alwyn A was installed in 1986. Due to similar levels of activity expected from these two platforms, it is expected that sediments contaminants will be comparable.

Figure 3-1 Sediment composition at Alwyn East



3.3 *BIOLOGICAL ENVIRONMENT*

3.3.1 *Plankton*

Planktonic assemblages exist in large water bodies and are transported simultaneously with tides and currents as they flow around the North Sea. Plankton forms the basis of marine ecosystem food webs and therefore directly influences the movement and distribution of other marine species.

In both the northern and central areas of the North Sea, the phytoplankton community is dominated by dinoflagellates of the genus *Tripos* (*fusus, furca, lineatum*) and diatoms such as *Thalassiosira spp*. and *Chaetoceros spp*. In recent years the dinoflagellate *Alexandrium tamarense* and the diatom *Pseudo-nitzschia* (known to cause amnesic shellfish poisoning) has been observed in the area (DECC, 2016). Densities of phytoplankton fluctuate during the year, with sunlight intensity and nutrient availability driving its abundance and productivity together with water column stratification (Johns & Reid, 2001; DECC, 2016). In the 10-year period between 1997 and 2007, two main blooms are seen to occur in the NNS: one in May, and a second in August before levels decrease through the winter months when light and temperature are less abundant (SAHFOS, 2015).

Zooplankton species richness is greater in the northern and central areas of the North Sea, than in the south and displays greater seasonality. Zooplankton in this area is dominated by Calanoid copepods, in particular *Calanus* spp., *Eupahsusiid* spp, *Acartia*, and decapod larvae are also important to the zooplankton community in this region (DECC, 2016).

Calanus finmarchicus has historically dominated the zooplankton of the North Sea and is used as an indication of zooplankton abundance. Analysis of data provided by the Continuous Plankton Reader (CPR) surveys in the 10-year period between 1997 and 2007 shows a sharper spring increase in *C. finmarchicus* biomass in May in the NNS compared to more southerly areas. This peak in numbers is 70% greater than seen in the central North Sea and 88% greater than the southern North Sea over the same period (SAHFOS, 2015). The increase is likely a reflection of the increased availability of nutrients and food (including phytoplankton) in spring. Overall abundance of *C. finmarchicus* has declined dramatically over the last 60 years, which has been attributed to changes in seawater temperature and salinity (Beare *et al*., 2002; FRS, 2004). *C. finmarchicus* has largely been replaced by boreal and temperate Atlantic and neritic (coastal water) species in particular, and a relative increase in the populations of *C. helgolandicus* has occurred (DECC, 2009; Edwards *et al*., 2010; Baxter *et al*., 2011).

3.3.2 *Benthos*

The biota living near, on or in the seabed is collectively termed benthos. The diversity and biomass of the benthos is dependent on a number of factors including substrata (e.g. sediment, rock), water depth, salinity, the local hydrodynamics and degree of organic enrichment (DECC, 2016). The species composition and diversity of the benthos or macrofauna found within sediments is commonly used as a biological indicator of sediment disturbance or contamination.

In the central North Sea and the NNS, where oily cuttings tend to accumulate as discrete piles, surveys show a typical pattern of physical, chemical and biological gradients. Following initial smothering of the existing seabed fauna, the most contaminated sediments are colonised by a range of characteristic species, typically including the worm *Capitella*, an opportunistic worm able to rapidly colonise sediments disturbed by natural events and human activities, including pollution (DTI, 2001). Epifaunal studies in the same areas (Basford *et al*. 1989 and 1990) in which 152 stations were sampled for epifauna (animals living on the sediments) found the northern North Sea typified by *Asterias rubens*, *Astropecten irregularis* (starfish), *Brissopsis lyrifera* (sea urchin), with the Fladen Ground further distinguished by the presence of the seapens.

As mentioned in Section 3.2.3, environmental survey results indicated two habitat types present within the Alwyn field (Fugro, 2012). The first habitat type was 'Deep circalittoral sand' (A5.27) and was recorded across the majority of stations. This habitat is likely to be predominant within the Alwyn East field (Figure 3-1). It is characterised by a motile epifaunal community comprising sea urchins *Echinoidea*, sea stars *Asteroidea* and hermit crabs *Paguroidea* and occasional squat lobsters *Galatheidae*. Sedentary epifauna included anemones *Actinaria* and cup corals *Hexacorallia*. Evidence of the infaunal community from seabed photography data included brittle stars *Ophiuroidea*, worm tube worms *Polychaeta* along with empty shells observed to belong to tusk shells *Scaphopoda*. Sieve grab samples photos also identified the presence of sea potatoes *Spatangoida* and polychaete worms. Example photographs representative of this habitat type is provided in Figure 3-2 (Fugro, 2012).

Figure 3-2 Example images of deep circalittoral sand habitat observed in the Alwyn field (Fugro, 2012)

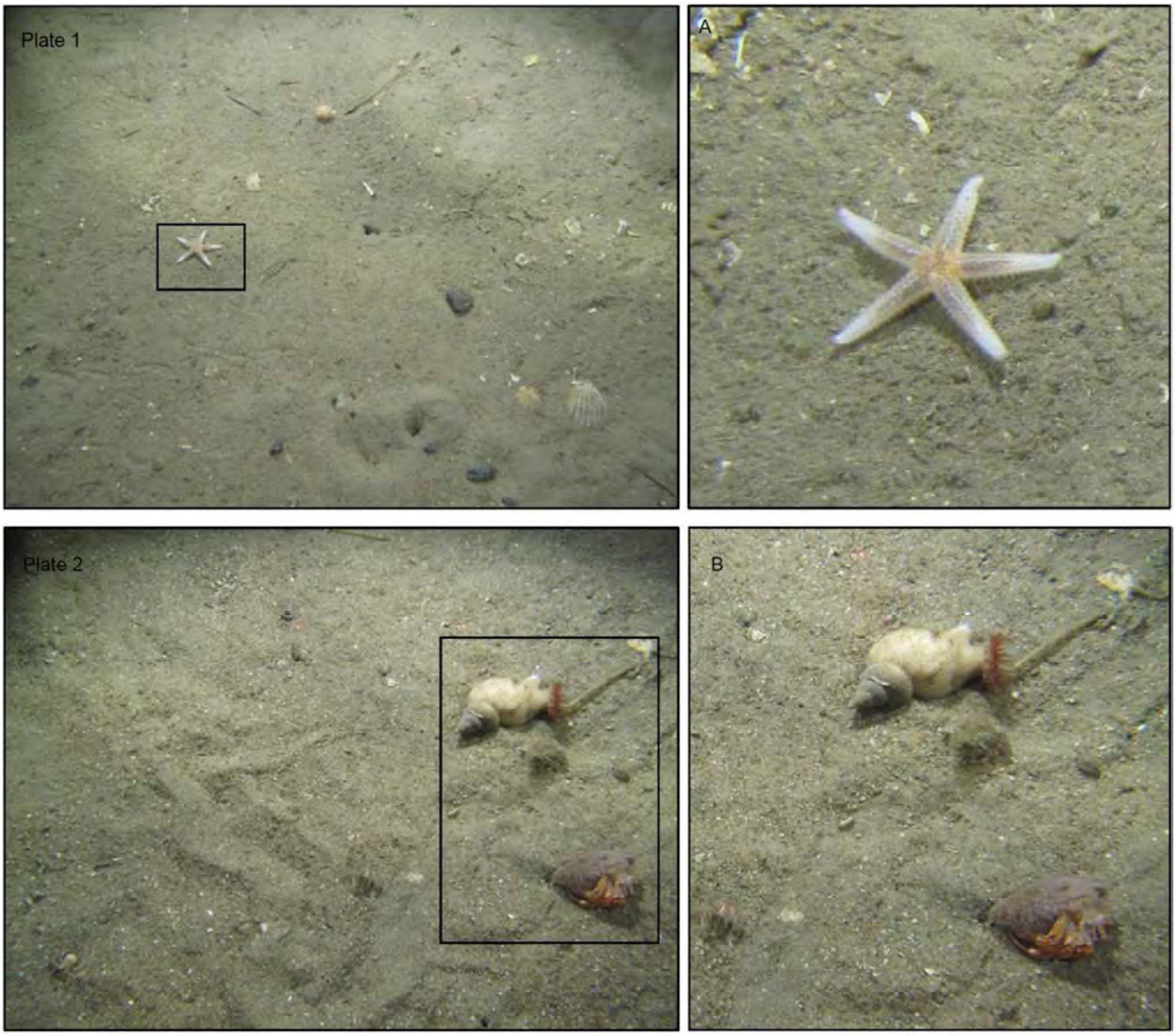


Plate 1 Station 1 Image 288 Easting: 431 171 mN Northing: 6 732 321 mN
Sediment: Silty sand with rare shell fragments

Fauna: A: Sea star (Asteroidea)

Plate 2: Station 17 Image 338 Easting: 429 358 mE Northing: 6 742 399 mN
Sediment: Silty sand with rare shell fragments
Fauna: B: Hermit crab (Paguroidea) with anemone (Actinaria) growth

The second habitat recorded was ‘Deep circalittoral mixed sediment’ (A5.45) which was found at two locations in the area, one approximately 1.2 km south of Alwyn and one approximately 6 km to the east. The seabed within this biotope complex was characterised by coarse sand with aggregates of pebbles and boulders. Boulders were often encrusted with an array of erect and encrusting sponges *Porifera*, bryozoans *Bryozoa*, hydroids *Hydroida*, cup corals *Hexacorallia* and anemones *Ascidians*. Motile species, consisting of hermit crabs *Paguroidea* and squat lobsters *Galantheidae* were seen in areas of high pebble and boulder cover, as well as urchins *Echinoidea* in intervals of coarse sand. Infaunal species in areas of coarse sand included brittle stars

Ophiuroidea, tube worms *Polychaeta* and tusk shells *Scaphopoda* resting on the sea floor. Example photographs representative of this habitat type is provided in Figure 3-3 (Fugro, 2012).

Figure 3-3 Example images of deep circalittoral mixed sediment habitat observed in the Alwyn field (Fugro, 2012)

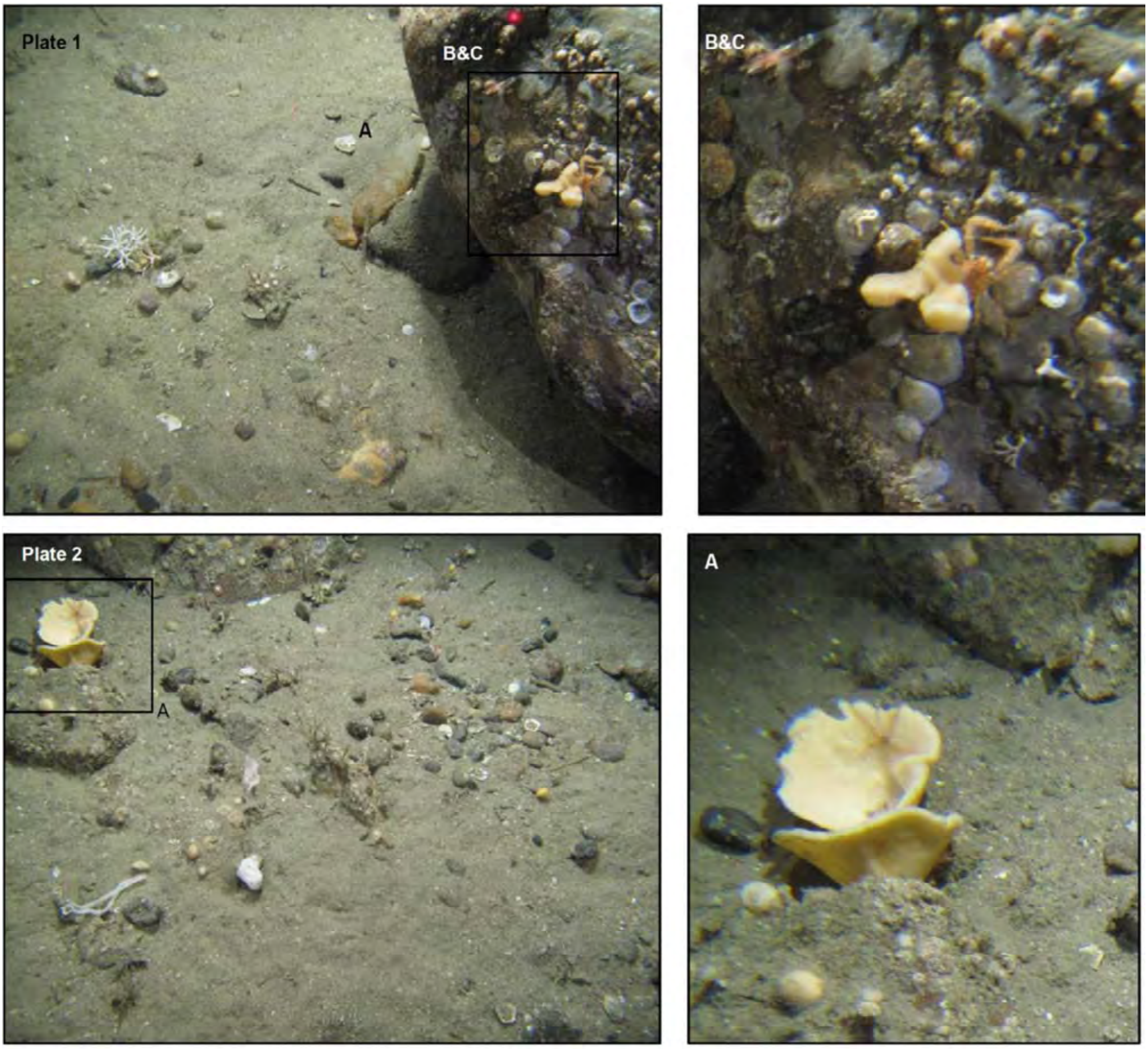


Plate 1:- Station: 24 Photograph: 408 Easting: 437 176 mE Northing: 6 742 463 mN
Sediment: Coarse sand with pebbles, cobbles and boulders
Fauna: A: Sea squirt (Ascidiacea) B: Squat lobster (Galatheidae) C: Encrusting and erect sponges (Porifera)

Plate 2:- Station: 24 Photograph: 410 Easting: 437 174 mE Northing: 6 742 458 mN
Sediment: Coarse sand with pebbles, cobbles and boulders
Fauna: A: Sponge (*Phakelia ventilabrum*)

While the majority of the survey area was found to be covered in silty sand, occasional areas of mixed sediments were observed which contained aggregations of pebbles, cobbles and boulders. The largest aggregations were seen from the seabed photographic data at station 24, located approximately 6 km east of the Alwyn Platform (Fugro, 2012). A summary of the assessment made for station 24 as an area of potential stony reef is provided in Table 3-2. Given the proximity of Alwyn East, 5.8 km north east of Alwyn, it is possible that reef-like habitat could be present within the field.

Table 3-2 Summary of 'Reefiness' criteria observed at Station 24 (Fugro, 2012)

Station	'Reefiness' Criteria		
	Percentage Cover of Cobbles and Boulders	Elevation*	Percentage Cover of Epifauna*
24	<10%	10 cm	<10%

After assessing the video footage and photographic stills using Irving stony reef assessment criteria (Irving, 2009) it was concluded that these areas showed a low potential for 'reefiness' and therefore were not considered as an Annex I habitat.

There were no other Annex I habitats or habitats of conservation importance observed within the vicinity of the Alwyn platform (Fugro, 2012).

3.3.3 *Fish and Shellfish*

A number of commercially important fish and shellfish species can be found in the vicinity of the Alwyn East field. Fish and shellfish populations may be vulnerable to impacts from offshore installations such as hydrocarbon pollution and exposure to aqueous effluents, especially during the egg and juvenile stages of their lifecycles (Bakke *et al*., 2013).

The Alwyn East field is located in International Council for the Exploration of the Sea (ICES) rectangle 50F1 in an area of spawning and nursery grounds for several commercially important species. There are periods of peak spawning for cod *Gadus morhua*, haddock *Melanogrammus aeglefinus*, Norway pout *Trisopterus esmarkii* and saithe *Pollachius virens*. It is an area of high spawning intensity for cod and Norway Pout and a high intensity nursery area for blue whiting *Micromesistius poutassou*. Information on spawning and nursery periods for these different species are detailed in Table 3-3. Additionally, the following species are listed as being Scottish Priority Marine Features (PMFs) anglerfish *Lophius piscatorius*, blue whiting, cod, herring *Clupea harengus*, ling *Molva*, mackerel, *Scomber scombrus,* Norway pout, saithe, sandeels *Ammodytes marinus,* spurdog *Squalus acanthius* and whiting *Merlangius merlangus.*

The geographical extent of the spawning and nursery areas for species listed in Table 3-3 is illustrated in Figure 3-4 for spawning grounds and Figure 3-5 and Figure 3-6 for nursery grounds. Figure 3-5 and Figure 3-6 also present data from Aires *et al.* (2014) showing the probability of aggregations of "0 group" fish (fish in the first year of their lives), including where these are not captured as nursery areas in the older data.

Table 3-3 Fish spawning and nursey areas in the vicinity of Alwyn East (Coull *et al.*, 1998 and Ellis *et al.*, 2012)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anglerfish	N	N	N	N	N	N	N	N	N	N	N	N
Blue Whiting	N	N	N	N	N	N	N	N	N	N	N	N
Cod	S	S*	S*	S								
European hake	N	N	N	N	N	N	N	N	N	N	N	N
Haddock	N	S*N	S*N	S*N	SN	N	N	N	N	N	N	N
Herring	N	N	N	N	N	N	N	N	N	N	N	N
Ling	N	N	N	N	N	N	N	N	N	N	N	N
Mackerel	N	N	N	N	N	N	N	N	N	N	N	N
Norway Pout	SN	S*N	S*N	SN	N	N	N	N	N	N	N	N
Saithe	S*	S*	S	S								
Sandeel	SN	SN	N	N	N	N	N	N	N	N	SN	SN
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Whiting	N	SN	SN	SN	SN	SN	N	N	N	N	N	N

S = Spawning, N = Nursery, SN = Spawning and Nursery; * = peak spawning, Species = High nursery intensity as per Ellis *et al*, 2012; Species = High intensity spawning as per Ellis *et al* (2012); Species = High concentration spawning as per Coull *et al.*, 1998;

Figure 3-4 Spawning grounds for Cod, Haddock, Norway Pout, Saithe, Sandeel and Whiting

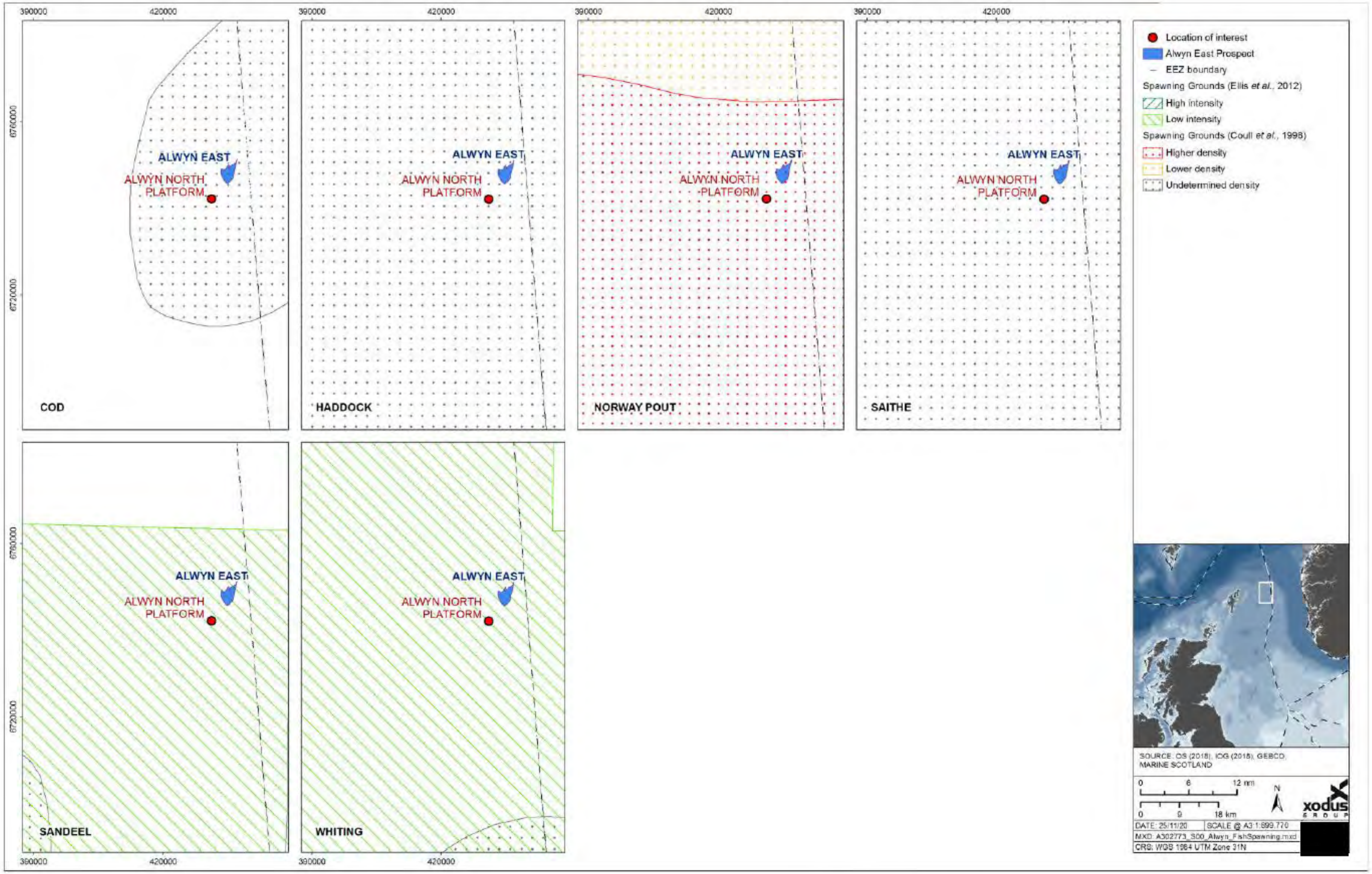


Figure 3-5 Nursery grounds of Anglerfish, Blue whiting, Cod, Haddock, Hake, Herring, Horse Mackerel and Mackerel

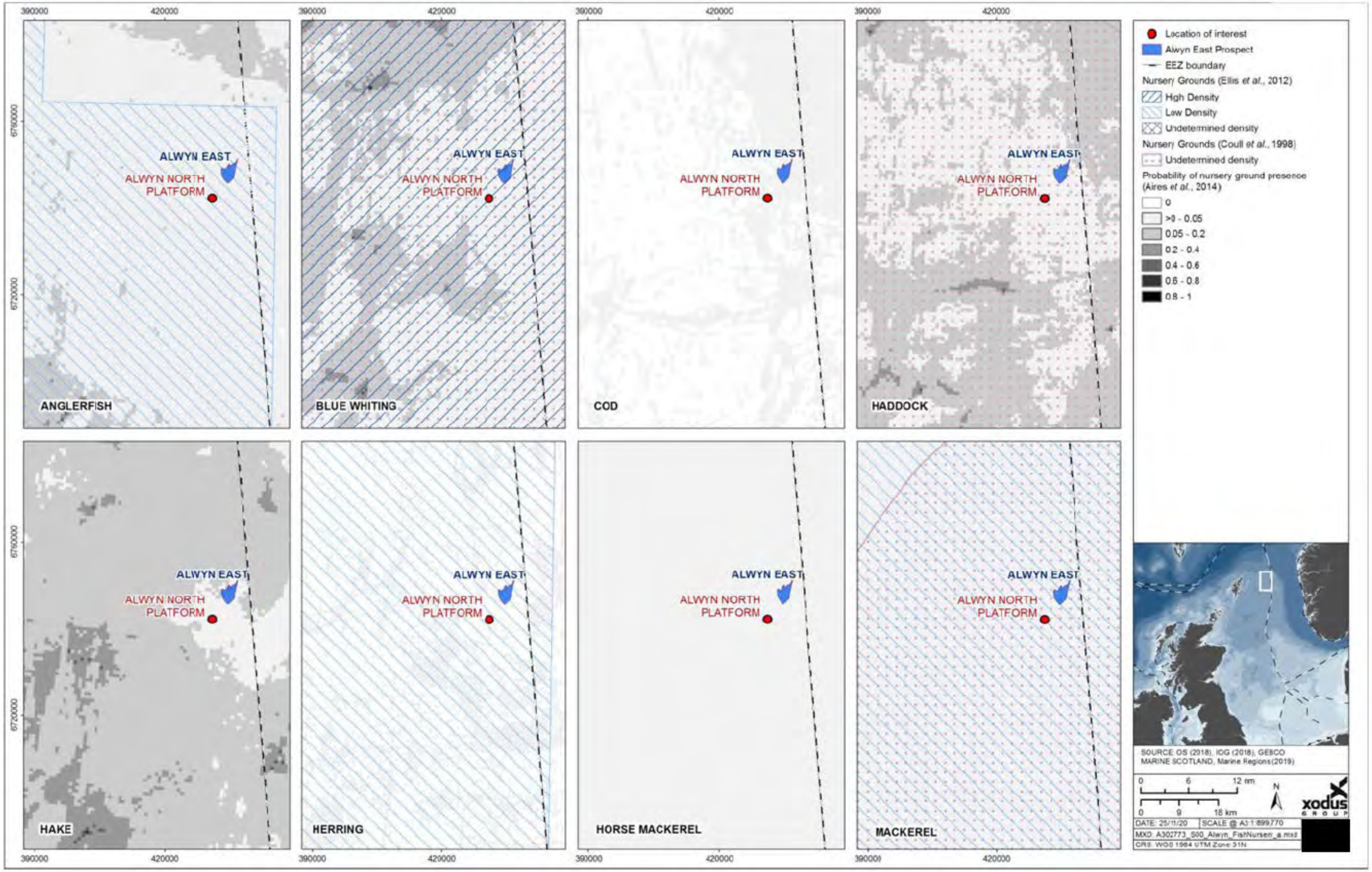
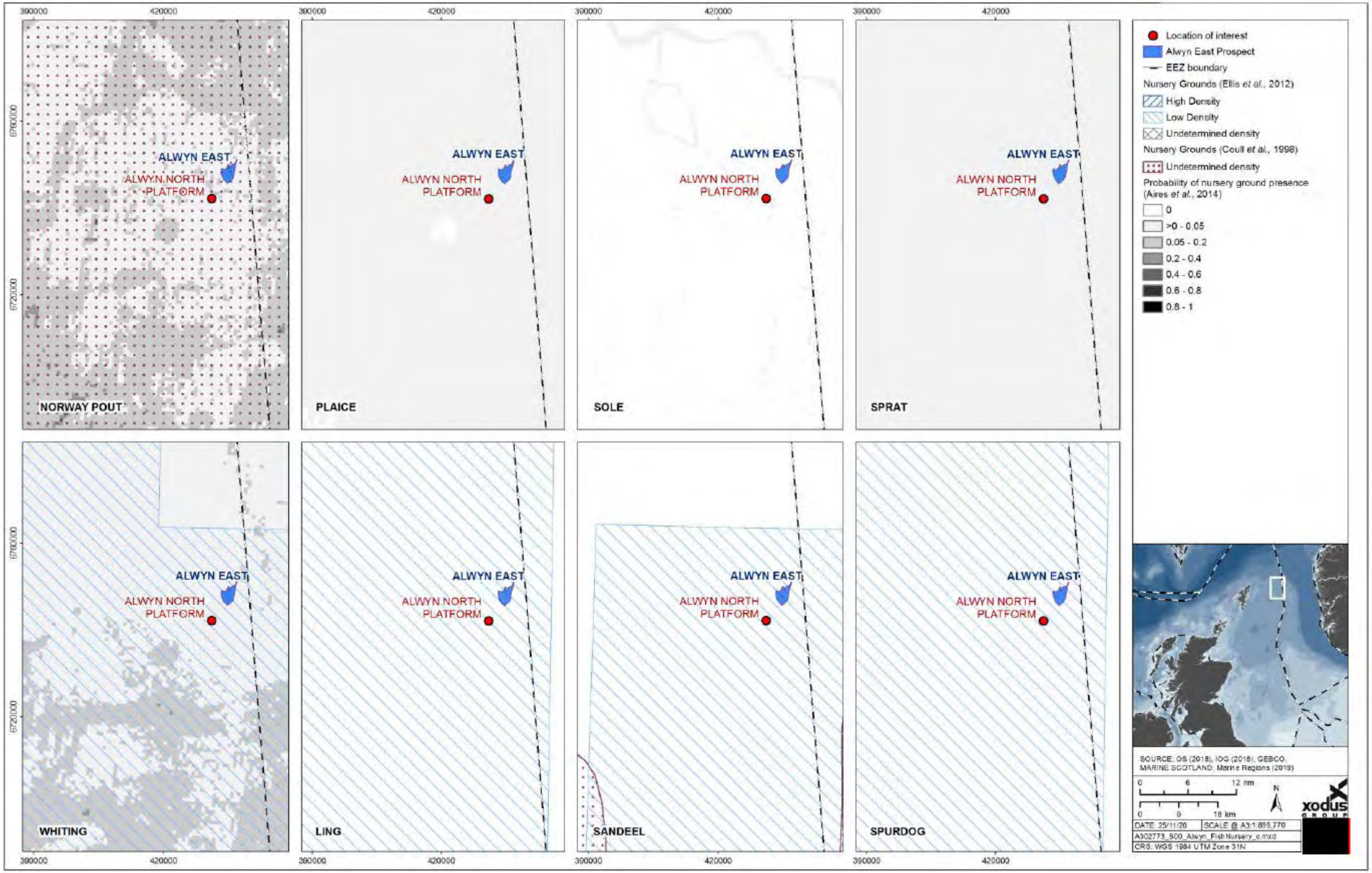


Figure 3-6 Norway Pout, Plaice, Sole, Sprat, Whiting, Ling, Sandeel, Spurdog



Fisheries sensitivity maps produced by Aires *et al*., (2014) for Marine Scotland Science detail the likelihood of aggregations of fish species in the first year of their life (i.e. group 0 or juvenile fish) occurring around the UKCS. Maps from Aires *et al*., (2014) which show the probability of the presence of aggregations of 0 group anglerfish, blue whiting, European hake *Merluccius*, haddock, herring, mackerel, horse mackerel, Norway pout, plaice *Pleuronectes platessa*, sprat *Sprattus* and whiting are available on the NMPi (2021). The probability of 0 group fish species occurring at Alwyn East was low[i] for all species.

Spawning areas for most species are not rigidly fixed and fish may spawn either earlier or later from year to year. In addition, the mapped spawning areas represent the widest known distribution given current knowledge and should not be seen as rigid unchanging descriptions of presence or absence (Coull *et al*., 1998). Whilst most species spawn into the water column of moving water masses over extensive areas, benthic spawners (e.g. sandeel) have very specific habitat requirements, and as a consequence their spawning grounds are relatively limited and potentially vulnerable to seabed disturbance and change.

There are five species of sandeels known to occur in the North Sea, with the majority (90%) of the commercial catch made up of the lesser sandeel. Sandeels are shoaling fish which lie buried in the sand during the night, and hunt for prey in mid-water during daylight hours (DECC, 2016). They are restricted to sandy sediments (Holland *et al*., 2005; DECC, 2016). They feed mainly on planktonic prey such as copepods and crustacean larvae, but they can also consume polychaete worms, amphipods, and small fish including other sandeels. When active, sandeels swim continually in order to remain clear of the bottom (DTI, 2001). Sandeels usually spawn between November and February and lay eggs in clumps on sandy substrates (DECC, 2016). The larvae are pelagic up to approximately two to five months after hatching and are believed to over-winter buried in the sand (DECC, 2016). Sandeel are important not only to commercial fisheries but also are also of ecological significance as they are a vital food source for marine birds and predatory fish (DECC, 2016). According to Mazik *et al*., (2015), sandeels are likely to avoid areas with greater than 10% of silt/clay or very fine sand. As sand is the predominant sediment type at Alwyn East (Figure 3-1), there is potential for sandeels to spawn in the area.

3.3.4 *Seabirds*

Much of the North Sea and its surrounding coastline is an internationally important breeding and feeding habitat for seabirds. In the Central North Sea (CNS) and NNS, the most numerous species present are likely to be northern fulmar *Fulmarus glacialis*, black-legged kittiwake *Rissa tridactyla* and common guillemot *Uria aalge* (DECC, 2009; DECC, 2016). Seabirds are not normally affected by routine offshore oil and gas operations. In the unlikely event of an oil release, however, birds are vulnerable to oiling from surface pollution, which could cause direct toxicity through ingestion, and hypothermia as a result the birds' inability to waterproof their feathers. Birds are most vulnerable in the moulting season when they become flightless and spend a large amount of time on the water surface.

After the breeding season ends in June, large numbers of moulting auks (common guillemot, razorbill *Alca torda* and Atlantic puffin *Fratercula arctica*) disperse from their coastal colonies and into the offshore waters from July onwards. At this time these high numbers of birds are particularly vulnerable to oil pollution. In addition to auks, black-legged kittiwake, northern gannet *Morus bassanus*, and northern fulmar, are present in sizable numbers during the post breeding season.

According to the density maps provided in Kober *et al*., (2010), the following species have been recorded within the Alwyn and Alwyn East area: northern fulmar, northern gannet, Arctic skua *Stercorarius*, great skua *Stercorarius skua*, black-legged kittiwake, great black-backed gull *Larus marinus*, common gull *Larus canus*, lesser black-backed gull *Larus fuscus*, herring gull *Larus argentatus*, glaucous gull *Larus hyperboreus*, Arctic tern *Sterna paradisaea*, common guillemot, razorbill, little auk *Alle* and Atlantic puffin.

The JNCC has released the latest analysed trends in abundance, productivity, demographic parameters and diet of breeding seabirds, from the Seabird Monitoring Programme (JNCC, 2016). This data provides at-a-glance UK population trends as a % of change in breeding numbers from complete censuses. From the years 1998-2015, the following population trends for species known to use the Alwyn East field area have been recorded: northern fulmars (-31%), black legged kittiwakes (-44%) and common guillemots (+5%). Breeding seabird numbers of some species have shown a long-term decline, most probably as a result of a shortage of

[i] The probability maps show information detailing the performance of the Random Forest model used to classify the data sets, this ranked probability of the presence of aggregations each species from low to high. In all instances, the probability was checked on the NMPi (2021) and considered to be at the low end of the probability scale.

key prey species such as sandeels associated with changes in oceanographic conditions (Baxter *et al.*, 2011: DECC, 2016).

The Seabird Oil Sensitivity Index (SOSI) (Webb *et al.*, 2016) identifies sea areas where seabirds are likely to be most sensitive to oil pollution. It is an updated version of the Oil Vulnerability Index (OVI) (JNCC, 1999) as it uses survey data collected between 1995 and 2015 and includes an improved method to calculate a single measure of seabird sensitivity to oil pollution. The survey area covers the UKCS and beyond. Seabird data was collected using boat-based, visual aerial, and digital video aerial survey techniques. This data was combined with individual species sensitivity index values and summed at each location to create a single measure of seabird sensitivity to oil pollution (Webb *et al.*, 2016). Block/month combinations that were not provided with data have been populated with the SOSI using the indirect assessment method provided by Webb *et al.* (2016).

Seabird sensitivity in the region of the Alwyn East field is medium in May and June (in Block 3/05), then low throughout the rest of the year, as shown in Table 3-4 as well as in Figure 3-7 and Figure 3-8. The region around Alwyn East reflects a similar sensitivity, with the sensitivity at the Alwyn platform (Block 3/09) being low throughout the year.

Table 3-4 Seabird oil sensitivity the vicinity of Alwyn and the surrounding area (Webb *et al.*, 2016)

Quad/Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
211/28	5	5	5	5*	N	5*	5	5	4	4*	5*	5
211/29	5	5	5	5*	N	5*	5	5	5	5*	5*	5
211/30	5	5	5	5*	N	5*	5	5	5*	N	N	5*
3/3	5	5	5	5*	5*	5	5	5	4	4*	5*	5
3/4	**5**	**5**	**5**	**5***	**N**	**5***	**5**	**5**	**5**	**5***	**5***	**5**
3/5	**5**	**5**	**5**	**5***	**4***	**4**	**5**	**5**	**5***	**N**	**N**	**5***
3/8	5	5	5	5*	5*	5	5	5	5	5*	5*	5
3/9	5	5	5	5*	N	5*	5	5	5	5*	5*	5
3/10	5	5	5	5*	4*	4	5	5	5*	N	N	5*
Key	1=Extremely High		2=Very High		3=High		4=Medium		5=Low		N=No Data	
*in light of coverage gaps, an indirect assessment of SOSI has been made												

In addition, Alwyn is located approximately 136 km from the nearest UK coast and is therefore remote from sensitive seabird breeding areas on the coast.

According to the JNCC, Blocks 03/04, 03/05 and 03/09 have no restrictions for drilling activities (Oil and Gas Authority, 2019).

Figure 3-7 Seabird Oil Sensitivity at the Alwyn Field from January to June (Webb *et al.*, 2016)

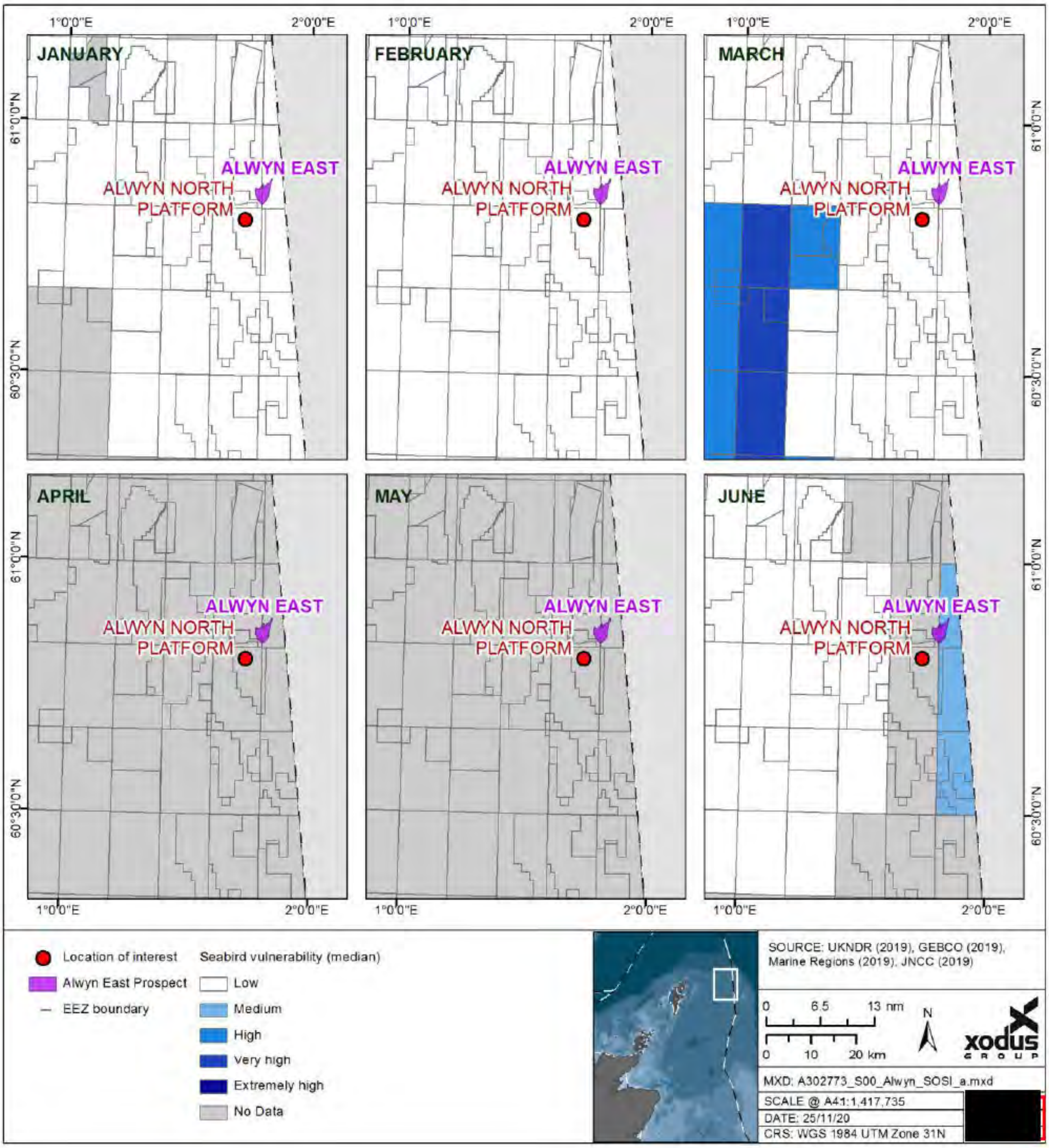
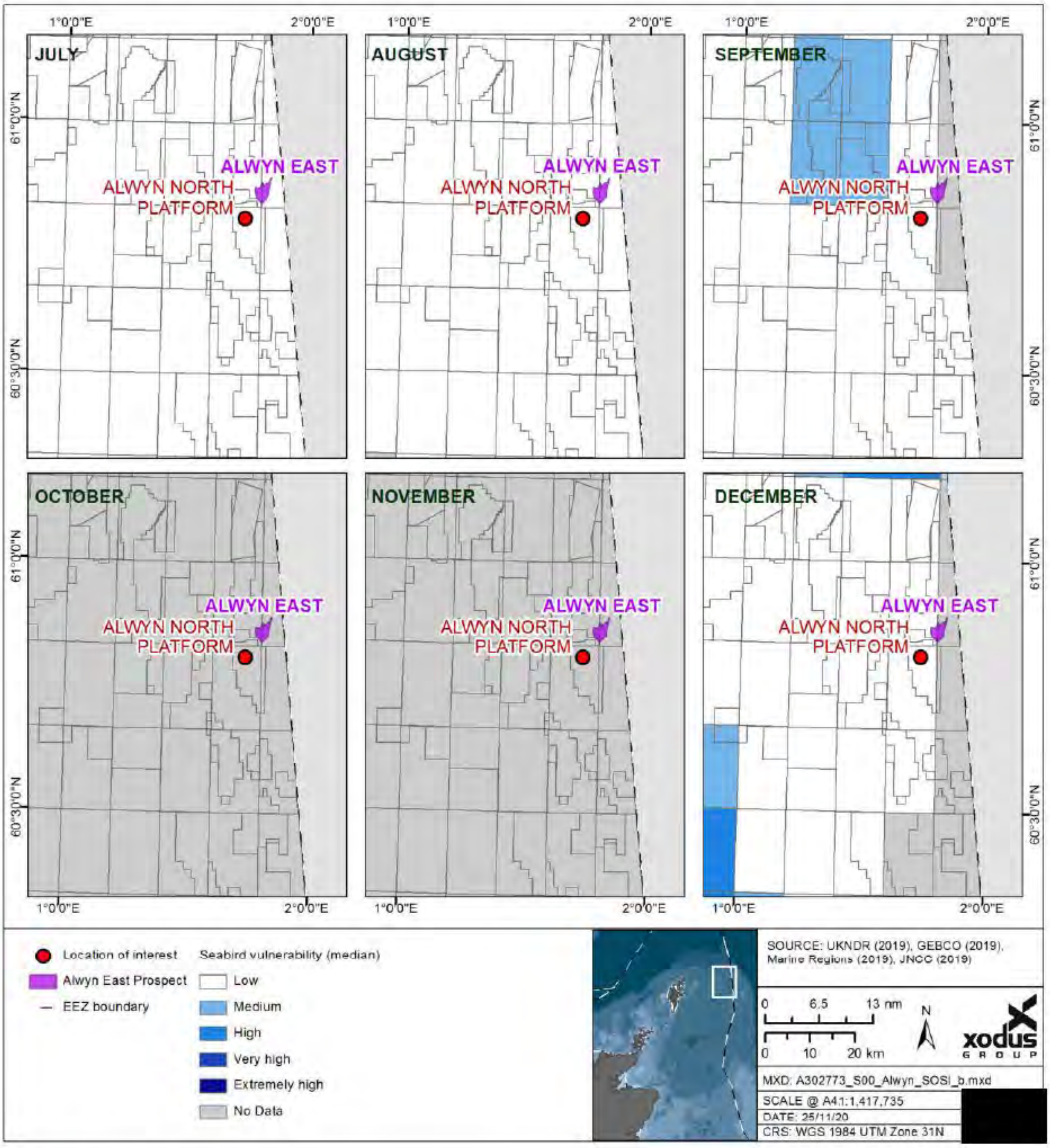


Figure 3-8 Seabird Oil Sensitivity in the Alwyn Field from July to December (Webb *et al.*, 2016)



3.3.5 *Marine Mammals*

3.3.5.1 Cetaceans

The central and NNS has a moderate to high diversity and density of cetaceans, with a general trend of increasing diversity and abundance with increasing latitude. Harbour porpoise *Phocoena* and white-beaked dolphin *Lagenorhynchus albirostris* are the most widespread and frequently encountered species, occurring regularly throughout most of the year. Minke whales *Balaenoptera acutorostrata* are regularly recorded as frequent seasonal visitors. Coastal waters of the Moray Firth and east coast of Scotland support an important population of bottlenose dolphins *Tursiops truncatus*, while killer whales (*Orcinus orca*) are sighted with increasing frequency towards the north of the area. Atlantic white-sided dolphin *Lagenorhynchus acutus*, Risso's dolphin *Grampus griseus* and long-finned pilot whale *Globicephala melas* can be considered occasional visitors, particularly in the north of the area (DECC, 2016).

Atlantic white-sided dolphins, harbour porpoise, minke whale, long-finned pilot whale and white-beaked dolphins have been recorded in the vicinity of the Alwyn field (Reid *et. al.,* 2003 and NMPi, 2021) (see Table 3-5). All of these species are listed as PMFs, European Protected Species (EPS) and under Annex IV under the EU Habitats Directive. Additionally, harbour porpoise is listed under Annex II of the Habitats Directive (Scottish Natural Heritage (SNH), 2014).

Table 3-5 Seasonal Occurrence of the most frequently sighted cetaceans in the vicinity of Alwyn East (Reid *et al.*, 2003; NMPi, 2021)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Atlantic white-sided dolphin							3					
Harbour porpoise		2				2	1	1	1			
Minke whale							2					
Long-finned pilot whale												2
White-beaked dolphin						3	3					
Key: 1 = High Density, 2 = Moderate Density, 3 = Low Density, Blank = No data/												

3.3.5.2 Seals

Two species of seals live and breed in the UK, namely the grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* (Jones *et al.,* 2015; DECC, 2016). Both grey and harbour seals are listed under Annex II of the EU Habitats Directive and are PMFs. Approximately 38% of the world's grey seals breed in the UK and 88% of these breeds at colonies in Scotland, with the main concentrations in the Outer Hebrides and in Orkney, while approximately 30% of harbour seals are found in the UK. However, this proportion has declined from approximately 40% in 2002. Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles (Special Committee on Seals, 2018).

Grey and harbour seals will feed both in inshore and offshore waters depending on the distribution of their prey, which changes both seasonally and yearly. Both species tend to be concentrated close to shore, particularly during the pupping and moulting season. Seal tracking studies from the Moray Firth have indicated that the foraging movements of harbour seals are generally restricted to within a 40–50 km range of their haul-out sites (Special Committee on Seals, 2017). The movements of grey seals can involve larger distances than those of the harbour seal, and trips of several hundred kilometres from one haul-out to another have been recorded (SMRU, 2011).

The Alwyn field is located approximately 136 km offshore, so grey and harbour seals may be encountered from time to time, but it is not likely that they use the area with any regularity or in great numbers. This is confirmed by the grey and harbour seal density maps published by the Sea Mammal Research Unit (SMRU), which are provided in the NMPi (2021). The maps report the presence of grey and harbour seals in the vicinity of Alwyn as less than 1 individual per 25 km^2.

3.4 *CONSERVATION*

3.4.1 *Offshore Conservation*

There are no protected sites located within 40 km of the Alwyn East field (Figure 1-1). The closest protected site is the Pobie Bank Reef Special Area of Conservation (SAC) which lies approximately 88 km to the southwest of the Alwyn East field. The Pobie Bank Reef is designated for the presence of stony and bedrock reef, an Annex I Habitat. This reef is a habitat for an extensive community of encrusting and robust sponges and bryozoans (JNCC, 2014). Areas of coarse sediment around the Alwyn North platform surveyed in 2011, appeared to satisfy criteria for assessment as Annex I stony reef habitat under the EU Habitats Directive (Fugro, 2012). Still photographs were assessed for 'reefiness' according to JNCC guidelines incorporating measures of percentage cover of cobbles and boulders, elevation from the seabed and epifaunal. However, it was concluded that the aggregates seen in the photographic data had a low potential of 'reefiness' and were not considered to be Annex I habitat (Fugro, 2012). Given the considerable distance to the Alwyn East field from these conservation areas, no impacts are predicted on them as a result of the planned operations.

Based on the results of the study and the benthic habitat, as described in Section 3.3.2, no Annex I habitats, or habitats of conservation significance are expected to be within the vicinity of the Alwyn East field. There are no designated Marine Protected Areas (MPAs) in the vicinity of the Alwyn East field.

3.4.2 *Protected Species*

Four species identified under Annex II of the Habitats Directive occur in UK offshore waters; the grey seal, harbour seal, bottlenose dolphin and harbour porpoise. It is unlikely that either seal species will be present in anything but very low numbers in the vicinity of the Alwyn East field (as detailed in Section 3.3.5.2). Harbour seals are typically concentrated around and between haul out sites and foraging areas whilst grey seals do travel further offshore. There is a resident population of bottlenose dolphins on the east coast of Scotland; however, they typically remain near the east coast in the vicinity of the Moray Firth. Harbour porpoises could be present in the vicinity of the Alwyn field; however, due to their mobile nature they are likely to move away and not be adversely affected by routine operations at Alwyn.

All species of cetaceans (Atlantic white-sided dolphins, harbour porpoise, minke whale, long-finned pilot whale and white-beaked dolphins) observed within the vicinity of the Alwyn field are EPS and are listed under Annex IV of the Habitats Directive. Other marine species listed as EPS's include turtles and sturgeon *Acipenser sturio*, which are not likely to be present within this area of the North Sea.

Additionally, along with all species of cetaceans, the following fish species are listed as PMFs anglerfish, blue whiting, cod, herring, ling, mackerel, Norway pout, saithe, sandeels, spurdog and whiting (SNH, 2014).

3.4.3 *National Marine Plan*

The National Marine Plan (NMP) covers the management of both Scottish inshore waters (out to 12 nautical miles) and offshore waters (12 to 200 nautical miles). The aim of the NMP is to help ensure the sustainable development of the marine area through informing and guiding regulation, management, use and protection of the Marine Plan areas. The proposed additional production from Alwyn as described in this ES, have been assessed against the Marine Plan Objectives and policies, specifically GEN 1 (Scottish Government, 2015).

TEPUK will ensure that they comply with all the new policies that have been introduced; with particular attention being made to the policies as detailed in Table 3-6. For all relevant policies and objectives, TEPUK will ensure that any potential impacts associated with Alwyn operations, will be kept to a minimum as detailed in Chapter 2.

Table 3-6 NMP policies relevant to Alwyn operations

Policy	Title	Details
GEN-1	General planning and principle	Development and use of the marine area should be consistent with the Marine Plan, ensuring activities are undertaken in a sustainable manner that protects and enhances Scotland's natural and historic marine environment.
GEN-4	Co-existence	Where conflict over space or resource exists or arises, marine planning should encourage initiatives between sectors to resolve conflict and take account of agreements where this is applicable.
GEN-5	Climate change	Marine planners and decision makers should seek to facilitate a transition to a low carbon economy. They should consider ways to reduce emissions of carbon and other greenhouse gasses.
GEN-9	Natural heritage	Development and use of the marine environment must: • Comply with legal requirements for protected areas and protected species. • Not result in significant impact on the national status of Priority Marine Features. • Protect and, where appropriate, enhance the health of the marine area.
GEN-12	Water quality and resource	Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply.
GEN-13	Noise	Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects.

Policy	Title	Details
GEN-14	Air quality	Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits. Some development and use may result in increased emissions to air, including particulate matter and gasses. Impacts on relevant statutory air quality limits must be taken into account and mitigation measures adopted, if necessary, to allow an activity to proceed within these limits.
GEN-21	Cumulative impacts	Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.
Oil and Gas 1*	-	Activity should be carried out using the principles of Best Available Technology (BAT) and Best Environmental Practice (BEP). Consideration will be given to key environmental risks including the impacts of noise, oil and chemical contamination and habitat change.
Oil and Gas 3*	-	Supporting marine and coastal infrastructure for oil and gas developments, including for storage, should utilize the minimum space needed for activity and should take into account environmental and socio-economic constraints.
Oil and Gas 6*	-	Consenting and licensing authorities should be satisfied that adequate risk reduction measures are in place, and that operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan and the Offshore Safety Directive.
*Note: There are 6 Oil and Gas policies (listed under Chapter 9 of the NMP), all of which are taken into account when carrying out activities. Only the three policies specifically related to environment are listed here.		

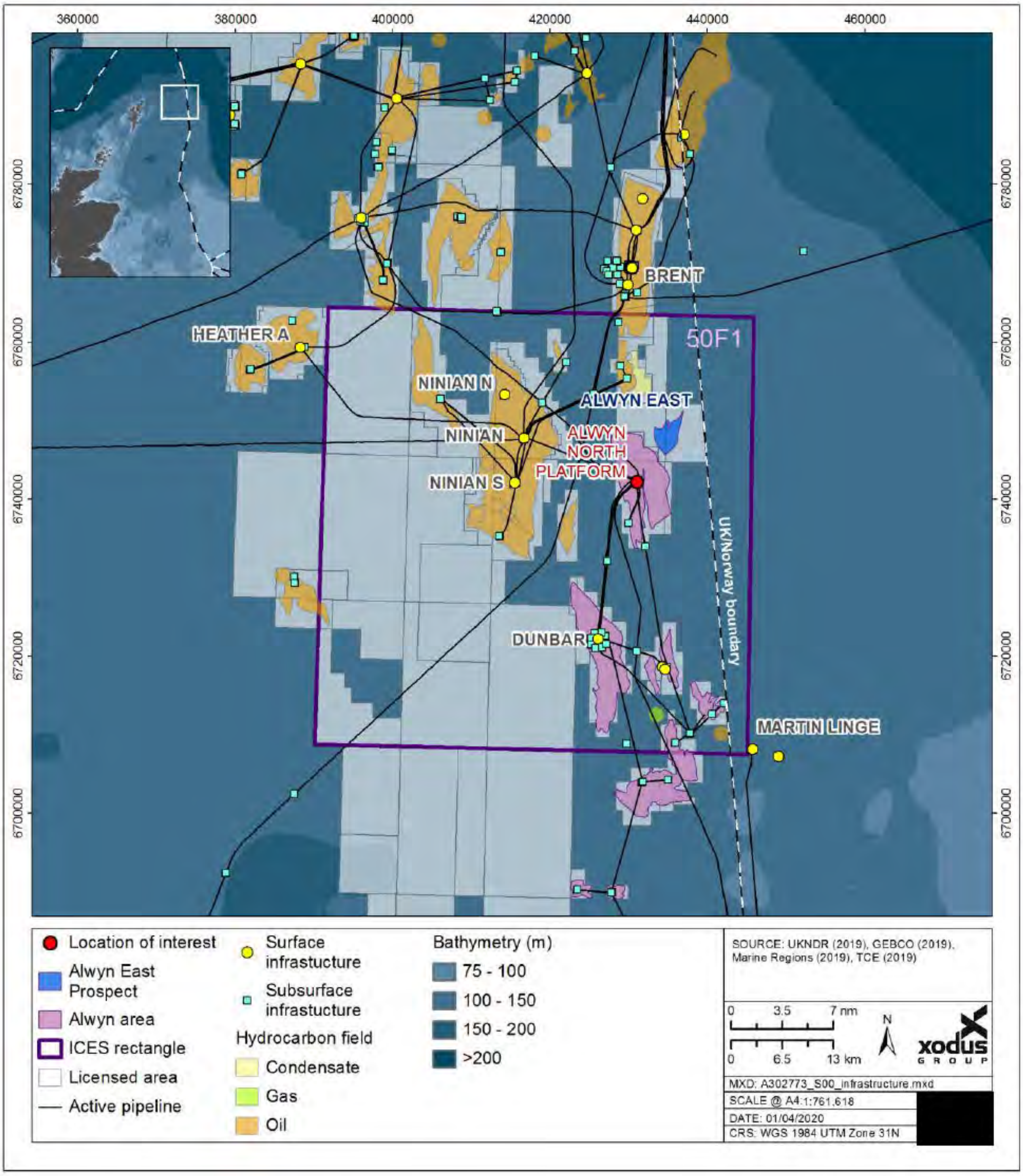
3.4.4 *Onshore Conservation*

The nearest coastline, are the Shetland Islands, located approximately 136 km to the west of the Alwyn field. Due to the distance from the nearest coastline, no impacts are expected from routine operations.

3.5 *SOCIO-ECONOMIC ENVIRONMENT*

The following section describes the key features of the socio-economic environment in the vicinity of the Alwyn East field, details of which can be found in Figure 3-9.

Figure 3-9 Socio-economic environment in the vicinity of Alwyn



3.5.1 *Commercial Fisheries*

The North Sea has important fishing grounds fished by the fishing fleets of the UK and other nations, targeting demersal, pelagic and shellfish species. The Alwyn East field is located within ICES rectangle 50F1 (Scottish Government, 2021a).

According to provisional fishing data from Scottish Government (2021a), ICES 50F1 is predominately targeted for demersal species, comprising 99.4% of the live weight and approximately 99% of the value of ICES rectangle 50F1 (Table 3-7). Shellfish species accounted for 1% of the value and 0.6% of the weight, whilst there was no pelagic fishing recorded in the area. As ERD will be occurring, the majority of operations at Alwyn

East will be taking place within an established 500 m exclusion zone, therefore only one year of fishing data has been provided.

To put landings into context, a total of 517,595 tonnes with a value of £643,626,072 was landed in the UK in 2020 (Scottish Government, 2021a). Therefore, contributions from ICES 50F1 are low, comprising 0.3% of the value and 0.2% of the weight of the UK total (Scottish Government, 2021a).

Table 3-7 Live weight and value of fish and shellfish from ICES rectangle 50F1 in 2020 (provisional) (Scottish Government, 2021a)

Species type	2020	
	Value (£)	Live weight (tonnes)
Demersal	2,108,872	1,192
Pelagic	0	0
Shellfish	29,973	7
Total	**2,138,845**	**1,199**

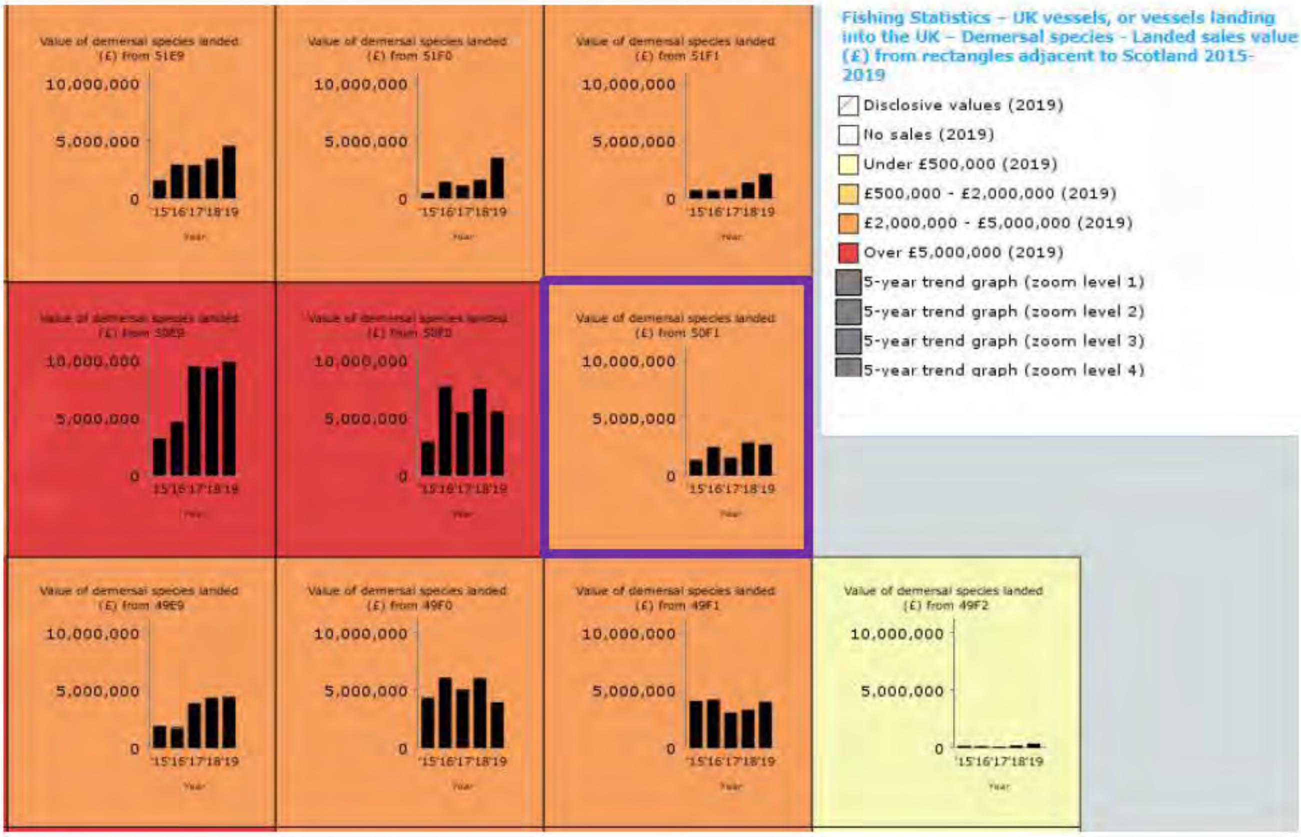
Effort across the months in ICES rectangle 50F1 was relatively consistent over the year. Effort was highest in the months of January, June and July (Table 3-8). A total of 251 days were fished in 50F1 during 2020 (Scottish Government, 2021a). To put effort into context, a total of 103,917 days were fished in the UK during 2020 (Scottish Government, 2021a), therefore, contributions from ICES rectangle 50F1 can be considered low; comprising 0.2% of the UK total.

Table 3-8 Number of days fished per month in ICES rectangle 50F1 in 2020 (provisional) (Scottish Government, 2021a)

ICES	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
50F1	2020	33	15	22	21	13	33	32	27	13	18	12	12	**251**
Note: Monthly fishing effort by UK vessels landing into Scotland: Blank = no data, D = Disclosive data (indicating very low effort), green = 0 – 100 days fished, yellow = 101 – 200, orange =201-300, red = ≥301														

Vessel Monitoring System (VMS) data from 2009-2013 for demersal fishing indicate that intensity within the area is moderate to high (Marine Scotland, 2015). According to fisheries statistics from Marine Scotland (2019), visualised using the NMPi tool (2021, sales from demersal species in ICES rectangle 50F1 are moderate (£2,000,000 - £5,000,000) in comparison to the wider area (Figure 3-10).

Figure 3-10 2015-2019 Demersal landings value (£) for ICES Rectangle 50F1 and the surrounding area (NMPi, 2021)



3.5.2 *Oil and Gas Activities*

The North Sea is of considerable importance to the oil and gas industry. There is a long history of oil and gas activity, with oil being discovered in the early 1960s and the first well coming online in the early 1970s. Gas activities are most common in the south of the North Sea, whilst both oil and gas are found in the northern areas. The Alwyn East field is located in the NNS region, in an area of extensive oil development.

The closest oil and gas activities to Alwyn is the Ninian field located in Block 3/08 (approximately 15 km from the Alwyn platform) and the Strathspey field located in Block 3/04, approximately 11.4 km from Alwyn as illustrated in Figure 3-11. The Staffa field which lies 8 km from Alwyn is no longer active.

3.5.3 *Shipping Activities*

The North Sea contains some of the world's busiest shipping routes, with significant traffic generated by vessels trading between ports at either side of the North Sea and the Baltic. North Sea oil and gas fields generate moderate vessel traffic in the form of support vessels, principally operating from Peterhead, Aberdeen, Montrose and Dundee in the north and Great Yarmouth and Lowestoft in the south (DECC, 2016). The Alwyn East field is located in an area that experiences low shipping intensity (Oil and Gas Authority, 2016).

3.5.4 *Military Activities*

The Alwyn North platform is located within Block 3/09, which lies within a Military of Defence (MoD) training range (Oil and Gas Authority, 2019). The Alwyn East is also located within an MoD training range area. However, as all routine operations will take place from the Alwyn platform, there will be no requirement for any additional notifications to be issued to the MoD. All activity will be covered under the existing notifications.

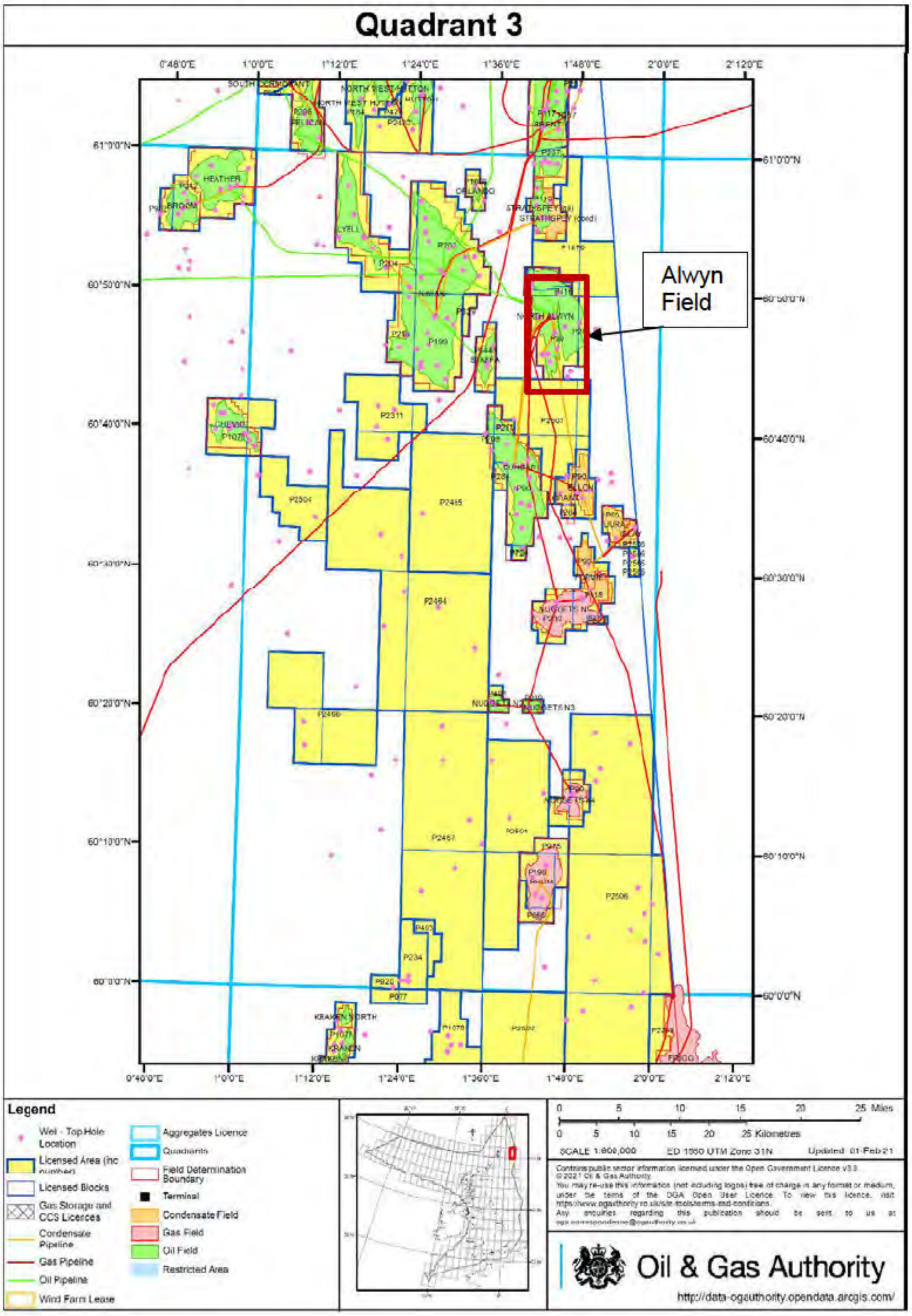
3.5.5 *Submarine Cables*

There are no cables in the immediate vicinity of the Alwyn East platform (KIS-ORCA, 2021).

3.5.6 *Wrecks*

There is one wreck, possibly of the Blagdon, which is located north of the centre of Block 3/04 (NMPi, 2021). Due to the nature of the operations, this wreck is not considered to be at risk from the additional production operations at Alwyn East. There are no other wrecks, historic Marine Protected Areas (HMPAs), scheduled monuments (including wrecks) or war graves located with the vicinity of the Alwyn platform which are close enough to be impacted by operations (NMPi, 2021).

Figure 3-11 Oil and Gas activities within Quadrant 3 (Oil and Gas Authority, 2021)



3.6 NATURAL DISASTERS

This section aims to identify natural features of the environment in the Alwyn area that could pose a risk to the proposed operations, including the possible effects of seismic events, and particularly those events that could result in a hydrocarbon spill.

The prevailing winds in the NNS are from the southwest and north-northeast. Wind strengths in winter are typically in the range of Beaufort scale force 4-6 (6-11 m/s) with higher winds of force 8-12 (17-32 m/s) being much less frequent. Winds of force 5 (8 m/s) and greater are recorded 60-65% of the time in winter and 22-27% of the time during the summer months. In April and July, winds in the open, central to NNS, are highly variable and there is a greater incidence of north-westerly winds (DECC, 2016).

Historical records show that seismic activity in the North Sea is concentrated between the Fladen Ground and the waters offshore of Norway, and within the Dogger Bank area. It is considered that earthquakes with magnitude of 4 or higher may require special structural design and are of concern for oil and gas activities. In the North Sea, the expected frequency of occurrence for a magnitude 4 natural seismic event is approximately every two years and a magnitude 5 natural seismic event every 14 years (DTI, 2001). Using revised seismic hazard data for the North Sea (HSE, 2002), it is noted that the Alwyn installations are located in an area that has a moderate-to-high level of seismicity for the North Sea but is low compared to other oil and gas producing areas.

Alwyn North was originally designed for naturally occurring events with a return period of 1 in 100 years. The original jacket design allowed for a minimum air gap of 1.5 m between wave crest of a 100-year wave (31 m) and the underside of the main structural members together with a 1 m allowance for settlement. Surveys of the platform are carried out on a 5 yearly frequency and the results from the latest survey confirm no settlement of the platform has been observed (Fugro, 2014). Considering the surveyed platform elevation in conjunction with the more recent metocean criteria, the predicted air gap expected during extreme storm events have been revised; for the 100 year return period storm event an air gap of 4.7 m and 4.6 m is predicted for NAA and NAB respectively. For the revised 10,000 year return period extreme water level, a small level of wave inundation of both platform cellar decks is predicted (Fugro, 2011).

3.7 OVERALL SUMMARY OF KEY ENVIRONMENTAL SENSITIVITIES

A summary of the key seasonal sensitivities within the Alwyn area, illustrating the change in seasonal sensitivities throughout the year is provided in Table 3-9.

Table 3-9 Summary of key environmental sensitivities

Plankton	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The increase in phytoplankton productivity reaches its peak between May and August in the NNS. Levels fall in June but remain elevated during the summer months before a sharp decline in October. Zooplankton provide an important source of food for many fish and marine mammal species.												
Benthos	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Surveys within the greater Alwyn area showed two broad types of surficial sediment present; these were 'silty sand with shell fragments and pebbles' and 'coarse sand with pebbles, cobbles and boulders'. Species present include sea urchins, sea stars and hermit crabs, occasional squat lobsters, anemones, cup corals, brittle stars, worm tube worms, sea potatoes and polychaete worms. This is expected to be representative of the benthic habitat at Alwyn East. There are no known Annex II and Annex I seabed species or habitats, PMFs or OSPAR (Oslo Paris Convention) habitats and species in the greater Alwyn area.												
Finfish and shellfish	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The Alwyn East field is located within the nursery grounds for a number of commercially important fish species including anglerfish, blue whiting, haddock, European hake, herring, ling, mackerel, Norway pout, sandeels, spurdog and whiting. The area is also located in an area of spawning grounds for cod, norway pout, whiting, haddock and saithe.												
Birds	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The following bird species have been recorded within the vicinity of Alwyn East: northern fulmar, northern gannet, Arctic skua, great skua, black-legged kittiwake, great black-backed gull, common gull lesser black-backed gull, herring gull, glaucous gull, Arctic tern, common guillemot, razorbill, little auk and Atlantic puffin. Seabird sensitivity in the region of the Alwyn East field is medium in May and June, then low throughout the rest of the year.												

<table>
<tr><td>Cetaceans</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td colspan="13">Atlantic white-sided dolphins, harbour porpoise, minke whale, long-finned pilot whale and white-beaked dolphins have been recorded in the vicinity of the Alwyn East field. Sightings are in moderate densities in February, June and December, increasing to high in July, August and September.</td></tr>
<tr><td>Conservation</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td colspan="13">There are no designated sites or protected areas within 40 km of Alwyn East. Additionally, there were no Annex II species observed during the surveys in the Alwyn area. All species of cetaceans observed within the vicinity of the field are listed as European Protected Species (EPS) as well as Scottish PMFs. Several species of fish observed to be present in the ICES rectangle 50F1 are also considered to be PMFs. However, due to the mobile nature of these species and the nature of the operations, no impacts to these species are envisaged. Additionally, the proposed operations are remote from sensitive breeding areas on the coastline. Due to this distance (136 km) from the shoreline no onshore conservation sites are deemed to be at risk.</td></tr>
<tr><td>Other sea users</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td colspan="13">The waters surrounding Alwyn East are targeted for demersal species. Fish landings and effort are considered to be relatively low, comprising <1% of the UK total in 2020. The closest existing active oil and gas infrastructure to Alwyn East will be the NAA, and the Ninian and Strathspey fields (located approximately 15 and 11.4 km respectively from the Alwyn platform). There are no existing or planned renewable projects within the vicinity. While Alwyn East does lie within an area of concern to the Ministry of Defence (MoD), due to the nature of the operations, there is no requirement for additional notifications to the MoD. There is one wreck located in block 3/04, although it is not considered to be at risk, nor is it a danger to the proposed activities, due to its distance and the nature of the operations.</td></tr>
<tr><td>Air Quality</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td colspan="13">Previous modelling assumed that each turbine was operated under maximum load. For both gas and diesel fuel combustion predicted NO_2, SO_2 and CO concentrations were lower than background concentrations and therefore did not approach local air quality thresholds for these pollutants used onshore.

The current turbine load and the number of turbines operating is less than that previously modelled. Therefore, it is considered that the previous modelling will provide an over-estimate of ambient pollutant concentrations compared with current operation but sits within the operational envelope previously modelled with the existing modelling capturing the potential worst-case impacts on local air quality resulting from the platform.</td></tr>
</table>

Key: Sensitivity level	High	Moderate	Low	Negligible

4 EIA METHODOLOGY

4.1 INTRODUCTION

The EIA process requires an understanding of the proposed project and the environment upon which there may be an impact. Fundamental to the process is the systematic identification of issues that could impact the environment, including other users of the environment. Once identified, these issues have to be assessed to define the level of potential impact they present to the environment, so that if necessary, measures can be taken to remove or reduce such effects through mitigation.

4.2 CONSULTATION

TEPUK informed OPRED of the new Alwyn East field in August 2019 and updates on the timing of the drilling campaign have been provided at regular intervals since then.

4.3 ENVIRONMENTAL ISSUES IDENTIFICATION

Having defined the project (Section 1.3) and the baseline environment including the sensitivity of receptors (Chapter 3), it is then necessary to identify and assess the possible effects. Identification of the potential implications from the proposed drilling campaign and additional production from Alwyn East has been undertaken and the issues requiring assessment as part of the EIA have been identified below. For clarity, the potential for impacts to occur has been assessed using the 2020 production data as a baseline since this is the latest whole year for which an appropriate production consent has been granted (called the 'base year'). The addition of the Alwyn East field to the Alwyn facilities will not result in the processing capacity of the NAB platform increasing.

The impacts taken forward for further consideration are:

- Atmospheric emissions:
    - During drilling activities at Alwyn East, emissions are expected to increase due to the requirement for a third GTG to ensure the critical drilling phases are completed safely. However, once production starts, the platform will revert to using two generators for power generation as a base case. Additional fluids from Alwyn East are within the process capacity of Alwyn therefore no additional export compressors are required. Operational load flaring is not an approach used on Alwyn when a gas export route is not available although four additional start-ups are expected per year for the first two years of production. Emissions due to venting are not expected to change during the production phase. Emissions from fuel gas consumption (GTGs and gas export compressor) will not increase proportionally to the Alwyn East production as the topsides equipment will run more efficiently as a result of processing the additional fluids, however there may be times where additional power is required under certain process conditions. The additional emissions from fuel gas consumption are difficult to quantify and are likely to be indistinguishable from data reported in recent years, however a worst-case emissions scenario has been used for this assessment.
    - There will be emissions from supply vessels and helicopters required for the drilling campaign as well as emissions created as a result of well annuli venting and flaring during the well start-up. An assessment of the atmospheric emissions associated with Alwyn East has been undertaken and is presented in Chapter 5.
- Discharges to sea:
    - There may be small quantities of chemicals discharged to sea during the drilling campaign and new production from the Alwyn East reservoir may result in increased water production, as well as greater volumes of water being treated and discharged to sea, which could lead to changes in water quality and impact upon the species that make use of the water column. The assessment of the potential impacts arising from these discharges is presented in Chapter 6.
- Accidental events:
    - The drilling of a new well and the increase in production associated with Alwyn East creates opportunity for a Major Accident Hazard (MAH) associated with operations to cause a Major Environmental Incident (MEI). This is assessed further in Chapter 7.

A number of other potential impacts have been scoped out of the EIA; these, along with a rationale for scoping out, are provided in Table 4-1. The subsequent sections of this ES have been used to justify (where required) where no impacts are expected and assess the significance of any potential impacts. Where appropriate they highlight the management and mitigation measures that TEPUK will ensure are in place during operations.

Table 4-1 Impacts scoped out of further assessment

Potential impact	Justification for approach
Seabed disturbance, including benthos and benthic spawning fish species	There will be no new seabed infrastructure, no drill cuttings or any other form of seabed disturbance as a result of the drilling of the Alwyn East well and the subsequent production increase. The Alwyn East well will be drilled via ERD and all cuttings will either skipped and shipped to shore or disposed of via CRI. As such, there is no opportunity for the seabed to be affected by the proposed activities. Additionally, despite the potential for some reef-like habitat in the Alwyn East field, no Annex I habitats have been noted in the area. Nor were any sensitive protected benthic species identified in surveys in the vicinity of Alwyn. Therefore, it is unlikely that species or habitats of conservation concern are located within either the Alwyn or Alwyn East fields. ICES rectangle 50F1 is an area of spawning and nursery grounds for several commercially important species. However, the probability of juvenile fish aggregations was low for all species assessed. Therefore, the area is not likely to constitute an important area for spawning activity. However, as sandeels are reliant on sandy substrate which may be present at Alwyn there is the potential for the species to use the area for spawning. No impact to the benthic environment is anticipated as a result of the proposed activities. Therefore, by extension, the proposed drilling campaign and production increase at Alwyn East will not affect fish species which may use the area for spawning.
Disturbance or injury to marine mammals as a result of noisy activities	There will be an increase in the number of vessel trips (two supply vessel trips per week). However, the increased vessel presence and drilling activities will be temporary and short term (up to 175 days). During the production phase, there will be no requirement for additional vessel trips or helicopter flights to what is currently deployed at the platform. Present noise generated by operations at Alwyn North are negligible in the context of ambient noise levels. As the well will be drilled through an existing donor well from the platform, with drilling operations starting from the previously drilled 17½" section, over 2,000 m below the seabed, underwater noise-emitting activities as a result of ERD are expected to be minimal. Due to the distance of Alwyn to the coast, both grey and harbour seals are unlikely to be encountered in great numbers as they are typically found at low density in the field area (<1 individual per 25 km^2). Observation data suggests that the area could be moderately frequented by a variety of cetacean species (Atlantic white-sided dolphin, Harbour porpoise, minke whale, long-finned pilot whale, and white beaked dolphin). However, given the increase in production will not alter levels of noise, no change in impact on receptors is predicted. Therefore, no disturbance or injury to marine mammals is anticipated.
Displacement to other users of the sea e.g. fisheries and shipping caused by security zones and infrastructure	There will be no new infrastructure as a result of the Alwyn East drilling campaign and additional production from the Alwyn East field. There will be a small increase in vessel movement during the drilling phase (two supply vessel trips a week). However, this will be temporary and short term (up to 175 days) and there will be no requirement for additional vessel trips during the production phase to what is currently deployed at the platform. Over the course of the drilling campaign, there will be no significant change in impact to other users of the sea, including fisheries and shipping in the vicinity of the Alwyn field.

Potential impact	Justification for approach
Physical presence impacts to landscape / seascape and cultural heritage	There will be some new equipment and/or modifications to existing equipment associated with the NAA topsides to accommodate the additional production from the Alwyn East field. These alterations are all surface structures. The additional production is expected to extend the life of the Alwyn field. Furthermore, the Alwyn field is a well-established field which has been producing since 1987. Due to the longevity of Alwyn, no change in impact to the seascape is predicted as a result of the proposed increase in production. The Alwyn East well will be drilled via ERD from the NAA, located approximately 136 km from shore, thus no impacts on costal landscape, onshore visual receptors and cultural heritage are expected.
Population and human health	The NAA is located approximately 136 km from the UK coast, therefore direct impacts to population are not expected. Atmospheric emissions can impact human health through global climate change; however, due to the Alwyn platform being located so far offshore and the local air quality of the offshore environment, no impacts are expected as a result of the additional production from the Alwyn East field.
Cumulative Impacts	The potential for cumulative impacts via atmospheric emissions and accidental releases is negligible. However, cumulative impacts are further assessed throughout this report where relevant.

4.4 *IMPACT SIGNIFICANCE*

4.4.1 *Overview*

The EIA Regulations require that the assessment should consider the likely significant effects of the development on the environment. The decision process related to defining if a project is likely to significantly impact on the environment is the core principal of the EIA process. The 2020 EIA guidance (BEIS, 2020) does not provide a specific definition of significance, however, the Regulations do state that predictions of the magnitude and significance of the likely effects of the project must be included, and discussion of likely significant effects should be accompanied by an indication of the criteria used to determine whether an impact is 'likely' and whether it is 'significant'. Where recognised criteria are used, they should be referenced.

The method presented here has been developed by reference to the principles and guidance provided by the Charted Institute of Ecology and Environmental Management (CIEEM) guidelines for marine impact assessment (CIEEM, 2010; 2018), the Marine Life Information Network (MarLIN) species and ecosystem sensitivities guidelines (Tyler-Walters *et al.*, 2001), guidance provided by SNH in its handbook on EIA (SNH, 2013) and the equator principles for determining, assessing and managing social and environmental risk in project financing (http://www.equator-principles.com/). This established method has been used previously for the assessment of impacts associated with oil and gas projects on the UKCS.

Despite the determination of impact significance being a subjective process, a defined methodology is used to make the assessment as objective and auditable as possible. The significance of any potential impact is determined through the use of a risk assessment approach which employs the standard philosophy of:

Magnitude of potential impact (consequence) x Likelihood of occurrence (frequency or probability) = Risk

The following sections describe the criteria that have been used to assess the significance of the potential impacts identified in this Chapter and assessed further in Chapters 5–7 below.

4.4.2 *Consequence of Potential Impact*

Consequence of a potential impact (Table 4-2) involves the consideration of three drivers:

- **Potential environmental impact (E)** – consideration of potential environmental sensitivities and scientific evidence on potential environmental impacts;
- **Stakeholder concern (S)** – consideration of other users, interest groups, media and the general public, and perceived potential impacts; and
- **Regulatory compliance (R)** – consideration of current and anticipated future legislative requirements.

This three-pronged approach allows important consideration of public perception of a project as well as scientifically measured potential impact. Once each of the three consequences has been assessed, a final single rating for the potential impact must be assigned. Overall ranking is undertaken using agreed rules applied by experienced assessors.

Key rules employed are:

- A potential impact rated as severe by any consequence driver remains severe;
- A potential impact rated major by any driver usually remains major;
- Major regulator (R) consequence makes the final ranking major;
- A potential impact ranked as moderate for two or three drivers is seriously considered for major ranking in the overall ranking;
- All lower rankings are examined for important negative criteria before overall ranking can be considered negligible; and
- In the cases of uncertainty, the highest ranking of the three should be taken as the final ranking.

Table 4-2 Environmental consequence criteria definitions

Category	Regulatory compliance (R)	Potential environmental impact (E)	Stakeholder concern (S)
Severe	Activity proh bited. L kely major breach of regulatory requirements resulting in non-compliance or significant project approval delays	Regional (widespread) potential impact on the quality or availability of a habitat and / or wildlife with no recovery expected or irreversible alteration (permanent) Long-term effect on the conservation objectives of nationally / internationally protected sites, habitats or populations Major transboundary effects expected Major contribution to cumulative effects	International public concern and extensive international media interest likely Well established and widely held areas of concern in society, including perception of threat to the global environment Decrease in the availability or quality of a resource to the extent of affecting over five plus years the wellbeing of the persons using that resource e.g. loss of fishing access or recreational use Potential major effect on human health
Major	Possible major breach of specific regulatory consent limits resulting in non-compliance	Regional (widespread) potential impact on the quality or availability of a habitat and / or wildlife and where recovery may take place over the long term and could involve significant restoration effort Short-term potential impact on the conservation objectives of nationally / internationally protected sites, habitats or populations Moderate transboundary effects expected Moderate contr bution to cumulative effects	National public concern and extensive national media interest likely Well established and widely held areas of concern in national society Decrease in the availability or quality of a resource to the extent of affecting over two to five years the wellbeing of the persons using that resource Potential moderate impact on human health
Moderate	Possible minor breach of specific regulatory consent limits resulting in non-compliance	Regional (widespread) change in a habitat or species beyond natural variability with recovery likely within the short-term following cessation of activities, or localised degradation with recovery over the long-term following cessation of potential impact / activity Potential impact on the conservation objectives of locally important sites or species Possible transboundary effects Possible contribution to cumulative effects	Regional concerns at the community or broad interest group level Decrease in the availability of a resource to the extent of affecting over one to two years the wellbeing of the persons using that resource Possible but unlikely effect on human health, but may result in or be perceived to result in a minor potential impact
Minor	Regulatory terms set defined conditions	Regional (widespread) change in habitats or species which can be seen and measured, but is at same scale as natural variability or localised change in a habitat or species beyond natural variability with recovery expected in the short-term following cessation of potential impact or activity Unlikely to contribute to transboundary or cumulative effects	Issues that might affect individual people or businesses or single interests at the local level. Some local public awareness and concern A short-term decrease in the availability or quality of a resource likely to be noticed by persons using it, but does not affect their well-being

Category	Regulatory compliance (R)	Potential environmental impact (E)	Stakeholder concern (S)
Negligible	No I kelihood of breach of regulatory, corporate or company goals	Effects unlikely to be discernible or measurable No contr bution to transboundary or cumulative effects	No noticeable stakeholder concern and only limited public interest A possible short-term decrease in the availability or quality of a resource, which is unl kely to be noticed by persons using it, or those who live in the immediate area, and does not affect their well-being
Positive	N/a	An enhancement of some ecosystem or population parameter	No public opposition Positive public support An enhancement in the availability or quality of a resource to the extent of potentially benefiting the wellbeing of the persons using that resource or benefiting from it in some way

4.4.3 *Likelihood of Potential Impact*

In order to assess the significance of a potential impact, the overall consequence is combined with the likelihood (frequency/probability) of the potential impact occurring. Frequency and probability categories are defined in Table 4-3. Definitions are provided for routine/planned events as well as for accidental/unplanned events.

Table 4-3 Probability and frequency guidance

Frequency / probability category	Routine (planned) operation frequency	Accidental event (probability)
5	Continuous emission or activity over life of field or development	Likely More than once per year Event I kely to occur more than once on the facility
4	Regular emission or activity Once per year for ≤ 6 months OR Once per month for ≤ 15 days Once per day for ≤ 12 hours	Possible One in 10 years Could occur within the lifetime of the development
3	Intermittent emission or activity Once per year for ≤1 month OR Once per month for ≤ 3 days OR Once per day for ≤ 2 hours	Unlikely One in 100 years Event could occur within lifetime of 10 similar facilities. Has occurred at similar facilities.
2	One off event or activity over lifetime of development of ≤ 3 months duration OR Once per year for ≤ 5 days OR Once per month for ≤ 8 hours	Remote One in 1,000 years Similar event has occurred somewhere in industry or similar industry but not I kely to occur with current practices and procedures.
1	One off event or activity of ≤ 10 days duration	Extremely remote One in 10,000 years Has never occurred within industry or similar industry but theoretically possible

4.4.4 *Overall Risk and Impact Significance*

For every impact, the potential environmental risk is obtained by combining the consequence and frequency or likelihood via the matrix presented in Table 4-4. Both components are at best semi-quantitative representing best judgements on the basis of knowledge and experience available. A simple matrix provides a consistent basis for presenting such a broad-based risk assessment. Interpretation of the overall risk in terms of potential significance can then be undertaken as outlined in Table 4-5.

Table 4-4 Environmental risk

Consequence	Likelihood				
	5	4	3	2	1
	Continuous / likely	Regular / possible	Intermittent / unlikely	One off event / remote	One off event / extremely remote
Severe	Severe	Severe	Major	Moderate	Minor
Major	Severe	Major	Moderate	Minor	Neglig ble
Moderate	Major	Moderate	Minor	Minor	Neglig ble
Minor	Moderate	Minor	Minor	Negligible	Neglig ble
Negligible	Minor	Neglig ble	Negligible	Negligible	Neglig ble
Positive	Positive	Positive	Positive	Positive	Positive

Table 4-5 Impact significance

	Environmental risk	Potential impact significance (as defined under the EIA Regulations)
Severe	Elevated risk - requires major consideration in design process and / or operational planning	Significant
Major	Elevated risk - requires immediate attention and major consideration in design process and / or operational planning	Significant
Moderate	Moderate risk - requires additional control measures where possible or management / communication to maintain risk at less than significant levels	Not significant providing additional management measures in place
Minor	Minor risk - however will require some management / commitment to maintain risk at less than significant levels	Not significant
Negligible	No risk - no action required	Not significant
Positive	Positive – to be encouraged	Positive significance

4.5 *MITIGATION AND ASSESSMENT OF RESIDUAL IMPACTS*

Where potentially significant impacts are identified, mitigation measures are considered. The intention is that such measures should remove, reduce or manage the potential impacts so that they are not significant. For some potential impacts, mitigation has been identified even where potential impacts are considered to be insignificant. In these instances, mitigation is recommended to maintain potential impacts at insignificant levels.

4.6 *CUMULATIVE IMPACTS*

Cumulative impacts are described as the effects that result from incremental changes caused together with other past, present or reasonably foreseeable actions. In the case of the additional production covered in this ES, the majority of impacts identified are of a cumulative nature. Potential cumulative impacts have been considered throughout the EIA and are assessed in the following impact chapters (Chapters 5, 6 and 7).

4.7 *TRANSBOUNDARY IMPACTS*

The EIA Directive requires special procedures in the case that a project may have potentially significant impacts on the environment of other countries (any European Economic Area (EAA) State[j]). For the purposes of providing adequate and effective consultation, any country which may be an affected party, should be consulted. Each of the impact chapters (Chapters 5, 6 and 7) identifies the potential for transboundary impacts.

[j] EEA state is defined as a party to the Agreement on the European Economic Area, not just EU member states. Consideration of potential transboundary impacts are required under the EIA Directive and UNECE (United Nations Economic Commission for Europe) Convention on EIA in a Transboundary Context (the Espoo Convention).

4.8 PROTECTED HABITATS AND SPECIES

A closely linked and integral aspect of the EIA process is the requirement to inform a Habitats Regulations Assessment (HRA) under the European Habitats Directive. HRA requires the competent authority, in this case OPRED, to determine if a project or proposal may have a Likely Significant Effect (LSE) on the integrity of a European site. European sites include Special Protection Areas (SPAs) and SACs. A similar but distinct process of its own exists for Nature Conservation Marine Protected Areas (NC MPAs) and Marine Conservation Zones (MCZs). Following screening of the potential impacts, it has been determined that potential impacts on internationally protected habitats and species are not likely because of the additional production and they are not considered further in this ES.

5 ATMOSPHERIC EMISSIONS

5.1 INTRODUCTION

This chapter assesses the atmospheric emissions associated with energy use that will occur as a result of the drilling, commissioning and operation of the Alwyn East well.

On a global scale, concern with regard to atmospheric emissions is increasingly focused on global climate change. The Intergovernmental Panel on Climate Change (IPCC) in its fifth assessment report (IPCC, 2014) states that 'Anthropogenic GHG (Greenhouse gas) emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever.' This has led to atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century.

Climate change projections included in the IPCC Fifth Assessment Report (AR5) predict a mean surface temperature change between 2016 and 2035 will likely be in the range of 0.3°C and 0.7°C (medium confidence) (IPCC, 2014). Further, it is anticipated that global warming is likely to reach 1.5°C between 2030 and 2053, if it continues at its current rate (high confidence). The increase in temperature between 2006 – 2015 was 0.87°C higher than pre-industrial levels and increasing at a rate of 0.2°C per decade, based on past and ongoing emissions trends (high confidence) (IPCC, 2018a). GHGs include water vapour, CO_2, CH_4, N_2O and chlorofluorocarbons. The most abundant GHG is water vapour, followed by CO_2. IPCC (2014) states that the increased in GHGs emissions since the pre-industrial era have driven large increases in the atmospheric concentrations of CO_2, CH_4 and N_2O and that CO_2 emissions from fossil fuel combustion and industrial processes contributed about 78% to the total GHG emission increase between 1970 and 2010, with a contribution of similar percentage over the 2000–2010 period. Recent trends in emissions are above those which would limit warming to below 2°C, with urgent mitigation required in order to reduce global warming to below 1.5°C (IPCC, 2018b).

5.2 REGULATORY CONTROL

In the UK, there are a number of atmospheric regulatory controls which apply to offshore developments and require the provision of atmospheric emissions inventories which are derived from:

- International Conventions;
- EU Directives; and
- National Regulations.

Following the UK's departure from the EU, the atmospherics legislation that is derived from EU regulations has effectively been transcribed into UK law so there will be little variation in the regulations as a result of this. The most notable change will arise from the withdrawal from the EU Emissions Trading Scheme (EU ETS) but the UK cap-and-trade scheme that will come into force is set to mirror this (References to EU ETS throughout this chapter should be interpreted as EU ETS or its UK replacement post-Brexit).

The UK's Environmental and Emissions Monitoring System (EEMS) database has been designed to enable the analysis of offshore oil and gas environmental data. The database is operated by OPRED and acts as the primary data storage and reporting resource for both the UK Government and offshore industry. EEMS provides the vehicle for offshore oil and gas industry emissions to be incorporated into annual UK inventories of atmospheric emissions.

A Consent to Flare is required for a field flaring greater than or equal to 40 tonnes per day (this is reviewed annually). This level of flaring is considered by the regulator to represent a potential opportunity for further reduction in levels and therefore applications need full supporting details with medium and long-term plans for flare reduction. Where a field is flaring less than 40 tonnes per day, a longer-term flare consent may be issued. Applications should be commenced at least 3-4 months before first oil.

The UK target to be net-zero GHG by 2050 is complementary to these regulatory requirements. The UK's commitment to Net Zero 2050 was made in 2019 and is aligned with Paris Agreement to which the UK is a signatory. There is also an initiative introduced by the World Bank to have Zero Routine Flaring by 2030 which is aligned with OGA's objective "*To ensure consistency of the OGA's offshore flaring and venting regime with*

MER UK and wider government policy, including emissions targets, by eliminating any unnecessary or wasteful flaring and venting of gas throughout the lifecycle of a petroleum installation and relevant facilities such as terminals".[k] This initiative is focused in eliminating routine flaring and not flaring for safety reasons or non-routine flaring, which nevertheless should be minimised.

The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008 implement MARPOL Annex VI in the UK and establish controls on marine engines and marine fuel in order to limit emissions, in particular NO_x and SO_x. All vessels used during the drilling of the Alwyn East well will have the appropriate UK Air Pollution Prevention Certificate (UKAPP) or International Air Pollution Prevention Certificate (IAPP) in place, as required.

5.3 *ASSUMPTIONS AND DATA GAPS*

The following assumptions have been made when calculating the atmospheric emissions for the Alwyn East well:

- The Alwyn East drilling campaign will be for a maximum of 175 days;
- During drilling, there will be four return helicopter flights per week (5 hours per round trip) from Aberdeen to Alwyn NAA;
- Two supply vessels will be used per week (56 hours per round trip) for the duration of the drilling period;
- Alwyn East well will use a temporary vent for 30 days, with a maximum of four annuli bleeds per day;
- The only additional flaring that will occur is during initial start-up of the well and during the four start-ups following planned or unplanned well shutdowns that are likely to be required per year (anticipated to occur only for the first two years of production, 2023/24);
- No extra compressors are needed to export the gas from Alwyn East once it is producing, as described in Section 4.3; and
- During normal operations power generation will return to being provided by two of four GTGs as much as possible, however under certain process conditions additional power may be required to process fluids from Alwyn East. As this is difficult to quantify accurately, a worst case has been assumed in this assessment.

5.4 *DESCRIPTION AND QUANTIFICATION OF POTENTIAL EMISSIONS*

5.4.1 *Drilling*

Atmospheric emissions from the Alwyn East well will be related largely to fuel consumption during the drilling campaign. Fuel gas will be used to generate power on the platform. A summary of predicted atmospheric emissions for the campaign is provided in Table 5-2.

During the drilling period, it is expected there will be a change in the amount of GTGs used. Currently two turbines (running at 22 MW load) are used on a continuous basis to power the Alwyn facilities, although there may be occasional instances where a third turbine is needed. For some periods of the drilling of the Alwyn East well, three turbines will be used instead of the base case of two turbines. This is largely driven by the need to ensure a high reliability of additional power supply required for any critical drilling phases throughout the drilling campaign. Three turbines running at 28 MW load will be used for a total of 92 days during the critical phases of the drilling campaign, with two turbines at 28 MW load for the remaining 83 days of 'non-critical' operations, which requires less power. As stated in Section 2.1, 175 days is a worst-case duration for this drilling campaign and includes substantial contingency time to account for weather delays.

The Alwyn platform's base case is to run two GTG (22 MW load). To calculate the difference during the drilling campaign, the fuel consumption of the drilling period was compared to the fuel consumption of the same period without drilling. The calculation is described as follows:

- Fuel consumption during drilling period (175 days)
  - 92 days - fuel consumption of three 28 MW load turbines
  - 83 days - fuel consumption of two 28 MW load turbines

[k] https://www.ogauthority.co.uk/media/5014/flaring-and-venting-policy-position-website.pdf

- Fuel consumption during same period without drilling (175 days)
  - 175 days - fuel consumption of two 22 MW load turbines
- Difference = Drilling period – Normal period

A number of the platform wells on Alwyn have "live annuli" in which there are subject to hydrocarbon ingress over time. Assuming the Alwyn East well also has live annuli, it will be necessary to maintain the annuli in their correct operating windows for well integrity, by performing periodic bleed offs during well start up to remove excess gas from the annuli. The annuli would be bled off into a temporary liquid / gas separation package with the gas being routed into the drilling derrick vent stack for disposal. For conservatism, it has been assumed that the Alwyn East well will use a temporary vent for 30 days (to allow for completion and start up) at a rate of 75 kg/d gas (based on experience with similar Dunbar wells). This equates to a maximum of four annuli bleeds per day. There is no venting of the well annuli expected during production phase, as no LOT is anticipated. During production activities, venting only occurs during *ad hoc* maintenance operations which will not increase in frequency as a result of Alwyn East. Hence, there will be no changes to venting as a result of additional production from Alwyn East.

Emissions of relevant GHGs have been calculated from the estimated total volume of fuel that will be required by supply vessels, helicopters and turbines working during the drilling of the Alwyn East well, as well as the live annuli venting and flaring on well test and start-up. Conversion factors to convert fuel use into estimated GHG emissions have been taken from Institute of Petroleum (IP) (2000), EEMS, Atmospheric Emissions Calculations (OGUK, 2008) and IPCC (2014). The conversion Factors can be seen in Table 5-1.

Emissions of individual GHGs have then been converted to a single value of carbon dioxide equivalent (CO_2e[l]), in order to describe different GHGs in a common unit. For any quantity and type of GHG, CO_2e signifies the amount of CO_2 with the equivalent global warming impact. CO_2e can be used to compare the emissions from the drilling of the Alwyn East well with total UKCS emissions and the UK carbon budget. Additional emissions during drilling operations are shown in Table 5-2.

5.4.2 *Production*

During 2020, production activities on Alwyn North predominantly (72% of running hours) utilised two or less GTGs to meet all power requirements, with occasional increases to three GTG in the event of higher power demand. Average fuel gas use in 2020 was 9.3 MMscf/day (in 2018 and 2019 the platform used 9.6 and 10.3 MMscf/d of fuel gas, respectively) and this, in association with venting and flaring, resulted in the emission of approximately 266,224 tonnes[m] of CO_2e emissions in 2020 (Table 5-3). The fuel use and therefore the atmospheric emissions from production when Alwyn East fluids are produced through Alwyn North are expected to be similar to those from the more recent years of reported data. In particular, 2020 represents a good analogue as the platform predominantly ran in 2-out-of-4 GTG mode - the intended operating mode going forward. Whilst there will be potential additional power requirements at times due to certain process conditions, these are difficult to quantify and are likely to be indistinguishable from data reported in recent years. To estimate possible increases in fuel use and therefore changes in emissions profile, daily fuel gas use was calculated for two GTGs operating at 22 and 28 MW load and three GTGs at 22 and 28 MW load. The results were:

- For the two GTG 22 MW load scenario, fuel gas use was calculated as a maximum 8 MMscf/d (i.e. less than the 2020 reported average daily fuel use);
  - Indicating lower emissions to those reported to EEMS in 2020;
- For the two GTG 28 MW load scenario, fuel gas use was calculated as a maximum 9.3 MMscf/d (i.e. equivalent to the 2020 reported average daily fuel use),
  - Indicating equivalent emissions to those reported to EEMS in 2020;
- The three GTG 22 MW load scenario produced a daily fuel gas use of 9.7 MMscf/d
  - a value which whilst higher than that the amount in 2020 is less than the platform fuel use in 2019;
- In the three GTG 28 MW load scenario fuel gas use was calculated to be 11 MMscf/d,
  - which is 18% more fuel than used in 2020.

If the same mix of time periods for running on 1, 2 and 3 GTGs as occurred in 2020 is assumed, then this results in an average daily fuel use of 9.8 MMscf/d which is a 5% increase in fuel gas compared to 2020 and

[l] Carbon dioxide equivalent (CO_2e) is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO_2e signifies the amount of CO_2 which would have the equivalent global warming impact.
[m] Figure slightly higher than EU ETS reported due to diesel logistics and vent.

would result in a proportional increase in pollutant emissions. By contrast if the 22 MW load scenario was achieved throughout the year this would result (even with the same mix of turbines in operation as 2020) in a decrease in fuel use compared to 2020 of 9%. Thus, CO_2e emissions from power generation are presented as a range in Table 5-3, whilst the highest of these values has been used in the impact assessment. The emissions of local air quality pollutants from the worst-case fuel use are shown in Table 5-4 and are within the currently permitted values for Alwyn North and are less than those reported to EEMS for Alwyn North in 2019. As the load on the GTGs will be lower than the worst-case scenario, fuel use will be consistent with that seen over the last three years and therefore it is not expected there will be any noticeable increase in emissions above the range currently reported to EEMS for the GTGs on Alwyn North. These values are below those previously modelled for Alwyn North, detailed in Section 3.2.2, and as this earlier modelling showed no impact on local air quality it is clear that these lower emissions will also not affect local air quality.

Quantifying additional emissions from the gas export compressor also presents difficulties as the increased volume of export gas will result in the compressor running more efficiently. High-level estimates of additional daily fuel gas requirements range between zero and 0.38 MMscf/day (i.e. a 44% increase in compressor fuel gas consumption on a daily basis). If this coincided with the need to run the platform at 28 MW load with 3 GTGs, this would correspond to an additional 39 MMscf of fuel gas use per year.

The quantity of gas flared is expected to increase over the first two years of production from Alwyn East (2023/2024) as a result of the additional four well start-ups that are likely to be required, during which up to 25 tonnes per start-up will be flared; this is presented in Table 5.3 in comparison to 2020 figures. Operational load flaring is not an approach used on Alwyn when a gas export route is not available so there will be no change in operational load flaring as a result of production from Alwyn East.

The forecast carbon intensity of the Alwyn Area clearly shows that the production of Alwyn East significantly reduces the carbon intensity of production from Alwyn over the short to medium term. This demonstrates that the inclusion of Alwyn East results in a more efficient use of energy to produce the hydrocarbons and operate this platform until CoP:

- The mean carbon intensity for Alwyn Area was 22.4 kgCO_2e / barrels of oil equivalent (BOE) over the period from 2016 to 2019. The current P50 case for the inclusion of Alwyn East predicts that the carbon intensity of Alwyn Area will decrease with the new production to around 15 kgCO_2e / BOE by 2023/4 and then slowly increase back to the currently predicted Alwyn Area carbon intensity of around 37 kgCO_2e / BOE in 2029. In the P10 case whilst the carbon intensity increases from 15 kgCO_2e / BOE after 2025 the intensity is still predicted to be below 25 kgCO_2e / BOE in 2029.

Table 5-1 Conversion Factors - CO_2 Equivalent (te/te)

CO_2	CH_4	N_2O	SOx	NOx	CO	NMVOC
1	28	265	0	0	1.6	5.6

Table 5-2 Atmospheric emissions from the Alwyn East drilling campaign (fuel use and emissions factors derived from IP (2000) and OGUK (2008))

Activity	Source	Details	Emissions (tonnes)							
			CO_2	CO	NOx	N_2O	SO_2	CH_4	VOC	CO_2e
Drilling	Supply Vessels	117 days	3,698	18.32	68.83	0.2567	14.0	0.21	2.8	3,900
	Helicopter Sikorsky S-92	100 trips	837	2.20	0.0266	0.0584	0.122	0.0231	0.638	860
	Well Test	Flaring – 128 tonnes	358	0.858	0.154	0.0104	0.0016	5.76	0.640	528
	Live annuli venting	Venting – 2.25 tonnes	-	-	-	-	-	1.82	0.02	51.16
	Platform fuel Use	Additional gas turbine	24,800	27	55	2.0	0.115	8.2	0.32	25,652
Totals*			**29,694**	**48.2**	**123.6**	**2.3**	**14.24**	**16.1**	**4.42**	**30,991**

**Note: Totals based on non-rounded figures.*

Table 5-3 Atmospheric emissions at Alwyn as a result of Alwyn East production

Year	Emissions (CO_2e / tonnes)				
	Fuel Gas [n]Combustion	Flaring	Diesel Use (Platform and Logistics)	Venting	Total
2020	219,227	33,408	13,363	176	266,224
Additional Alwyn East emissions during 2023/24 compared to 2020 as a base year	-19,915 to +11,803	335	0	0	-19,580 to +12,138
Alwyn East proportion % during 2023/24 compared to 2020 as a base year	-9.08 to 5.38	1	0	0	-7.35 to +4.56
Additional Alwyn East emissions (future years) compared to 2020 as a base year	-19,915 to +11,803	0	0	0	-19,915 to +11,803
Alwyn East proportion % (future years) compared to 2020 as a base year	-9.08 to 5.38	0	0	0	-7.48 to 4.43

[n] Range presented represents a maximum and minimum load scenario on the GTGs and assumes that the platform will predominantly run in 2 out of 4 mode with occasional increases to 3 out of 4. The proportion of GTGs online over a year was assumed to be equivalent to that measured for Alwyn North in 2020.

Table 5-4 Emission load permitted under PPC/5 compared to predicted worst-case emissions including additional production from Alwyn East

	Emissions				
	CO	NOx	SO_2	CH_4	VOC
PPC/5 permit: Total annual emissions of polluting substances from combustion equipment authorised under the permit (tonnes)	685	696	3	106	4
Actual 2020 performance (tonnes)	319	511	2.6	74	3.7
2020 performance as percentage of permitted value	46.6	73.4	86.6	69.8	92.5
Predicted emissions from Alwyn, assuming worst-case production scenario (whole year 28 MW load) as a result of the additional production from Alwyn East (tonnes)	*334*	*536*	*2.7*	*77.6*	*3.9*
Worst-case Alwyn predicted performance as percentage of permitted value	*48.8*	*76.7*	*90.8*	*0.73*	*97.0*

5.5 CONTRIBUTION TO ACHIEVING NET ZERO TARGET

TEPUK understands the OGA strategy to support the achievement of the UK Government's Net Zero by 2050 policy through the reduction of GHG emissions from the UK's oil and gas industry and will take any practical steps possible to contribute to this.

As the new Alwyn East well comes into production, atmospheric emissions from the Alwyn platform will revert back to similar levels as they were before the drilling campaign;

- After the drilling of the new well, power generation will return to being provided by two of four GTGs as much as possible;
- The platform will continue to be run in the most efficient way, with plans for more specific metering to further increase efficiencies. TEPUK plans to fit fuel gas meters on compressors which will provide a better understanding of fuel consumption and inform a more efficient power generation strategy[o];
- The quantity of gas flared during the additional eight well start-ups that may be required in the first two years of production from Alwyn East is negligible in comparison to the overall annual emissions from Alwyn;
- During production, venting will only occur during *ad hoc* maintenance operations which will not increase in frequency as a result of Alwyn East. There will be no requirement for LOT of the new well annuli. Therefore, no additional venting activity is currently expected. Any additional venting associated with well maintenance of the Alwyn East well would be assessed under Annual Vent Consent Application for the applicable year; and
- There will be no planned change in fugitive emissions as a result of the Alwyn East well coming online.

The greatest contributor to atmospheric emissions from the Alwyn East drilling campaign will be from the combustion of fuel gas to power the additional GTG which is required to ensure the very high reliability of additional power during critical drilling phases, so that it can be completed safely. The emissions from these generators are determined by the power requirements of the drilling period, the type of fuel used, the efficiency of the machines and the efficiency of the use of the generated electrical power.

5.6 MANAGEMENT AND MITIGATION MEASURES

TEPUK will ensure that correct management procedures are in place to ensure the following:

- All combustion equipment will be subject to regular monitoring and inspections to ensure an effective maintenance regime is in place, ensuring all combustion equipment runs as efficiently as possible. Energy Performance checks are conducted by a third party as part of this maintenance regime;
- Fuel monitoring on Alwyn North is a platform-wide system rather than turbine specific. It is externally verified as part of ETS and EEMS reporting;
- Current platform load and operating philosophy is resulting in the turbines operating at the higher end of their efficiency curves – this typically results in reduced CO and unburnt hydrocarbon emissions. Burner Temperature spreads are routinely measured giving indication of combustion performance;
- The platform is currently investigating a number of options to optimise load control and process optimisation on the platform as a result of recent energy efficiency audits;
- All supply vessels employed during drilling activities will comply with the Merchant Shipping (Prevention of Air Pollution from Ships) (Amendment) Regulations 2014;
- Drilling, crew change and vessel operations will be carefully planned to reduce helicopter and vessel numbers and the duration of operations; and

[o] This modification is currently in detailed design phase, with installation expected in Q4 2021 and testing through Q1 2022. A project with similar aims to give a live feed of power generation, export compression and flare configurations, estimated fuel load, CO_2 output, has estimated saving 1,700 tonnes CO_2e/year. Although it is difficult to give an exact estimate of efficiencies/reduction of fuel consumption a better understanding of fuel gas demand between gas turbine generators and compressors should give further scope for load optimisation.

- Use of low sulphur diesel (as per UK regulatory requirements).

Throughout development of the Alwyn East well, TEPUK will endeavour to:

- Monitor atmospheric emissions from all fuel streams on a daily basis where possible, against the business performance contract and annual CO_2e target to enable operations to be optimised accordingly;
- Monitor performance of main combustion equipment using a live digital tool to ensure its optimum configuration in order to reduce GHG emissions as far as practically possible.

Predicted emissions and mitigation measures associated with current and anticipated production are covered by the following permits and internal documents:

- PPC/5 covers emissions from the plant qualifying combustion equipment (e.g. the GTGs on the platform);
- Flare Consent - flaring activities during well test and initial start-up and following additional well start-up events will be applied for under the Alwyn Annual Flare Consent (2022 application expected in October 2021) and the duration of flaring will be limited as far as is practicable to reduce the emissions;
- Vent Consent – any venting activities during drilling or production will be applied for under the Alwyn Annual Vent Consent (2022 application expected in October 2021). Venting levels are typically very low and limited to programmed well maintenance routines, such as those required for leak testing; and
- Various processes and procedures (i.e. maintenance procedures, ongoing monitoring, competent personnel, internal/third party auditing) will contribute to optimisation of energy efficiency and thereby minimising emissions.

5.7 *CUMULATIVE AND TRANSBOUNDARY IMPACTS*

5.7.1 *Local Air Quality*

Throughout the Alwyn East drilling campaign, atmospheric emissions will be released, which have the potential to have local or regional (including transboundary) effects. Releases during drilling from the supply vessels, helicopters, gas turbines, well annuli venting and well test and start-up flaring will be temporary, and releases during production from occasional well start-ups and fuel gas consumption will be minimal in comparison to the overall emissions from Alwyn.

As noted in Section 3.5.2, the closest active oil and gas activities to Alwyn are the Ninian field (approximately 15 km from Alwyn) and the Strathspey field (approximately 11 km). There are no offshore windfarms in the vicinity. There is unlikely to be any cumulative effects in terms of local air quality with the addition of Alwyn East emissions in the area. The proposed activities and associated emissions arising from the Alwyn East drilling campaign and subsequent production will be approximately 136 km east of Shetland. This is not expected to result in any impact on air quality in the coastal area around Shetland. Whilst the UK/Norway transboundary line is approximately 9 km from the Alwyn field it is not anticipated that there will be significant transboundary impacts as the duration of the emissions in-field during the drilling campaign will be short-lived (worst-case of 175 days). Once Alwyn East starts producing, there will be a slight increase in emissions from flaring during the additional eight well start-ups likely to be required during the first two years and also potentially an increase in emissions from occasional additional fuel gas consumption, though it is not possible to definitively quantify what the additional quantity of emissions may be. However, transboundary impacts from these emissions are not considered to be significant.

5.7.2 *Global Climate Change*

To understand the potential impact from the atmospheric emissions associated with the Alwyn East well, it is useful to set the emissions in the context of wider UK emissions. Whilst an exact figure for offshore emissions in UK waters does not exist, the contribution of emissions from shipping activities can be summed with oil and gas industry emissions to provide a benchmark against which the Alwyn East well can be considered. The latest available total annual CO_2 emissions estimate from oil and gas exploration and production is 13,200,000 tonnes (for 2018, OGUK, 2019b) and the latest total annual CO_2 emissions estimate for UK shipping is approximately 7,800,000 tonnes (for 2017, BEIS, 2019a), giving a total of 21,000,000 tonnes of CO_2. The annual CO_2e emissions from the drilling and completion activities of the Alwyn East well are estimated to be approximately 30,991 tonnes, which, for comparison, represents a small proportion of the total TEPUK annual emissions of 1,583,022 tonnes CO_2e emitted in 2020. Production activities on Alwyn North emitted approximately 266,224 tonnes of CO_2e emissions in 2020, approximately 1.27% of the UKCS total. The expected flaring to be required as a result of the additional well start-ups during the first two years of production from Alwyn East will produce a maximum of 334.5 tonnes of CO_2e emissions per year, and the additional CO_2e emissions from the GTGs and compression in the worst-case production scenario will be a maximum of 11,803 tonnes per year. Combined these emissions equate to an increase of 4.6% to the Alwyn annual emissions and 0.8% of the total TEPUK emissions. The CO_2e emissions from Alwyn East drilling will contribute approximately 0.15% of the CO_2 atmospheric emissions associated with UK offshore shipping and oil and gas activities[p], whilst the additional emissions during production will contribute approximately 0.06%.

Whilst this is a very small percentage of current UK offshore emissions, the UK Government has set a target of reducing the UK's overall GHG emissions to net zero by 2050 as part of the Climate Change Act 2008. To achieve this, a series of phased budgets have been implemented (Table 5-5), with the 4th carbon budget setting a 50% reduction by 2030 (UK Government, 2017). As such, it is likely that the total annual emissions from the UK will decline over the life of the well and it is important therefore to examine how the Alwyn East drilling campaign will sit within the context of declining UK emissions. Table 5-6 presents the Alwyn East drilling emissions against the current UK carbon budget period. The additional flaring from well start-ups and the emissions from the worst-case production scenario fall into the 4th carbon budget; this is also shown in Table 5-6[q].

Table 5-5 UK Carbon Budget

Budget	Annual carbon budget	% reduction below base year (1990)
1st carbon budget (2008 to 2012)	3,018 million tonnes (Mt) CO_2e	23%
2nd carbon budget (2013 to 2017)	2,782 MtCO_2e	29%
3rd carbon budget (2018 to 2022)	2,544 MtCO_2e	35% by 2020
4th carbon budget (2023 to 2027)	1,950 MtCO_2e	50% by 2025
5th carbon budget (2028 to 2032)	1,765 MtCO_2e	57% by 2030

Table 5-6 Alwyn East CO_2e emissions against UK carbon budget

Emission Item	Carbon Accounting Period
	2018 to 2022
UK carbon budget for period (tonnes CO_2e)	2,544,000,000
Alwyn East emissions for period - drilling (tonnes CO_2e)	30,991
Alwyn East drilling campaign CO_2e emissions as % of UK budget for period	0.0012%
	2023 to 2027
UK carbon budget for period (tonnes CO2e)	1,950,000,000
Worst-case Alwyn East emissions for period - production (tonnes CO_2e)[q]	47,212
Worst-case Alwyn East flaring CO_2e emissions as % of UK budget for period	0.0024%

All of the emissions from the Alwyn East drilling campaign occurs in the 3rd UK carbon budget period from 2018 – 2022. For this carbon budget period, the UK's total carbon budget is 2,544 MT CO_2e. The total estimated CO_2e emissions from the Alwyn East drilling campaign for this five-year period is equal to 30,991 tonnes; 0.0012% of the whole UK budget, representing a very small component of the overall emissions in the UK. The emissions during production from flaring during the eight anticipated well start-ups and the potential increase in fuel gas consumption fall into the subsequent carbon budgets, with the worst-case emissions from production of Alwyn East during the 4th budget representing 0.0024% of the whole UK budget.

[p] CO_2e emissions for the UK marine industries are not available.

[q] In the best-case production scenario, CO_2e emissions are likely to be reduced from 2020 Alwyn values by 98,905 tonnes over the 4th carbon budget period. The worst-case values have been used for the impact assessment.

Overall, this assessment shows that the potential emissions from the Alwyn East drilling campaign and production operations will likely have a limited cumulative effect in the context of the release of GHGs into the environment and their contribution to global climate change (i.e. they will have negligible cumulative or transboundary impact).

5.8 *DECOMMISSIONING*

At the end of field life, the Alwyn East well will be decommissioned. The decommissioning process will generate atmospheric emissions both directly from cessation operations and associated vessel traffic, and indirectly through the reuse and recycling of materials (e.g. steel). It is not possible at this stage to fully quantify the likely atmospheric emissions as these will depend on the removal technologies available at that time, as well as the regulatory requirements. It is anticipated that energy use and atmospheric emissions involved in decommissioning the Alwyn East well are likely to be limited compared to those seen during the drilling activities, since the main source of such emissions is from the additional generator required to ensure a safe and successful drilling campaign.

5.9 *PROTECTED SITES*

Atmospheric emissions associated with the Alwyn East well will not occur within any SAC, SPA, or NCMPA. The atmospheric emissions are expected to represent a very small percentage of UK emissions and there is considered to be no cumulative impact from the Alwyn East well with regards to the potential impact on protected sites. As such there is considered to be no LSE on SACs and SPAs and hence no impact on conservation objectives or site integrity. This assessment also considers there to be no potential for atmospheric emissions to interact with protected features of an NCMPA and there is therefore no significant risk to the conservation objectives of any NCMPA. No impact is expected on the seabed habitat features.

5.10 *RESIDUAL IMPACTS*

The atmospheric emissions from the Alwyn East drilling campaign will be temporary and limited in nature. Whilst flaring is anticipated to increase slightly during the first two years of production from Alwyn East as a result of additional well start-ups, and in the worst-case production scenario there is likely to be an increase in emissions from fuel gas consumption, these emissions would have a minor effect on Alwyn's contribution to overall UK emissions.

Taking into account the distance from any potentially sensitive receptors, it is not expected that atmospheric emissions will negatively impact local air quality or result in significant local cumulative impacts. In terms of global climate change (i.e. cumulative and transboundary impacts), the Alwyn East well will add a relatively small increment to the overall offshore emissions of the UK and the release of GHG into the environment, and its contribution to global warming will be negligible in relation to those from the wider offshore industry and outputs at a national or international level.

On the basis that the atmosphere has sufficient capacity to accommodate the emissions without measurable change, and there is expected to be no measurable impact on long-term function of the local or wider atmosphere, the impact is considered minor and therefore not significant, as shown below.

Consequence	Likelihood/frequency	Environmental risk	Significance
Minor	Regular	Minor	Not Significant

6 DISCHARGES TO SEA

6.1 INTRODUCTION

The discharge of produced water to sea poses a limited environmental risk, in so much as there will be a component of the discharge that is hydrocarbon and a component that is chemical discharge. These components have the potential, if they are not managed appropriately, to impact upon the quality of the water column.

Whilst there will be no mud and cuttings discharges as these will be either skipped and shipped to shore or re-injected, the proposed drilling of a new well at Alwyn East will result in some chemicals being discharged to sea. Additionally, as a result of the proposed additional production from the Alwyn East field, there is an anticipated increase in the volume of produced water processed and discharged from the Alwyn platform, and consequently a higher actual tonnage of oil-in-water discharge to sea on an annual basis. Whilst chemical management will not change as a result of the additional production at Alwyn East (i.e. there is not expected to be any requirement for the use of other additional chemicals), the potential impacts of increased volume of chemical use and discharge is considered herein. The potential impacts from these discharges on the water column are discussed further in this section and each impact ranked in terms of its significance.

6.2 REGULATORY CONTROL

6.2.1 Oil discharges

The OPPC Regulations 2005 (as amended) were introduced to meet the OSPAR goal of reducing discharges of oil to the marine environment from the offshore oil and gas industry. The Regulations require an Oil Discharge Permit SAT to be in place prior to the discharge of any oil to sea. During the operational phase, the Regulations apply to oil in produced water, whether this is re-injected into the reservoir or discharged to sea, and also to oil associated with produced sand and drainage water. The dispersed oil-in-water content of produced water discharged to sea should not exceed a monthly average of 30 mg/l or a maximum of 100 mg/l at any time.

Any discharges of reservoir hydrocarbons resulting from the drilling and well clean-up operations targeting the Alwyn East field are also regulated under the OPPC Regulations and consequently a drilling Oil Discharge Permit will be submitted prior to the drilling campaign commences, if required. The oil-in-water content of fluids discharged to sea should not exceed an average of 30 mg/l.

6.2.2 Chemical discharges

OPRED has implemented the OSPAR Decision relating to the Harmonised Mandatory Control System for the Use and Discharge of Offshore Chemicals on the UKCS through the Offshore Chemical Regulations 2002 (as amended). Under these Regulations, operators require a permit to use and discharge chemicals. A PRA must be in place during the operational phase of the development; operational chemical use and discharge is currently managed under the existing Alwyn PRA/15.

6.2.3 Other applicable legislative controls

Although not its primary purpose, EEMS allows the analysis of offshore oil and gas industry environmental data. EEMS acts as the primary data storage and reporting resource for both UK Government and the offshore industry. Under this system, operators are required to submit the following data:

- For applicable installations, as detailed in the relevant Oil Discharge Permit SAT for the installation, a monthly report is required highlighting any discharges of oil in produced water to the sea, any discharges of displacement water to sea or re-injection of produced water; bi-annual returns are required for additional produced water constituents; and
- Production chemical returns are required on a quarterly basis.

6.3 ASSUMPTIONS AND DATA GAPS

There are no anticipated alterations to the way hydrocarbon discharges will be managed as part of the planned production at Alwyn East.

The types of chemicals used to treat produced fluids from the Alwyn East field are not anticipated to change compared to the existing chemicals used on the Alwyn platform. The treatment rate, or dosage level, for the batch chemicals is anticipated to remain unchanged. However, the volume of continuously applied chemicals may increase due to higher production, though according to initial estimation the increase is not expected to be higher than 5% as a result of Alwyn East. Other chemical treatment volumes are expected to remain largely unchanged. Actual chemical management will be assessed and adjusted accordingly after the start-up, with any required changed to be risk assessed and detailed as part of a variation to the Chemical Permit SAT.

There are no other key data gaps or uncertainties associated with discharges to sea.

6.4 *DESCRIPTION AND QUANTIFICATION OF POTENTIAL DISCHARGES*

6.4.1 *Produced water discharges*

Produced water may contain small amounts of reservoir hydrocarbons (oil), dissolved organic and inorganic compounds present in the geological formation and chemicals added during the production process. The majority of produced water at Alwyn is re-injected via the PWRI system, however at times when this system is unavailable there will be some produced water discharged overboard to the marine environment. The produced water treatment system is designed to remove the majority of residual hydrocarbons and therefore minimise discharge of oil within the produced water as far as practical, in line with the Best Available Techniques (BAT) Assessment for Alwyn produced water management. Table 6-1 provides the actual and predicted annual produced water discharges from the Alwyn NAB platforms. During early 2021 there has been an extended outage of the PWRI system due to the unavailability of an injection well and this has resulted in a need to discharge significantly more produced water overboard during 2021 than would normally be discharged; this has been captured under the current Alwyn Oil Discharge Permit (OLP/144). This outage is not expected to continue into 2022, which is reflected in the volumes shown in Table 6-1.

As discussed in Chapter 2, the Alwyn platform produced water facilities handle produced water from all fields that tie into the production installation, including the future planned Alwyn East field. Therefore, produced water volumes are not specific to the Alwyn field alone.

Table 6-1 Actual and predicted annual produced water volumes associated with production from the Alwyn area

Year	Annual volume of produced water (m^3/year)	Annual volume of produced water re-injected (m^3/year)	Annual volume of produced water discharge (m^3/year)
2020	1,467,822 (actual)	1,448,315 (actual)	19,507 (actual)
2021	1,976,475	1,726,414	250,061
2022	2,054,220	2,013,136	41,084
2023	2,594,055	2,542,174	51,881

Once the Alwyn East well is drilled and producing it is not anticipated to significantly increase the volume of produced water received at the Alwyn facilities. Table 2.4 provides the estimated produced water volumes from the Alwyn East well; in 2022 the produced water from Alwyn East is predicted to be approximately 6,935 m^3/year, representing 0.34% of the overall Alwyn produced water volumes (2,054,220 m^3/year). In 2023, the predicted produced water production from Alwyn East is predicted to be approximately 23,360 m^3/year within a total production volume from Alwyn of 2,594,055 m^3/year, representing 0.90% of the total produced water at the platform. There will be no change to the produced water handling strategy at the Alwyn platform as a result of the production from Alwyn East.

Using current forecasts the predicted total annual mass of oil in the produced water that is discharged overboard from Alwyn during 2022 and 2023 is 3.07 tonnes and 4.41 tonnes, respectively. Based on the expected contribution of the produced water that will come from Alwyn East in these years (0.36% and 0.9%), the annual mass of oil from the Alwyn East well discharged in the Alwyn produced water is expected to be approximately 0.011 tonnes in 2022 and 0.040 tonnes in 2023. Whilst the produced water from Alwyn East is expected to increase annually to a peak in 2028, the contribution to the overall produced water volumes and subsequent mass of oil in produced water at Alwyn will not be significant.

As discussed above, the additional production from Alwyn East in combination with other fields in the Alwyn area, will not exceed historic peak produced water volumes, for which the Alwyn platform was designed to process. Oil discharges within produced water are assessed as part of the OPPC regulatory submission and approval process and have not been identified as having the potential to cause a significant impact on the environment.

6.4.2 *Chemical discharges*

The Alwyn East well will be drilled as a deviated secondary wellbore away from the original N43 well. After the lower section of the N43 well is abandoned, the sidetrack will be drilled in two sections using OBM. The first section will be started below the previously drilled 17½" section and a new 12¼" section will then be deviated. Following the drilling of this section, a 9⅝" casing will be cemented in place to provide stability to the well before starting drilling of the second section (8½"), again using OBM. There is a contingency option to drill a further 6" section, which will involve installing a 4½" liner that will be cemented in place. The OBM used to drill the well will not be discharged to sea, it will be skipped and shipped to shore. There will be no use of WBM and therefore no discharges of mud or drill cuttings to sea.

Cement will be used for the well casings and liner, however since it is a sidetrack from an existing well there will be no deposit of cement around the wellhead. Whilst any excess cement will be discharged overboard to the marine environment during cement unit and batch tank clean-up operations, this is likely to be minimal as the cement will be mixed as required in order to limit excess quantities being produced. During cementing operations, there is the potential that the job has to be aborted due to unforeseeable circumstances (e.g. failure of equipment or a blockage in the pipes through which the cement and additives are pumped). In these circumstances, cement slurry may have to be disposed of to prevent it setting in pits, pumps and lines on the drilling rig. In addition, any prepared mix water or spacer fluids in pits may have to be disposed of as they have a limited shelf life. There would therefore need to be an emergency discharge of these products to sea in the event of an aborted job, however the frequency of such events is low. Any excess cement is typically less than 10% of the total cement slurry. Any such contingency discharges are not expected to have a significant impact on marine water quality, benthos or fish populations.

During well clean-up, the wastewater generated will be routed to a test separator to allow hydrocarbons to be separated from the water. The wastewater would then be re-injected via the PWRI system as described above in Section 6.4.1. If the PWRI system was unavailable during the drilling campaign, seawater returns would be managed in line with permit conditions; once the seawater returns are clean (not exceeding 30mg/l oil-in-water concentration), it will be discharged at the sea surface. During drilling, contaminated effluents can collect in the drain gullies on the drilling rig substructure and the wellhead area, which are then collected in the mud drainage sump. The effluent is returned via a pump to the waste oil tank. From this tank the effluent is then either sent across to NAB for disposal via the PWRI system or pumped out via the waste oil pump to supply boats for treatment and disposal onshore.

There are expected to be no new additional chemicals to be used on the Alwyn platform as a result of the additional production from Alwyn East. However, as chemicals are dosed routinely into the production stream, increased production from Alwyn East means that there is likely to be an increase in use and discharge for a small number of chemicals that are currently used on the platform. Chemicals that are likely to be used during production include corrosion inhibitors, process demulsifier, biocides, gas hydrate and scale inhibitors, glycol, and hydrogen sulphide, as detailed in Section 2.5.5.

A limited quantity of chemicals will be discharged during drilling, cementing, well clean-up and production at Alwyn East, and these are expected to disperse rapidly in the water column. Additionally, the use of appropriate management and mitigation measures will limit the likelihood of measurable impacts.

Further details on the chemicals and volumes to be used during drilling will be provided in a Chemical Permit SAT prior to drilling operations commencing. If additional chemical volumes are required for production from Alwyn East, TEPUK will submit a variation request to the existing Alwyn Production Chemical Permit SAT. As part of the variation request, and to demonstrate no environmental impact, a detailed impact assessment on the specific chemical use will be undertaken.

6.5 MANAGEMENT AND MITIGATION MEASURES

Oil discharges are controlled by the following:

- Alwyn North NAB Platform Oil Discharge Permit (Ref. OLP/144) monthly reports, highlighting oil-in-water discharge and biannual returns for other constituents of produced water under EEMS;
- Discharges of oil during drilling will be assessed and applied for under a drilling Oil Discharge Permit, if needed (to be submitted prior to drilling campaign commences);
- The PWRI system at Alwyn normally operates at a worst-case 90% efficiency, thereby significantly reducing the likelihood of discharge of produced water; and
- Alwyn Produced Water site management procedure, which provides operating guidance to ensure highest possible oil in water quality, and additional steps to be attempted in case of high oil levels.

Chemical discharges are controlled under the following permits and procedures:

- Alwyn North NAB Production Chemical Permit SAT (Ref. CP/69);
- All chemicals for the drilling campaign will be selected on their technical specifications as well as for their potential environmental impacts. Use and discharge of these chemicals will be assessed in detail using the CHARM system where appropriate, and the results will be submitted in a Chemical Permit SAT at least 28 days before drilling commences;
- Annual chemical substitution plan identifies how the use of hazardous chemicals is proposed to be phased out;
- Chemical management procedure, which helps to optimise chemical dosing thus minimising chemical discharges and ensures only approved chemical products can be used; and
- The discharge point from the Alwyn platform will be assessed under the UK implementation of the OSPAR Risk Based Approach (RBA) to Produced Water, currently scheduled for 2022. This will allow a thorough review of the produced water discharge and the functioning of the produced water treatment system on the platform.

In addition, it should be noted that chemical research and development is on-going, the ultimate aim of which is to reduce chemical volumes used offshore, to optimise dosages of specific products and reduce the harmfulness of specific chemical components in formulations. In turn this results in decreased discharges to the marine environment.

6.6 CUMULATIVE AND TRANSBOUNDARY IMPACTS

Around 2,296 tonnes of dispersed oil were discharged to sea with produced water in 2019 (OGUK, 2020). The predicted worst-case discharge from Alwyn is 3.067 tonnes of oil to be discharged in 2022. This represents approximately 0.13% of the 2019 yearly discharge of dispersed oil in produced water in the UKCS. Given that production from Alwyn East is not expected to significantly increase the produced water levels discharged at Alwyn, impacts associated with production at Alwyn East are not expected to contribute significantly to cumulative discharges within the UKCS.

Given the small quantities being discharged and the distance to the nearest transboundary line (9 km), it is unlikely that a sheen will form and cross the UK/Norway median line. Therefore, no transboundary effects are expected.

6.7 PROTECTED SITES

The nearest protected site to the Alwyn NAA and NAB platforms is the Pobie Bank Reef SAC, which lies approximately 88 km to the southwest. This site is identified for the protection of Annex I submarine structures made by leaking gases in the UK. Given the distance between Alwyn and the site, and that no water column risk or sediment deposition is expected to extend that far, no impact on this site is expected.

6.8 RESIDUAL IMPACTS

As part of the description of the baseline environment presented in Chapter 3 and of the activities described in this Section, consideration has been given to the sensitivity of the receiving environment to discharges into the water column. Receptors which have been identified as present in the vicinity of the Alwyn platform and which are sensitive to changes in water quality include plankton and fish and shellfish species. No reduction in water quality is expected as a result of the increased produced water discharge and therefore no impact is expected for these species groups.

Considering the limited increase in oil and chemical discharge resulting from the proposed drilling campaign and additional production from Alwyn East and the fact that any additional discharge will be dispersed rapidly and widely in the marine environment, the impact is considered minor and not significant, as summarised below. In addition, internal chemical management controls in place at TEPUK as well as the control of chemical use and discharge through the permit application and approval process further reduces the potential for any significant impacts to the marine environment.

Consequence	Likelihood/frequency	Environmental risk	Significance
Negligible	Continuous	Minor	Not Significant

7 ACCIDENTAL EVENTS

7.1 INTRODUCTION

All marine activities carry with them some risk of accidents. Accidents caused by human error, equipment failure or by extreme natural conditions may result in environmental impacts. The risk of accidental hydrocarbon releases is inherent in all offshore oil and gas activities, and an area of public concern as they may have potentially significant impacts on water quality, flora, fauna and other users of the sea.

The potential impact of any accidental hydrocarbon or chemical release will be determined by the location of the release, characteristics and weathering properties of the released material, the direction of travel and whether environmental sensitivities lie in the path of the release. These environmental sensitivities will have spatial and temporal variations. Therefore, the likelihood of any accidental release having a potential impact on the environment must consider the likelihood of occurrence against the probability of that hydrocarbon or chemical reaching a sensitive area and the environmental sensitivities present at that time.

Sources of accidental events include blowouts and well releases, structural failure, accidental releases from support vessels (via bunkering or collision), dropped objects and natural disasters. Given the nature of the proposed activities at Alwyn East there is no additional risk from dropped objects, structural failure, support vessels or natural disasters. As such, only blowouts and well releases are considered further as it presents an additional risk to what has already been assessed.

This chapter incorporates relevant information in assessing and mitigating the impacts of potential accidental events resulting from the proposed development of the Alwyn East field.

7.2 REGULATORY CONTROL

The key regulatory drivers associated with the prevention and response to spill risks are summarised as follows:

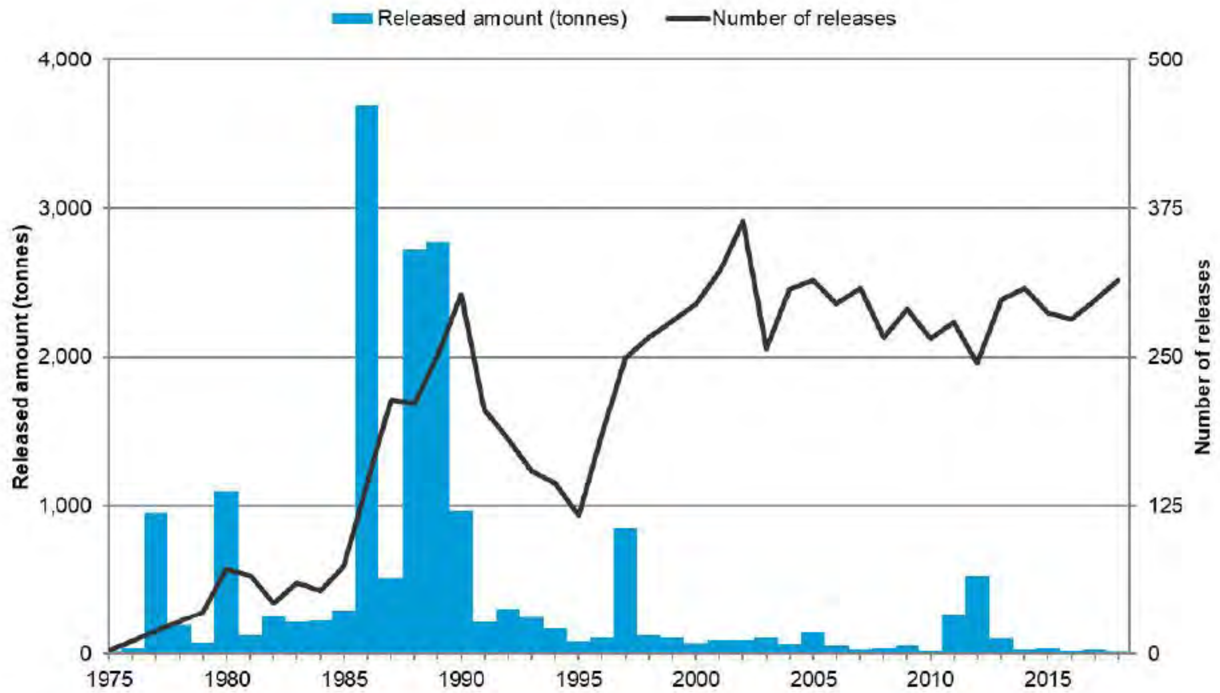
- The International Convention on Oil Pollution, Preparedness, Response and Cooperation (OPRC), which has been ratified by the UK, requires the UK Government to ensure that operators have a formally approved Oil Pollution Emergency Plan (OPEP) in place for each offshore operation or agreed grouping of facilities (TEPUK, 2018). This is enacted through The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998;
- The Offshore Installations (Emergency Pollution Control) Regulations 2002 give the Government power to intervene in the event of an incident involving an offshore installation where there is, or may be, a risk of significant pollution, or where an operator has failed to implement proper control and preventative measures. These Regulations apply to accidental hydrocarbon releases;
- The Offshore Petroleum Licensing (Offshore Safety Directive) Regulations 2015 implement Directive 2013/30/EU. The objectives of the Directive are to reduce as far as possible the occurrence of major accidents relating to offshore oil and gas operations and limit their consequences, thus increasing the protection of the marine environment and coastal economies against pollution. The Directive aims to achieve this objective by establishing minimum conditions for safe hydrocarbon exploration and exploitation offshore as well as improving the response mechanisms in case of an accident; thereby limiting possible disruptions to the EU's indigenous energy production.
- Assessment may also be required to determine if there could be any LSE from spill risk on any SACs or SPAs designated under the European Directives listed below, which are transcribed into UK legislation by the Conservation Regulations 1994 (as amended) (inshore out to 12 NM) and the Offshore Marine Conservation Regulations 2007 (as amended) (beyond 12 NM). These Regulations require the project developer to provide the information required by the Competent Authority (BEIS) to undertake such an assessment.
- EC Directive 92/43/EC (Habitats Directive). The central component of the Habitats Directive is the creation of the European sites network of SACs; and
- EC Directive 2009/147/EC (Birds Directive). This Directive sets out a broad spectrum of objectives although the precise legal mechanisms are at the discretion of the Member States. The Birds Directive also sets up a system of conservation designations for SPAs along the lines of SACs and the Habitats Directive. Together, SPAs and SACs from the European sites network.

7.3 SOURCES AND LIKELIHOOD OF OCCURRENCE

Major loss of containment events in offshore facilities are typically low frequency, high consequence scenarios. These differ from minor leaks which are more common to occur, however with lesser consequences. As such, the relative number of such large-scale events reported in any historical dataset for a given location, such as the UKCS, is naturally expected to be very low.

Figure 7-1 presents a summary of the accidental oil releases reported per year from 1975 to 2018 in the UKCS and the total quantities of oil spilled (in tonnes) for each year. Since the early 2000's (more specifically after 2002) the average number of reported oil spills remained approximately constant (fluctuating between 250 – 375 spills per year) (UKOOA, 2006). Overall, the number of reported spills increased considerably over the years since 1975, potentially associated with improvements in reporting behaviours, although a decrease between 1990 and 1995 was observed. The peaks in spilled amounts observed between 2010 - 2012 are a consequence of the three largest spills in the reported period - one spill of 131 tonnes in 2010, one spill of 218 tonnes in 2011, and one spill of 405 tonnes in 2012. In the 11 year period between 2008-2018 approximately 1,246 tonnes of oil were spilled, while in the preceding 11 years (1997-2007) this amount was approximately 1,700 tonnes. It was also seen that out of the 3,034 oil spills reported in the 11 years between 2008-2018, 97% were spills of less than a single tonne, only two events were of a magnitude greater than 100 tonnes and no event exceeded 1,000 tonnes.

Figure 7-1 Time series of the number of accidental oil releases in the UKCS and the associated released amount from 1975 to 2018



7.3.1 Accidental hydrocarbon releases

As discussed in Section 7.1, blowouts and well releases were selected as part of this review for further discussion due to the potential to result in losses of containment leading to large oil spills.

A surface blowout is defined as an uncontrolled flow of formation hydrocarbons from the reservoir to the surface which occurs as a result of loss of the primary and secondary well controls, i.e. oil flowing from a well from some point that was not intended. A blowout beneath the seabed may occur if the downhole pressure exceeds the fracture pressure of a formation and hydrocarbons flow into the weaker formation.

Primary well control is the process which maintains the hydrostatic pressure in the wellbore which is greater than the pressure of the hydrocarbons in the formation being drilled, but less than the formation fracture pressure. If the formation pressure is greater than the pressure of the drilling fluid in the wellbore (i.e. mud hydrostatic) the well will flow, and the hydrocarbons will enter into the wellbore. If the primary well control fails this flow may be stopped by closing the BOP, which is the initial stage of secondary well control. Secondary well control is completed by circulating out and displacing the wellbore with a high-density fluid to shut in the well. If the primary and secondary well controls fail, then a blowout may occur.

Based on International Association of Oil and Gas Producers analysis (IOGP, 2010), the likelihood of a blowout is remote. Nevertheless, as the consequence of a hydrocarbon release of any nature is potentially significant, TEPUK will implement rigorous measures to reduce the potential for a failure of well control and ensure effective response should an incident occur.

7.4 BEHAVIOUR OF HYDROCARBONS AT SEA

Relative to the existing wells at Alwyn, Alwyn East would not introduce any additional risks, with the exception of the well's potential flow rate being higher than that of any existing wells. Therefore, this section presents the updated worst-case flow rate oil spill modelling and associated MEI assessment.

The potential environmental impact of an accidental hydrocarbon release depends on a wide variety of factors, which include:

- Accidental release volume;
- Type of hydrocarbon release;
- Direction of travel of the surface slick;
- Weathering properties of the hydrocarbon;
- Any environmental sensitivities present in the path of the slick (these may change with time); and
- Sensitivity of the sea and beaching locations.

The Oil Spill Contingency and Response (OSCAR) model has been developed by SINTEF to model the fate of accidentally release hydrocarbons at sea. It has a built-in oil database, containing over 110 oils. OSCAR is a three-dimensional model, designed to predict the fate of oil particles at the surface, sub-surface and once dissolved. OSCAR calculates and records the distribution in three physical dimensions, plus time, of a contaminant on the water surface, along shorelines, in the water column, and in the sediments.

Seasonal (Winter – December to February; Spring – March to May; Summer – June to August; and Autumn – September to November) stochastic modelling using OSCAR was undertaken in line with the OPEP guidance provided by OPRED (BEIS, 2019b). Exactly 104 runs were performed for each season, with the historical metocean data used to inform the model spanning a period of 5-years from 2008 – 2013. The worst-case accidental release scenario for the development is detailed in Table 7-1.

In line with current regulatory and industry commentary and experience with the worst-case scenario identification, the following assumptions have been made while undertaking modelling:

- Interactions: all scenarios are run with the assumption that there is no response from any party, operator, local or national government. This approach is taken in order to view the worst-case predictions of a spill and should be used for guidance only to build and define oil spill contingency and response plans; and
- Timeframes: all modelled runs included at least an additional 10-days following cessation of release. The extra run time was in order to fully examine the fate of the released hydrocarbons.

In order to set limits for when the spilled hydrocarbon can be considered insignificant in the environment, the following thresholds have been used:

- The Bonn Agreement Oil Appearance Code is based on experimental evidence that has linked the visual appearance of surface oiling to known oil thicknesses. Under most viewing conditions, oil layers less than 0.04 µm in thickness cannot be easily detected by the human eye and appear silvery/grey up to a thickness of 0.3 µm. For this reason, a minimum surface oil thickness threshold of 0.3 µm has been used for all modelled scenarios; and

- The limit of 0.1 litres/m² for shoreline oiling was applied to all scenarios in agreement with the lowest band of light oiling, as set out by International Tankers Owners Pollution Federation (ITOPF) in 2011.

Table 7-1 Summary of Accidental Release Scenario Modelled for Alwyn East

Scenario description	Hydrocarbon type	Release volume (m^3)	Release rate (m^3/day)	Modelled depth of release	Model type
Unconstrained well blowout of crude oil at Alwyn East for 180 days (time taken to drill a relief well) Modelled over 4 seasons	Alwyn East crude	559,800	3,110	Surface	Stochastic

7.4.1 *Well blowout of crude oil at Alwyn East*

The stochastic modelling results for the unconstrained well blowout are summarised in Table 7-2 and Table 7-3. The probability plots for surface oiling above 0.3 µm (rainbow sheen) are displayed in Figure 7-2.

The minimum times for oil to cross the Norwegian, Danish, Swedish, Faroese, Icelandic, Jan Mayen and International maritime boundaries are summarised in Table 7-2. Modelling indicated that there was a worst-case probability of 100% for the crude crossing into Norwegian waters in all seasons. The shortest arrival time to a median line is to the UK/Norway median in 3 hours during autumn and spring.

The maximum probability of shoreline oiling and the minimum arrival times to shore are summarised in Table 7-3. Beaching was predicted to occur on the east coast of the UK from Shetland to Redcar and Cleveland in England and on European coastlines including Norway, Denmark and Sweden. The most likely place that the crude is predicted to beach is at Norway with a highest probability of 83.7% in summer. The minimum arrival time for oil to beach is in Norway and was predicted to be 6 days 1 hour during spring. UK protected sites have been considered in detailed assessment, of which there are five SPAs and one SAC predicted to receive more than 40% probability of beaching.

Table 7-2 Well blowout – Median lines crossed

Median line(s) crossed	Location	Minimum crossing time	Probability of Contamination (% range)
Winter	Norway	0 d 4 h - 210 d 0 h	1.0 % - 100 %
	Denmark	47 d 0 h - 209 d 22 h	1.0 % - 76.9 %
	Sweden	75 d 11 h - 208 d 21 h	1.0 % - 65.4 %
	Faroe Islands	45 d 16 h - 210 d 0 h	1.0 % - 67.3 %
	Iceland	115 d 21 h - 210 d 0 h	1.0 % - 14.4 %
	International Waters	47 d 3 h - 210 d 0 h	1.0 % - 97.1.0 %
	Jan Mayen	75 d 8 h - 210 d 0 h	1.0 % - 33.7 %
Spring	Norway	0 d 3 h - 210 d 0 h	1.0 % - 100 %
	Denmark	39 d 1 h - 172 d 1 h	1.0 % - 65.4 %
	Sweden	58 d 12 h - 204 d 10 h	1.0 % - 55.8 %
	Faroe Islands	50 d 13 h - 210 d 0 h	1.0 % - 37.5 %
	Iceland	127 d 14 h - 209 d 22 h	1.0 % - 7.7 %

Median line(s) crossed	Location	Minimum crossing time	Probability of Contamination (% range)
	International Waters	38 d 6 h - 210 d 0 h	1.0 % - 80.8 %
	Jan Mayen	99 d 21 h - 210 d 0 h	1.0 % - 10.6 %
Summer	Norway	0 d 4 h - 210 d 0 h	1.0 % - 100 %
	Denmark	35 d 9 h - 208 d 19 h	1.0 % - 10.6 %
	Sweden	44 d 7 h - 209 d 3 h	1.0 % - 6.7 %
	Faroe Islands	51 d 10 h - 210 d 0 h	1.0 % - 11.5 %
	Iceland	109 d 12 h - 210 d 0 h	1.0 % - 2.9 %
	International Waters	51 d 4 h - 210 d 0 h	1.0 % - 72.1.0 %
	Jan Mayen	119 d 0 h - 210 d 0 h	1.0 % - 15.4 %
Autumn	Norway	0 d 3 h - 210 d 0 h	1.0 % - 100 %
	Denmark	48 d 16 h - 210 d 0 h	1.0 % - 28.8 %
	Sweden	96 d 6 h - 209 d 22 h	1.0 % - 13.5 %
	Faroe Islands	72 d 0 h - 210 d 0 h	1.0 % - 35.6 %
	Iceland	136 d 4 h - 210 d 0 h	1.0 % - 7.7 %
	International Waters	31 d 12 h - 210 d 0 h	1.0 % - 88.5 %
	Jan Mayen	97 d 18 h - 210 d 0 h	1.0 % - 27.9 %

Table 7-3 Well blowout – Beaching timings and probabilities

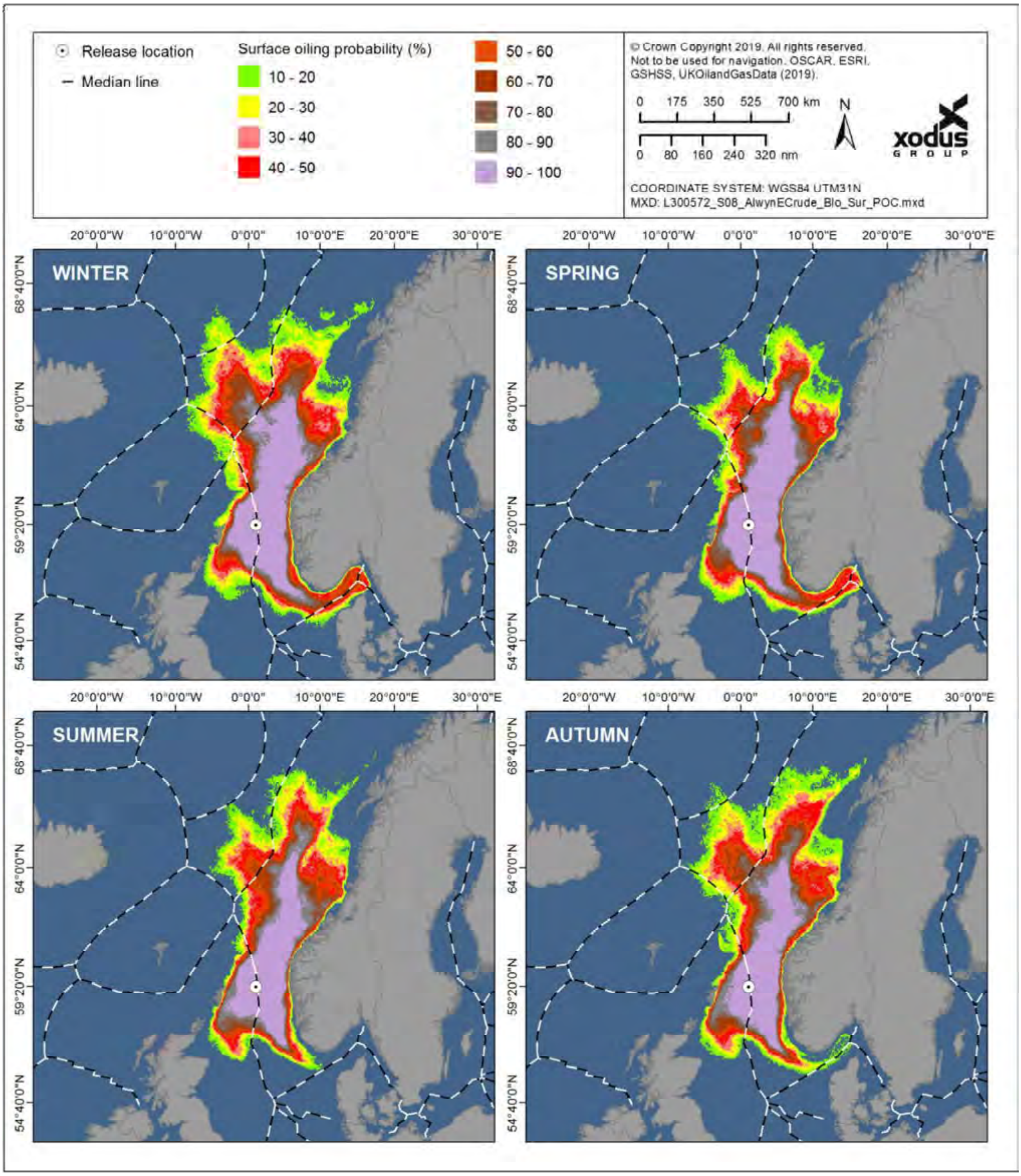
		Winter	Spring	Summer	Autumn
Fife	Probability of contamination (%)	Does not beach	Does not beach	1.0 % - 1.0 %	1.0 % - 1.0 %
	Arrival time	Does not beach	Does not beach	187 d 7 h - 187 d 7 h	130 d 21 h - 130 d 21 h
Aberdeen City	Probability of contamination (%)	1.0 % - 1.0 %	Does not beach	1.0 % - 1.0 %	1.0 % - 1.0 %
	Arrival time	173 d 3 h - 173 d 3 h	Does not beach	185 d 16 h - 185 d 16 h	122 d 9 h - 122 d 9 h
Highland	Probability of contamination (%)	1.0 % - 3.8 %	1.0 % - 1.0 %	1.0 % - 1.0 %	1.0 % - 1.0 %
	Arrival time	103 d 0 h - 204 d 16 h	70 d 9 h - 96 d 5 h	170 d 4 h - 208 d 3 h	111 d 0 h - 205 d 4 h
Aberdeenshire	Probability of contamination (%)	1.0 % - 2.9 %	1.0 % - 1.9 %	1.0 % - 1.9 %	1.0 % - 1.9 %
	Arrival time	105 d 17 h - 208 d 20 h	55 d 13 h - 132 d 19 h	142 d 17 h - 208 d 13 h	93 d 11 h - 165 d 10 h
Moray	Probability of contamination (%)	1.0 % - 1.9 %	1.0 % - 1.9 %	1.0 % - 1.0 %	1.0 % - 1.0 %

		Winter	Spring	Summer	Autumn
	Arrival time	129 d 23 h - 205 d 10 h	58 d 3 h - 128 d 22 h	129 d 1 h - 202 d 10 h	93 d 11 h - 157 d 9 h
Sunderland District	Probability of contamination (%)	Does not beach	Does not beach	Does not beach	1.0 % - 1.0 %
	Arrival time	Does not beach	Does not beach	Does not beach	204 d 6 h - 204 d 6 h
Redcar and Cleveland	Probability of contamination (%)	Does not beach	Does not beach	Does not beach	1.0 % - 1.0 %
	Arrival time	Does not beach	Does not beach	Does not beach	162 d 13 h - 162 d 13 h
Shetland Islands	Probability of contamination (%)	1.0 % - 77.9 %	1.0 % - 74 %	1.0 % - 80.8 %	1.0 % - 79.8 %
	Arrival time	14 d 13 h - 208 d 3 h	6 d 5 h - 155 d 1 h	7 d 18 h - 190 d 18 h	5 d 16 h - 202 d 12 h
Orkney Islands	Probability of contamination (%)	1.0 % - 6.7 %	1.0 % - 3.8 %	1.0 % - 1.0 %	1.0 % - 2.9 %
	Arrival time	41 d 14 h - 199 d 9 h	56 d 18 h - 98 d 21 h	150 d 5 h - 203 d 19 h	50 d 6 h - 200 d 7 h
Northumberland	Probability of contamination (%)	Does not beach	Does not beach	Does not beach	1.0 % - 1.0 %
	Arrival time	Does not beach	Does not beach	Does not beach	175 d 15 h - 178 d 7 h
Norway	Probability of contamination (%)	1.0 % - 64.4 %	1.0 % - 82.7 %	1.0 % - 83.7 %	1.0 % - 58.7 %
	Arrival time	7 d 16 h - 209 d 20 h	6 d 1 h - 209 d 18 h	19 d 0 h - 209 d 18 h	8 d 15 h - 209 d 15 h
Denmark	Probability of contamination (%)	1.0 % - 15.4 %	1.0 % - 5.8 %	1.0 % - 1.0 %	1.0 % - 5.8 %
	Arrival time	72 d 21 h - 197 d 13 h	67 d 17 h - 140 d 13 h	184 d 1 h - 209 d 21 h	95 d 17 h - 209 d 3 h
Sweden	Probability of contamination (%)	1.0 % - 6.7 %	1.0 % - 3.8 %	Does not beach	1.0 % - 3.8 %
	Arrival time	81 d 3 h - 209 d 6 h	73 d 0 h - 199 d 4 h	Does not beach	142 d 12 h - 209 d 16 h
Protected areas with beaching oil probability > 40%		**SPAs –** Hermaness, Saxa Vord and Valla Field SPA, Fetlar SPA, Noss SPA, Sumburgh Head SPA, Fair Isle SPA **SAC** – Mousa SAC			
Maximum mass of beached oil in any single run (te)		774	492	403	779
Maximum mass of beached emulsion in any single run (te)[r]		4,983	3,447	2,694	4,843
Maximum volume of beached emulsion in any single run (m^3)[s]		5,063	3,491	2,733	4,928

[r] Wind and waves act on oil on the sea surface and in the water column to mix oil with water, resulting in the formation of an emulsion.

[s] The volume of the beached emulsion will be larger than the volume of the oil alone and will have different physical chemical properties. In clean-up operations, understanding the volume of material requiring removal or treatment is important.

Figure 7-2 Well blowout – Probability of surface oiling (above 0.3 µm) above 10%



7.5 POTENTIAL RECEPTORS

Environmental vulnerability to spills is a function of both the likelihood of impact from a spill (as considered in previous sections) and the sensitivity of the environment. The severity of a release and its persistence time is largely dependent on the physical properties of the hydrocarbon being released.

7.5.1 Coastal Environments

The likelihood of a hydrocarbon spill impacting the coastal environment is a function of the likelihood of a hydrocarbon spill occurring and the probability of the released hydrocarbons beaching. The level of impact is also directly related to the volume of hydrocarbon beaching, the composition of the beached hydrocarbons, and the type of shoreline.

Coastal environmental sensitivities to spills include nearshore breeding seabird populations, shore birds, over wintering diver and duck species, marine mammals, aquaculture operations and sub-littoral and coastal habitats including SACs and SPAs.

Intertidal areas of the coast show varying degrees of sensitivity to spills; this variability is a function of both actual effects on specific organisms and the physical fate of the released substances within the habitat concerned. For example, high energy rock, boulder or cliff coastlines tend to have lower sensitivity to hydrocarbon pollution because oil is rapidly broken up and dispersed by wave action, and beached oil remains on the surface of rocks and is exposed to weathering. In contrast, sheltered, low energy shorelines tend to have moderate to high sensitivity because oil is not broken up by wave action and it can be mixed into the sediment where it is not exposed to weathering and therefore persists for longer.

7.5.2 Protected Sites

Sea surface and shoreline probability of contamination data exported from the stochastic oil spill modelling (see Section 7.4) were examined to identify protected sites which are at risk of hydrocarbon contamination and require further assessment. For the purposes of this assessment, it was concluded that a protected site required further assessment if the probability of shoreline contamination within the site was equal to or above 40% in any of the release scenarios.

The qualifying features in the majority of coastal sites with the potential to be impacted as a result of oiling are estuaries, mud and sandflats and dune features. These habitats are also more likely to be negatively affected by hydrocarbon contamination than sea cliff habitats.

Stony reefs that may be present in the Alwyn East area are likely to be the most sensitive habitat to hydrocarbon contamination, as well as species that forage in the contaminated areas. Various seal haul-out locations are present in the Shetland area. The animals most at risk from oil coming ashore on seal haul-out sites and breeding colonies are neonatal pups. These animals are born without any blubber and reply on their prenatal fur (the white lanugo in grey seals) and metabolic activity for thermal balance. They are therefore more susceptible than adults to external oil contamination (Ekker *et al.*, 1992). The pups remain on the breeding colonies until they are weaned and unlike adults or juveniles, would be unable to leave the contaminated areas.

As the blowout represents the worst-case scenario, the potential of contamination at protected sites was assessed for the crude blowout scenario only. The protected sites included in the assessment were SACs (including candidate SACs (cSACs)), SPAs (including proposed SPAs (pSPAs)) and MCZs (including proposed MCZs (pMCZs)). The six sites with at least 40% chance of being contaminated by shoreline oiling are presented in Table 7-4. The nine sites with at least a 40% chance of being contaminated by surface oiling (Figure 7-2) are presented in Table 7-5. The impact of contamination on the designation features are discussed below in the relevant sections.

Table 7-4 UK Protected sites potentially impacted as a result of hydrocarbon contamination from a well blowout at Alwyn East (>40% probability of shoreline contamination)

Site	Primary designation features (JNCC, 2020)
Noss SPA Maximum probability of shoreline oiling (%): 76	**Directive 2009/147/EC Article 4.1 (Annex I) species:** • Great skua *Catharacta skua* • Guillemot • Gannet **Directive 2009/147/EC Article 4.2 (non-Annex I regularly occurring migratory) species during breeding seasons:** • Dunlin • Great skua • Whimbrel Regularly supports 22,000 individual seabirds including: Arctic Skua *Stercorarius parasiticus*, Fulmar, Great Skua, Arctic Tern, Red-necked Phalarope *Phalaropus lobatus*.
Fetlar SPA Maximum probability of shoreline oiling (%): 74	**Directive 2009/147/EC Article 4.1 (Annex I) species:** • Arctic tern • Red-necked phalarope **Directive 2009/147/EC Article 4.2 (non-Annex I regularly occurring migratory) species during breeding seasons:** • Dunlin • Great skua • Whimbrel Regularly supports 22,000 individual seabirds including: arctic skua, fulmar, great Skua, Arctic Tern, Red-necked Phalarope.
Sumburgh Head SPA Maximum probability of shoreline oiling (%): 69	**Directive 2009/147/EC Article 4.1 (Annex I) species:** • Arctic tern **Directive 2009/147/EC Article 4.2 (non-Annex I regularly occurring migratory) species during breeding seasons:** Regularly supports 35,000 individual seabirds including: kittiwake, fulmar, guillemot, arctic tern.
Fair Isle SPA Maximum probability of shoreline oiling (%): 48	**Directive 2009/147/EC Article 4.1 (Annex I) species:** • Arctic tern • Fair Isle wren *Troglodytes fridariensis* **Directive 2009/147/EC Article 4.2 (non-Annex I regularly occurring migratory) species during breeding seasons:** • Guillemot Regularly supports 180,000 individual seabirds including: Puffin, Razorbill, Kittiwake, Great Skua, Arctic Skua *Stercorarius parasiticus*, Shag *Phalacrocorax aristotelis*, Gannet, Fulmar, Guillemot, Arctic Tern.
Hermaness, Saxa Vord and Valla Field SPA Maximum probability of shoreline oiling (%): 48	**Directive 2009/147/EC Article 4.1 (Annex I) species:** • Red-throated Diver *Gavia stellata* **Directive 2009/147/EC Article 4.2 (non-Annex I regularly occurring migratory) species during breeding seasons:** • Gannet • Great skua • Puffin

Site	Primary designation features (JNCC, 2020)
	Regularly supports 152,000 individual seabirds including: Guillemot, Kittiwake, Shag, Fulmar, Puffin, Great Skua, Gannet.
Mousa SAC (Coastal) Probability of surface oiling (%): 69	**Annex I habitats present as a qualifying feature** • Reefs • Submerged or partially submerged sea caves **Annex II species that are a primary reason for selection:** • Harbour seal

Table 7-5 UK Protected sites potentially impacted as a result of hydrocarbon contamination from a well blowout at Alwyn East (>40% probability of surface contamination)

Site	Primary designation features (JNCC, 2020)
Fetlar SPA Maximum probability of surface oiling (%): 78	See Table 7-4
Noss SPA Maximum probability of surface oiling (%): 76	See Table 7-4
Sumburgh Head SPA Maximum probability of surface oiling (%): 67	See Table 7-4
Fair Isle SPA Maximum probability of surface oiling (%): 46	See Table 7-4
Pobie Bank Reef SAC (Offshore) Probability of surface oiling (%): 99	**Annex I habitats that are primary reason for selection:** • Reefs
Braemar Pockmarks SAC (Offshore) Maximum probability of surface oiling (%): 98	• Submarine structures made by leaking gases
Mousa SAC (Coastal) Probability of surface oiling (%): 65	See Table 7-4
Central Fladen MPA (Offshore) Probability of surface oiling (%): 82	• Burrowed mud (seapens and burrowing megafauna and tall seapen components) • Sub-glacial tunnel valley representative of the Fladen Deeps Key Geodiversity Area
North-east Faroe-Shetland Channel NCMPA (Offshore) Probability of surface oiling (%): 80	• Deep-sea sponge aggregations • Offshore deep sea muds • Offshore subtidal sands and gravels

7.5.3 *Plankton and fish*

There can be impacts on plankton in the immediate area of the release for the duration of the release due to the dissolution of aromatic fractions into the water column. Such effects will be greater during a period of plankton bloom and during fish spawning periods as these lifestages are more sensitive to these dissolved contaminants. Contamination of marine prey including plankton and small fish species may then lead to aromatic hydrocarbons accumulating in the food chain. These could have long-term chronic effects such as reduced fecundity and breeding failure in fish, bird and cetacean populations. This may affect fish stocks of commercially fished species. A major release could also have a localised effect on the fishing industry, should certain areas be temporarily closed to fishing. Juvenile fish and eggs are potentially the most sensitive life-stage to hydrocarbon discharges. As outlined in Section 3.3.3, a number of commercially important pelagic and demersal fish species are found in the vicinity of the development. However, it is expected that it is unlikely to cause an adverse significant impact due to the short-life expectancy of the plankton and the small proportion of the North Sea population likely to be affected.

Fish and shellfish from aquaculture sites on the coast may also be impacted by oil on the sea surface. Shellfish production is an important activity in Scotland, economically, socially and environmentally. The Shellfish Farming Production Survey (Scottish Government, 2021b states that in 2020, the total value at first sale for all species was calculated at approximately £6.1 million, a decrease of 23% from the £7.9 million estimated in 2019. This decline is considered to be largely due to impacts from the COVID-19 pandemic with many businesses reporting lost trade while the hospitality sector was in lockdown during much of 2020. The industry contributed to approximately 142 full-time jobs and 158 part-time and casual workers during 2020. The number of full-time staff increased by six and the number of part-time and casual employees increased by 17 compared with 2019 (Scottish Government, 2021b). Production was dominated by mussel and Pacific oyster in terms of value and tonnage. Mussel production decreased by 15% to 5,661 tonnes and Pacific oyster production decreased by 33% to 2,938 tonnes during 2020, although small quantities of scallop, queen scallop (queen) and native oyster were also produced (Scottish Government, 2021b). An increase for finfish production was recorded between 2018 and 2019, where total production was 156,025 tonnes in 2018 and 203,881 tonnes in 2019 (Scottish Government, 2020). As noted above, Shetland is the most probable beaching site within the UK which supports both shellfish protection areas and aquaculture sites. Given the likelihood of spill occurring, along with the control measures in place to respond to a release, the risk to fishing (both off and nearshore) is considered to be effectively managed.

7.5.4 *Marine mammals*

Cetaceans are also present in the vicinity of the development area (see Section 3.3.5). In the event of a spill, the potential impact will depend on the encounter rate of the species with the oil and their feeding habits; the overall health of individuals before exposure; and the characteristics of the hydrocarbons. Cetaceans are pelagic (move freely in the water column) and migrate. Their strong attraction to specific areas for breeding or feeding may override any tendency cetaceans have to avoid hydrocarbon contaminated areas. It is thought unlikely that a population of cetaceans in the open sea would be affected by a spill in the long-term (St. Aubin, 1990). In contrast to seabirds, there is relatively little evidence of direct mortality associated with oil spills (Geraci & St. Aubin, 1990; Hammond *et al.* 2002), although the aggregated distribution of some species (especially dolphins) may expose large numbers of individuals to localised oiling.

Whilst it is possible that some marine mammals could come into contact with surface accumulations of oil and would be susceptible through inhalation or skin absorption, their ability for avoidance would reduce the potential for impact and it is considered to be unlikely that any marine mammal listed under the habitats directive would be impacted on a population level. As such, no significant impact is expected on marine mammals at sea.

However, as discussed in Section 7.5.2, there are a number of seal haul-out sites along the east coast of the UK. Any oil which comes ashore will therefore increase the exposure of oil to the seals at these sites. The pups remain on the breeding colonies until they are weaned and are particularly susceptible to oil. Therefore, the population could be significantly impacted for at least one breeding season.

7.5.5 *Benthic Environments*

Although there are a number of sites with the potential to be impacted by surface oiling (Table 7-5), it is very unlikely that the hydrocarbons would be mixed with the water column in sufficient quantities or and depth to interact with the protected seabed features. As such, no significant impact is expected on the benthic environment.

7.5.6 *Birds*

Impacts of sea surface oiling on seabirds is one of the greatest environmental risks posed by accidental hydrocarbon release events. This is primarily due to the high affinity of oil for seabird plumage. Once oil becomes incorporated into the feathers, there is a very high chance of death due to loss of body heat, starvation, drowning or oil ingestion from preening activity. Plumage is essential to flight, waterproofing and heat insulation and even small effects on any of these functions can result in mortality.

Some groups of seabirds are more vulnerable than others due to their particular behaviours. Guillemots, which spend much of their time on the sea surface and typically dive to avoid danger, are particularly sensitive to oil slicks. Common guillemot are particularly vulnerable in the post-breeding period because the male parents accompany their flightless young in swimming offshore from the breeding colonies. This generally occurs in late spring and early summer. Gannets are also sensitive due to their diving behaviour which causes then to repeatedly pass through any sea surface hydrocarbon layer.

Species that nest on cliffs and cliff tops are unlikely to have their nesting sites directly adversely affected by an accidental hydrocarbon release, although following the Sea Empress incident gannets were observed collecting contaminated nesting material (Santillo *et al*., 1998).

Sheltered habitats that encourage wading or resting on calm water may suffer significant losses of birds in the event of sea surface oiling due to the greater likelihood that large accumulations of birds will be exposed. Following the Sivand spill in the Humber Estuary, the Royal Society for the Protection of Birds (RSPB) reported 160 dead oiled birds were found and estimated that 4,000 birds may have been oiled in total (NOAA, 1992). It is likely that the vast majority of oiled birds would have died due to hypothermia and toxicity; it is common that only a small proportion of bird carcasses are recovered following hydrocarbon release mortality events.

Sensitivity of particular species also varies in line with the total biogeographical population, which influences the potential for population recovery following an incident.

The JNCC has stated in a memorandum to the UK Parliament that the greatest risks to nature conservation from oil on the offshore sea surface is to seabirds (JNCC, 2011). The seasonal vulnerability of seabirds to surface pollutants is identified using SOSI, derived from JNCC block-specific data. In the immediate vicinity of Alwyn, seabird sensitivity to oil releases ranges from low to medium (see Section 3.3.4 or further detail). The magnitude of any impact will depend on the number of birds present, the percentage of the population present, their vulnerability to spilled hydrocarbons and their recovery rates from oil pollution. The physical impact of a spill is one of plumage damage leading to loss of insulation and waterproofing.

Seabirds that rest and breed within SPA boundaries commonly feed in waters outside the site boundary, meaning that hydrocarbon releases may impact protected site features without actually entering the site.

The SPAs listed in Table 7-4 and Table 7-5 support a wide range of species that vary in seasonal presence, breeding, feeding and nesting behaviour. There is a range of probability of shoreline and surface contamination at these SPAs, up to 76% and up to 78% respectively. As discussed below, the impact of sea surface oiling on seabirds is one of the greatest environmental risks posed by accidental hydrocarbon release events. However, the contamination is unlikely to be long-term as the population will be able to recover.

Potential recovery rates may range from 1 to 10 or more years depending on the species affected and the extent of population loss. Recovery rates depend on numerous factors including:

- The percentage of the breeding population killed (and therefore numbers remaining);
- Number of juveniles lost (affecting recruitment rates in following years);
- Size of the existing pre-breeding pool and rates of recruitment into the colonies;
- Rates of reproduction of individual species;
- Long-term loss of feeding grounds and prey species; and
- Sub-lethal effects which may affect reproductive success.

7.6 MEI ASSESSMENT

7.6.1 Introduction

Under the Offshore Safety Directive (2013/30/EC) and the implementing UK regulations, the Offshore Installations (Offshore Safety Directive) (Safety Case) Regulations 2015 (OSCR), operators are required to identify in their well notifications where any MAHs associated with the operations has the potential to cause a MEI. A MEI is defined by the OSCR as an incident which results, or is likely to result, in significant adverse effects on the environment in accordance with the Environmental Liability Directive (2004/35/EC).

A range of potential blowout rates were calculated for both oil and gas case discharges, following the methodology described in TEPUK Group Guide and Manual to determine the level of environmental severity (TEPUK, 2014). TEPUK has defined that the most credible blowout rate must cover at least 90% of the potential blowout rates. TEPUK estimated that the most credible worst-case oil blowout rate as 19,560 bbl/day of oil plus 2.30 million Sm^3/day of gas.

These blowout rates were used to construct a worst-case discharge scenario (i.e. with no response or intervention), which was simulated using the Oil Spill Contingency and Response model (OSCAR) deterministic module, to predict the quantity and concentrations of oil reaching the sea surface, water column, shoreline and sediments, which may be classified as Valued Ecosystem Components (VEC). When relevant, and as far as practicable, VECs shall include the protected species or habitat, as defined by Annex I of the Birds Directive or Annex I, Annex II and Annex IV of the Habitats Directive.

An initial assessment was conducted in line with TEPUK's Environmental Risk Assessment Strategy (TEPUK, 2019). The likelihood of environmental damage and an evaluation of the environmental restoration time are discussed fully in Appendix B.1 and results in an initial assessment outcome of **Major (Sub MEI)**.

Environmental incidents not showing the potential for a MEI from the first assessment require a second assessment to ensure that all impacts to the environment have been considered. This assessment is completed following TotalEnergies Group Guide and Manual to determine the level of environmental severity (TEPUK, 2014), where environmental severity is calculated using four aspects:

- Volume that reaches the impacted medium;
- Hazard level of the spill product for the impacted medium;
- Sensitivity of the impacted medium; and
- Extent (length) of shoreline or surface area that is impacted.

The full calculation is detailed in Appendix B.2.

7.6.2 Assessment outcome

The environmental severity calculation (TEPUK, 2019) results in a potential **"Catastrophic" severity** for shoreline and offshore marine environmental receptors. Catastrophic severity is defined as a result of large-scale pollution of ecosystems that have recognised ecological value. Although the simulated oil released was not predicted to be very persistent, oil was predicted to arrive in UKCS, Norwegian, Danish and Swedish waters. The volumes are such that there are predicted to be four VECs within the UKCS with shoreline oiling greater than ITOPF heavy oiling threshold and 22 VECs within the UKCS predicted to receive oiling above 0.1 µm threshold (O'Hara and Morandin, 2010). Therefore the worst-case release is considered to result in a MEI (see Appendix B.2.5 for final calculation).

7.7 MANAGEMENT AND MITIGATION MEASURES

Measures to prevent and mitigate an accidental hydrocarbon release are as follows:

- The Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 implement the EC Offshore Directive. As part of this, a verification scheme exists for safety and environment critical elements (SECEs);
- There will be appropriate well control and blowout preventer for the Alwyn East well;

- TEPUK will conduct drill kick exercises that will be fully documented;
- The Alwyn East standalone drilling OPEP will be in place for the drilling activities, including modelling and appropriate response planning;
- Development of, and conformance to, appropriate maintenance procedures;
- Environmentally critical equipment to the operations will be identified within Alwyn's maintenance systems. These will be inspected regularly including audit; and
- Simultaneous operations (SIMOPs) will be actively identified and managed.

7.8 CUMULATIVE AND TRANSBOUNDARY IMPACTS

Existing hydrocarbon spill risks in the North Sea are associated primarily with oil and gas industry activities as well as other marine industries such as merchant shipping and fishing. As indicated by historical data, the likelihood of one major accidental release occurring is remote or extremely remote, limiting the cumulative impact from Alwyn East. A standalone OPEP will be in place for the proposed drilling activities, outlining the response measures to be implemented in the event of any accidental release.

MEI modelling predicted hydrocarbons crossing the median line, with the potential to reach Norwegian, Danish and Swedish waters. However, based on historical UKCS data, the likelihood of an accidental release large enough to lead to such a transboundary impact is remote. Therefore, consultation under the Espoo Convention is not required for the drilling of the Alwyn East well. As detailed in Section 4.7, the Espoo Convention requires notification and consultation only for developments likely to have a significant adverse environmental impact across boundaries.

The risk of an accidental hydrocarbon release having a transboundary impact, particularly from UKCS operations, is recognised by the UK Government and other governments around the North Sea. Agreements are in existence for dealing with international releases with states bordering the UK (e.g. Bonn Agreement). These agreements would operate within the framework of the National Contingency Plans (NCPs) and are oriented towards major spills. This becomes operational when agreement to the request for its implementation is reached. Responsibility for implementing joint action with neighbouring states rests with the Action Coordinating Authority (ACA) of the country on whose side of the median line a spill originated. The UK's ACA is the Counter Pollution Branch of the Maritime Coastguard Agency. In the event of a major accidental release which has the potential to drift into Norwegian waters, the Norwegian/British oil spill response (NORBRIT) plan will be activated.

7.9 RESIDUAL IMPACTS

Although the probability of an unplanned event occurring at Alwyn East and resulting in a MEI is remote, even with comprehensive prevention measures in place, a potential impact to the marine environment remains. This is recognised to be true for the offshore oil and gas industry in general. TEPUK will ensure appropriate response plans and mitigation measures are in place to address these risks. All activities will be covered by the appropriate OPEPs. The consequences associated with such an event would be significant and would affect a number of protected conservation areas within UK waters and along the coast. However, given the unlikely possibility of a MEI occurring, and the measures in place to prevent and mitigate such a scenario, the environmental risk has been deemed minor. Overall, accidental events are not thought to be a significant impact associated with drilling and production at Alwyn East.

Consequence	Likelihood/frequency	Environmental risk	Significance
Major	Remote	Minor	Not Significant

8 ENVIRONMENTAL MANAGEMENT

8.1 ENVIRONMENTAL POLICY AND MANAGEMENT SYSTEM

The activities of TEPUK in the UK reflect the global values of the TotalEnergies Group, as presented in the HSE Policy Statement (Figure 8-1). The commitments made in the HSE Policy are implemented through the TEPUK Company Management System and Safety, Health and Environmental Management System (SHEMS), which is accredited to the internationally recognised ISO 14001 and ISO 50001 standards.

TEPUK's overall aim is to minimise environmental impact wherever operations are carried out. It is also recognised that this has to be achieved alongside the need to meet increasingly rigorous environmental standards, both regulated and self-imposed. It is TEPUK's policy to comply with all legal requirements and TotalEnergies Group policies. TEPUK supports this overall aim with an environmental policy which encourages a positive SHE&I culture through:

- Strong leadership from management and supervisors;
- Workforce involvement;
- Personal responsibility; and
- A spirit of openness and co-operation.

TEPUK's environmental policy is underpinned by the company Environment and Energy Management System (E&EnMS), embedded in which is the achievement of continuous improvement in environmental performance (Figure 8-2). The E&EnMS provides a framework to ensure compliance with environmental legislation, the prevention of pollution, and achievement of continuous improvement of environmental performance. It also provides the framework to promote an overall reduction in energy use, energy costs and greenhouse gas emissions. The E&EnMS is continually under review in order to adapt to changing statutory requirements, corporate aspirations and new/evolving scientific knowledge and techniques. The E&EnMS has achieved third party certification against the internationally recognised EMS standards ISO 14001 and ISO 50001. Performance of the E&EnMS is ensured by third party on an annual basis; this is supported by a programme of internal audits.

The TEPUK HSE Policy and UK legislation jointly impose responsibilities on management, supervisors and individual employees for which they will be held accountable. Various groups and processes are in place within TEPUK that support this, including:

- Every site has a formally appointed responsible person for safety and environment on site (RSES). Specific HSE roles are defined in TEPUK processes and procedures. Sites are supported by a team of environment engineers onshore;
- Each site has a dedicated environmental engineer who would maintain environmental aspects registers, set environmental improvement targets and actions, co-ordinate progress on improvement actions, and review environmental suggestions;
- Various specialist teams have been put together to progress key environmental objectives such as a carbon footprint reduction (CFR) team with CFR focal points in each asset;
- Monthly environmental performance and emissions dashboards to closely monitor environmental performance;
- Quarterly asset HSE meeting where the asset management team meet to discuss environmental performance shared and continuous improvement progress, evaluate incident trends, progress against HSE plan objectives, etc.; and
- Bi-weekly and quarterly environmental shared learnings meeting which is a cross-asset opportunity to share best environmental practice, topics of interest, new guidance/legislation and set general environmental focus direction based on significant aspects and trends.

8.2 CARBON FOOTPRINT REDUCTION STRATEGY

TotalEnergies' ambition to become the responsible energy major means meeting growing energy demand whilst responding to the climate change challenge: reducing carbon emissions and minimising the environmental impact of operations.

Together with society, TotalEnergies is committed to achieving carbon neutrality - net zero - by 2050 across our global business. To support this, three major steps have been identified:

- Achieve net zero across TotalEnergies' worldwide operations by 2050 or sooner;
- Achieve net zero across all production and energy products used by TotalEnergies' customers in Europe (the European Union, Norway, and United Kingdom) by 2050 or sooner;
- Achieve a reduction of 60% or more in the average carbon intensity of energy products used worldwide by TotalEnergies customers by 2050 – with intermediate steps of 15% by 2030 and 35% by 2040.

TotalEnergies takes a four-pronged approach to help achieve this:

- Acting on emissions – This is focused on cutting greenhouse gas emissions by improving energy efficiency, eliminating routine flaring, electrifying processes, and continuing efforts to reduce methane emissions from oil and gas production.
- Acting on products – This ensures changes to the global energy mix are included in TotalEnergies' strategy. TotalEnergies is focused on expanding specifically in gases (natural gas, biogas, and hydrogen) and low carbon electricity, primarily generated from renewable resources. We are growing our role in biofuels and concentrating on oil investments with a low breakeven cost.
- Acting on demand – TotalEnergies' focus is on helping to shape demand and ensure carbon neutrality is a shared ambition with customers. This involves guiding customers towards lower-carbon energy solutions and helping them to use energy more efficiently.
- Carbon sinks – Lastly, TotalEnergies' strategy goes beyond just reducing emissions, adapting its energy mix, and shaping customer demand. It is also about investing in nature-based solutions (natural carbon sinks) and developing carbon capture and storage solutions[t].

Supporting this on a more local level, TEPUK has established and implemented an Energy Management System (EnMS) which is certified to ISO 50001:2018 standard, the first energy major in the UKCS to achieve this.

The EnMS provides a structured, auditable framework which supports TEPUK's carbon reduction targets, guiding the development of a CFR roadmap. It encourages a continuous improvement approach when it comes to the energy performance of all TEPUK sites and helps identification of best practice and improvement in operating philosophies and processes, across all activities.

Through implementation of the EnMS, over 200 separate projects have been identified that support emissions reduction of operational activities and energy use optimisation. A number of these were delivered in 2020, including projects which focused on: logistics; site power generation; and venting.

TEPUK has also established a Carbon Reduction Focal Point and an Energy Transition Leader. Following these appointments, a team was established to understand the contribution and support TEPUK can provide to TotalEnergies' wider business. This means not only looking at TEPUK Exploration and Production branch but identifying how TotalEnergies' other subsidiaries can be supported. For example, TEPUK personnel have supported the TotalEnergies Gas, Renewables & Power (GRP) branch in securing offshore wind opportunities.

TEPUK is also developing new ways of working within major projects and modifications. This involves engagement within teams across each project timeline to ensure that emissions and energy efficiency are a key driver of informed decision making, underpinned by data and following the framework of EnMS. As applied to Alwyn East, this would involve considerations around resource use, energy requirements and flaring,

[t] More information can be found in Getting to Net Zero report, Total, September 2020.

particularly during start-up. Over time, further efficiencies are expected to be implemented in these areas, supporting overall carbon reduction targets.

These strategies will be applied to Alwyn East mitigation measures:

- The Alwyn East development has been taken into account when assessing the implementation of GHG reduction projects;
- GHG management is built into the tender process so will be assessed as part of the contractor selection process;
- Studies have been undertaken to understand the impact of GTG optimisation for drilling activities;
- Development of culture both on and offshore to embed knowledge and understanding of ambitions; and
- The use of data visualisation through tracking and monitoring.

Current and ongoing projects being undertaken on Alwyn North which will reduce its carbon footprint include:

- 2 out of 4 generators – forecast to reduce CO_2 by around 35,500 tonnes per year which equates to 15% of Alwyn's annual CO_2 emissions from fuel gas;
- Passing valve replacements;
- Export compressor optimisation;
- Live end to end plant CO_2 emissions optimisation (as discussed in Section 5.5); and
- LED lighting implementation.

8.3 *ENVIRONMENTAL MONITORING*

Monitoring is an important activity and required for a number of different purposes:

- Monitoring data for compliance with environmental consents and regulatory requirements;
- Environmental data required by OPRED's oil and gas EEMS; and
- To track performance against corporate objectives and targets, including improvement programmes e.g. as set out in the Environmental Aspects register.

Measurements for the project include:

- Atmospheric monitoring;
- Chemical use and discharge; and
- Accidental hydrocarbon and chemical releases.

A commitments register will be established for tracking all the commitments made within this ES for the drilling campaign and the production phase, as laid out in Appendix C. This will also include any further commitments that arise out of the regulatory review of this ES and the stakeholder consultation process.

Figure 8-1 TEPUK Health, Safety and Environment Policy Statement

TotalEnergies

Health, Safety and Environment
Policy Statement

TotalEnergies E&P UK (TEPUK) as a subsidiary of TotalEnergies, is committed to delivering our business objectives whilst prioritising a safe working environment for our employees, contractors and other stakeholders; safeguarding the environment and preventing pollution; maximising energy efficiencies; complying with laws and regulations and preventing Major Accident Hazards. This commitment is visibly demonstrated through implementation and compliance with the Company Management System (CMS) and measured via the setting of annual targets and establishment of company objectives:

It is our stated policy to:

- Maintain safe, energy efficient and regulatory compliant operations in all our activities by providing assets, facilities and equipment that have been efficiently designed and procured in accordance with BATNEEC and installed, commissioned and maintained, in accordance with TEPUK and TotalEnergies company procedures.
- Systematically identify for all activities, the hazards to which people, the environment and assets are exposed, evaluate the risks and define the measures for eliminating or reducing them to as low as reasonably practicable (ALARP).
- Provide adequate resources and information to execute our activities whilst meeting our local, national and international compliance obligations, along with TEPUK and TotalEnergies company procedures.
- Continue to develop a positive HSE culture through strong visible leadership, active involvement of the workforce, individual accountability and a spirit of co-operation.
- Monitor the health of all employees to ensure they are not adversely affected by the work environment.
- Adopt the principles of continuous improvement by setting measurable business objectives and targets, monitoring and reviewing performance through independent audits and statistical analysis of results.
- Ensuring our emergency response capability is suitable for responding to hazards and regularly testing the effectiveness of this response by controlled exercises.
- Work with our contractors and suppliers to ensure they understand our HSE requirements, whilst being prepared to listen to suggested improvements in areas where they have highly developed knowledge, in order to deliver mutually beneficial results.

[redacted]

June 2021

Figure 8-2 TEPUK Environmental Management System framework

8.4 *INTERFACE WITH CONTRACTORS*

Management of contractors is an essential part of environmental management in order to ensure compliance with regulatory requirements and company policy and to ensure primacy and procedural interfaces, including management of environmental aspects, are identified and managed. The objectives of the TEPUK contractor management processes are to ensure that:

- All contractors apply Health, Safety, Security and Environment (HSSE) policies and standards that are compatible with TEPUK and TotalEnergies Group policy;
- All contractors' personnel are competent to perform their tasks;
- HSSE responsibilities of both contractor and TEPUK are clearly defined.; and
- Each contractor has a formal hazard management process to minimise HSSE risk.

The above objectives are applicable to all phases of the contracting process and existing contracts are reviewed periodically.

8.5 *ENVIRONMENTAL AWARENESS AND TRAINING*

All employees, suppliers and contractors of TEPUK undergo some training on environmental issues. This may include one or more of the following:

- Induction training;
- Applicable environmental awareness training modules;
- Safety management course (for supervisory and managerial employees);
- Incident investigation training (as required); and
- Risk assessment training.

9 CONCLUSIONS

The drilling of a new well at Alwyn East (drilled from the Alwyn platform) and the additional production of gas and oil as a result of this new well are associated with potential environmental impacts. The environmental issues identification process conducted for this EIA has identified potential impacts from increased atmospheric emissions, additional discharges to sea and accidental events from the proposed activities.

During drilling activities of the Alwyn East well, emissions are expected to increase due to the need to use a third power generator to complete the drilling phase safely. Additionally, there will be emissions from supply vessels and helicopters during this time as well as emissions from well annuli venting and flaring during well test and start-up. Flaring is anticipated to increase slightly during the first two years of production from Alwyn East as a result of the additional well start-ups that are likely to be required. Following the drilling period, Alwyn will run on only two generators whenever possible (as per the current base case at Alwyn). In the worst-case scenario, there may also be an increase in emissions from fuel gas consumption. However, these emissions will add a relatively small increment to the overall emissions from Alwyn and the release of GHG into the environment. New production from the Alwyn East reservoir will result in a small increase in water production, as well as potentially slightly greater volumes of water being discharged to sea, which has the potential to impact on water quality and the species that make use of the water column. The drilling of a new well and the increase in production associated with Alwyn East creates an opportunity for an accidental event to occur causing a MEI. However, the possibility of a MEI occurring is remote, and TEPUK will have measures in place to prevent and mitigate such a scenario.

A summary of the EIA conclusions for the Alwyn East well is presented in Table 9-1, and the mitigation measures that TEPUK commit to undertake are presented in Appendix C.

The nearest protected site to the Alwyn NAA and NAB platforms is the Pobie Bank Reef SAC, which lies approximately 88 km to the southwest. This site is identified for the protection of Annex I submarine structures made by leaking gases in the UK. Given the distance between Alwyn and this protected site, and that no water column risk or sediment deposition is expected to extend that far, no impact on this site is expected. As the new well at Alwyn East will be drilled as a sidetrack from the original platform well and no additional seabed infrastructure is required, no seabed impacts are expected from the proposed drilling campaign.

There are spawning and nursery grounds in the vicinity of Alwyn for several fish species, a number of which are listed as PMF in Scottish waters, including: anglerfish, blue whiting, cod, herring, ling, mackerel, Norway pout, saithe, sandeels, spurdog and whiting. Fish may be impacted by changes in water quality associated with discharges to sea, however, as concluded in Table 9-1, discharges of produced water from Alwyn East will result in a minimal increase to current levels during production and there will be no discharges of mud or drill cuttings during drilling. Whilst there are likely to be some limited chemical discharges during drilling these are expected to be dispersed rapidly and widely in the marine environment and not present significant environmental risk. An accidental oil spill has the potential to have a localised effect on fish populations however, given the very low likelihood of a spill event, the impact significance is negligible.

The presence within the Alwyn region of species protected under Annex II of the Habitats Directive is limited to marine mammals. The species that are most likely to occur at Alwyn include Atlantic white-sided dolphin, harbour porpoise (protected under Annex II), minke whale, long-finned pilot whale and white-beaked dolphin. These species are all listed as Scottish PMF. Based on the available information, the region around Blocks 3/04, 3/05 and 3/09 is not considered to be significant for feeding, breeding, nursery or migrating cetaceans. Therefore, no significant impacts on marine mammals are expected from the drilling of the Alwyn East well. In the unlikely event of an oil spill, seals would be the most impacted due to the presence of seal haul-out sites along the east coast of the UK. Therefore, the population could be significantly impacted for at least one breeding season. However, given the very low likelihood of such an event happening, the residual impacts on marine mammals from the Alwyn East well are not considered significant.

A number of seabird species may be present in the vicinity of Alwyn throughout the year, including northern fulmar, northern gannet, Arctic skua, great skua, black-legged kittiwake, great black-backed gull, common gull, lesser black-backed gull, herring gull, glaucous gull, Arctic tern, common guillemot, razorbill, little auk and Atlantic puffin. Seabirds are not normally affected by oil and gas operations, however, in the unlikely event of an oil release, birds are vulnerable to oiling from surface pollution. Given the very low likelihood of such an event happening, the residual impacts on seabirds from the Alwyn East well are not considered significant.

There are a number of offshore and coastal conservation areas on the UK mainland that have been designated under the Habitats Directive as SACs, under the EU Birds Directive as SPAs and under the Marine and Coastal Access Act 2009 as NCMPAs and MCZs. The potential for significant impacts on any such sites has been considered within each impact assessment chapter, with particular focus given to the potential for an accidental hydrocarbon release to interact with such sites. However, given the distance of the Alwyn East field and the Alwyn platform, and the mitigation and management measures in place, the proposed Alwyn East drilling campaign is considered unlikely to affect the conservation objectives or site integrity of any SAC and SPA, and neither is there a significant risk to the conservation objectives of any NCMPAs. Considering all of the above, no significant impacts are expected upon protected species and habitats. As such, there is considered to be no Likely Significant Effect on SACs, SPAs, NCMPAs and MCZs; hence no impact on any conservation objectives or site integrity.

The Alwyn East EIA has considered the objectives and marine plan policies of the Scotland National Marine Plan across the range of policy topics including natural heritage, air quality, cumulative impacts and oil and gas. TEPUK considers that the proposed drilling of the Alwyn East well is in broad alignment with such objectives and policies. TEPUK's existing environmental management procedures and practises will ensure that any potential impacts are managed and controlled.

Table 9-1 Summary of residual environmental impacts

Facilities	Potential impacts from increased production	Environmental risk	Impact significance
Atmospheric emissions	Atmospheric emissions will temporarily increase as a result of drilling of the new well at Alwyn East, due to the need to run a third power generator, as well as emissions from supply vessels, helicopters and well annuli venting and flaring during well test and start-up. Overall, despite the increase, when compared to emissions on a UK-wide scale, the atmospheric emissions associated with Alwyn East are minimal and do not contribute significantly to the UK carbon emissions budget. Given the temporary and limited nature of the majority of the atmospheric emissions from the Alwyn East drilling campaign and taking into account the distance from any potentially sensitive receptors, it is not expected that atmospheric emissions will negatively impact local air quality or result in significant local cumulative impacts. Whilst flaring is anticipated to increase slightly during the first two years of production from Alwyn East as a result of additional well start-ups, and in the worst-case production scenario there is likely to be an increase in emissions from fuel gas consumption, these emissions would have a minor effect on Alwyn's contribution to overall UK emissions.	Minor	Not significant
Discharges to sea	There will be no change to the produced water handling strategy at the Alwyn platform as a result of the production from Alwyn East. There is expected to be an increase in the volume of produced water and associated oil and chemical content, however, produced water will normally be reinjected into an available injection well through the PWRI system, which significantly reduces produced water discharges. These discharges will be managed in accordance with the relevant permitting system. The very small increases in oil-in-water and chemical discharges will be minimal and insignificant in the context of the UKCS. Drill cuttings generated during the drilling phase will be either re-injected or shipped to shore for processing, therefore there will be no discharges of cuttings or mud to sea. There will be some chemical discharges during drilling but these are expected to be limited and would rapidly disperse in the marine environment, therefore not presenting a significant risk to the marine environment.	Minor	Not significant
Accidental events	Accidental events associated with dropped objects and natural disasters are highly unlikely due to the scope of work and the location of Alwyn East. However, a hydrocarbon MEI at Alwyn could have major consequences. Modelling determined that such an event could cause severe surface and shoreline oiling. Preventative measures are in place to minimise and mitigate such an event. Furthermore, the likelihood of a MEI occurring is highly unlikely therefore such an event is still considered not significant.	Minor	Not significant

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APPENDIX A ALWYN AREA PRODUCTION PROFILES

The production figures for the Alwyn Area fields have been converted to tonnes using Table A-0 below.

Table A-0 Specific gravity for the Alwyn Area fields

	Alwyn	Dunbar	Ellon	Grant	Forvie	Islay	Jura	Nuggets
Density at 15°C (g/cm^3)	0.80	0.82	0.89	0.76	0.77	0.78	0.85	0.85

Table A-1 Maximum gas and oil production for the Alwyn North field (PCON/5456)

Year	Maximum gas consent	Maximum oil consent		
	1,000 m^3 per day	1,000 m^3 per day	Te per day	MMbbl per day
2019	2300	0.9	720	0.0057
2020	2254	0.767	613.6	0.0048
2021	2754	1.283	1026.4	0.0081
2022	2754	1.248	998.4	0.0078
2023	2685	1.161	928.8	0.0073
2024	2323	0.983	786.4	0.0062
2025	2291	0.926	740.8	0.0058
2026	1972	0.782	625.6	0.0049

Table A-2 Maximum gas and oil production for the Nuggets N1 field (PCON/5453)

Year	Maximum Gas Consent	Maximum Oil Consent		
	1,000 m^3/day	1,000 m^3/day	Te per day	MMbbl per day
2019	52	0.001	0.85	-
2020	52	0.001	0.85	-
2021	52	0.001	0.85	-
2022	52	0.001	0.85	-
2023	52	0.001	0.85	-

Table A-3 Maximum gas and oil production for the Nuggets N2 field (PCON/5131)

Year	Maximum gas consent	Maximum oil consent		
	1,000 m^3 per day	1,000 m^3 per day	Te per day	MMbbl per day
2019	28	0.001	0.84	-
2020	10	0.001	0.84	-
2021	10	0.001	0.84	-

Table A-4 Maximum gas and oil production for the Nuggets N3 field (PCON/5126)

Year	Maximum gas consent	Maximum oil consent		
	1,000 m^3 per day	1,000 m^3 per day	Te per day	MMbbl per day
2019	28	0.001	0.84	-
2020	10	0.001	0.84	-
2021	10	0.001	0.84	-
2022	10	0.001	0.84	-

Table A-5 Maximum gas and oil production for the Nuggets N4 field (PCON/5125)

Year	Maximum gas consent	Maximum oil consent		
	1,000 m^3 per day	1,000 m^3 per day	Te per day	MMbbl per day
2019	28	0.001	0.84	-
2020	50	0.001	0.84	-
2021	50	0.001	0.84	-
2022	50	0.001	0.84	-

Table A-6 Maximum gas and oil production for the Islay field (PCON/5128)

Year	Maximum gas consent	Maximum oil consent		
	1,000 m^3 per day	1,000 m^3 per day	Te per day	MMbbl per day
2019	182	0.007	5.53	-
2020	222	0.011	8.69	0.0001
2021	236	0.012	9.48	0.0001
2022	236	0.012	9.48	0.0001

Table A-7 Maximum gas and oil production for the Forvie North field (PCON/5454)

Year	Maximum gas consent	Maximum oil consent		
	1,000 m^3 per day	1,000 m^3 per day	Te per day	MMbbl per day
2019	445	0.042	32.34	0.0003
2020	425	0.04	30.8	0.0003
2021	345	0.026	20.02	0.0003
2022	287	0.021	16.17	0.0002
2023	259	0.019	14.63	0.0002
2024	213	0.016	12.32	0.0001
2025	194	0.014	10.78	0.0001
2026	159	0.011	8.47	0.0001

Table A-8 Maximum and oil production for the Jura field (PCON/5129)

Year	Maximum gas consent	Maximum oil consent		
	1,000 m^3 per day	1,000 m^3 per day	Te per day	MMbbl per day
2019	1810	0.12	94.8	0.0006
2020	1500	0.07	55.3	0.0003
2021	1406	0.062	48.98	0.0003
2022	1276	0.054	42.66	0.0003
2023	1276	0.053	41.87	0.0003
2024	1037	0.043	33.97	0.0002

Table A-9 Maximum gas and oil production for the Dunbar field (PCON/4573)

Year	Maximum gas consent	Maximum oil consent		
	1,000 m^3 per day	1,000 m^3 per day	Te per day	MMbbl per day
2019	788	0.755	619.1	0.0039
2020	645	0.674	552.68	0.0035
2021	615	0.587	481.34	0.0030
2022	570	0.565	463.3	0.0029

Table A-10 Maximum gas and oil production for the Ellon field (PCON/5127)

Year	Maximum gas consent	Maximum oil consent		
	1,000 m^3 per day	1,000 m^3 per day	Te per day	MMbbl per day
2019	400	0.13	117	0.0007
2020	359	0.129	116.1	0.0007
2021	342	0.127	114.3	0.0007
2022	305	0.118	106.2	0.0007
2023	283	0.115	103.5	0.0007
2024	263	0.105	94.5	0.0006

Table A-11 Maximum gas and oil production for the Grant field (PCON/5134)

Year	Maximum gas consent	Maximum oil consent		
	1,000 m^3 per day	1,000 m^3 per day	Te per day	MMbbl per day
2019	945	0.149	107.8	0.0007
2020	898	0.137	105.49	0.0007
2021	896	0.134	103.18	0.0006
2022	806	0.119	91.63	0.0006
2023	785	0.115	88.55	0.0006
2024	707	0.101	77.77	0.0005

APPENDIX B MEI ASSESSMENT

B.1 RESERVOIR HYDROCARBON RELEASE ASSESSMENT

The environmental event described in Section 7.6 has been plotted on a risk matrix, based on the likelihood of the major environmental incident occurring and the estimated restoration time (Table B-3). TEPUK's Environmental Risk Assessment Strategy (TEPUK, 2019) states that any incident generating a restoration time greater than three years on one or more VECs shall be classified as a MEI.

B.1.1 Likelihood

Table B-1 presents generic blowout and well release frequencies per Alwyn well based on OGP 434-02[u] and derived from blowout incident data in the SINTEF database.

The potential likelihood of a blowout occurring during the drilling of the Alwyn East exploration well, has been taken as **6.0E-05.**

Table B-1 Blowout[v] and well release frequencies (per Alwyn well)

Activity	Event	Frequency (per well)
Drilling	Blowout	6.0E-05
	Well release	4.9E-04
Production	Blowout	9.7E-06
	Well release	1.1E-05
Wirelining	Blowout	6.5E-06
	Well release	1.1E-05
Completion	Blowout	9.7E-05
	Well release	3.9E-04
Coiled Tubing	Blowout	1.4E-04
	Well release	2.3E-04
Snubbing	Blowout	3.4E-04
	Well release	1.8E-04
Workover	Blowout	1.8E-04
	Well release	5.8E-04

B.1.2 Restoration time

The ITOPF have produced a Technical Information Paper (ITOPF, 2011) providing guidance on how to estimate the stranded oil volume. Using this guidance, it was estimated that a light oiling of Alwyn East Crude equates to a volume of 0.1 l/m^2 (0.08 kg/m^2), moderate oiling equates to a volume between 0.1 l/m^2 (0.08 kg/m^2) and 1 l/m^2 (0.8 kg/m^2) and heavy oiling equates to a volume greater than 1 l/m^2 (>0.8 kg/m^2).

[u] International Association of Oil & Gas Producers (OGP). Report No. 434 02, March 2010 (Referenced within the Alwyn North QRA and FERA assumptions register NA-N00-00-S-RP-700038-001)

[v] A blowout is defined as an incident where formation fluid flows out of the well or between formation layers after all the predefined technical well barriers or the activation of the same have failed. The frequencies per well are combined with the numbers of drilling and well intervention activities and the numbers of production wells to give estimated blowout and well release frequencies on the platform and subsea.

Within the UK Continental Shelf (UKCS), the blowout modelling indicated beaching occurring mainly along the east coast of the Shetland Islands (Figure B-2). Oil masses greater than 0.8 kg/m^2 are predicted at two Special Protection Areas (SPAs); Sumburgh Head SPA (approximately 1.9 kg/m^2 of oiling) and Fetlar SPA (approximately 0.9 kg/m^2 of oiling). These sites support populations of seabirds that are listed on Annex I of the bird directive e.g. Arctic tern, red-necked phalarope, kittiwake, fulmar, guillemot as well as a number of wading birds including whimbrel and dunlin.

The boundary of the Sumburgh Head SPA is also coincident with that of a Site of Special Scientific Interest (SSSI) at Sumburgh Head and Quendale SSSI, whilst the Fetlar SPA overlaps North Fetlar SSSI, Lamb Hoga SSSI and Trona Mires SSSI. Oiling masses greater than 0.8 kg/m^2 are predicted at Quendale SSSI (approximately 1.9 kg/m^2 of oiling) and Lamb Hoga (approximately 0.9 kg/m^2 of oiling).

In terms of the restoration times of the shoreline VECs, it is expected that the birds protected within the potentially contaminated sites, are likely to recover through recruitment from nearby sites within a single breeding season. However, it is important to note that there are numerous factors which influence recovery rates which creates uncertainty in the determination of recovery.

Overall, the approach undertaken was based on the "Impact Scales and Gradation of Oil Spill Ecological Hazards and Consequences in the Marine Environments" classification guide described by Patin (2004), and presented in Table B-3, the outcome of this scenario concluded a temporal scale of "chronic", and a reversibility of changes of "slightly reversible".

Therefore, on balance, a restoration time of **>1 year** has been taken forward.

B.1.3 Assessment outcome

Table B-2 presents the matrix based on the likelihood of a major environmental incident occurring and the estimated restoration time, with any incident generating a restoration time greater than three years on one or more VECs being a MEI, as highlighted in red.

The likelihood of environmental damage and an evaluation of the environmental restoration time has been plotted in Table B-2, giving an initial assessment outcome of **Major (Sub MEI)**.

Table B-2 Risk assessment matrix with major environmental incidents

Likelihood of the environmental damage							
	$>10^{-2}$/yr	Likely					
	$>10^{-3}$/yr	Unlikely					
	$>10^{-4}$/yr	Very unlikely					
	$>10^{-5}$/yr	Extremely unlikely			X		
	$>10^{-6}$/yr	Remote					
			Moderate	Serious	Major	Catastrophic	Disastrous
		Restoration time	< 1 month	> 1 month	> 1 year	> 3 years	>10 years

B.2 ADDITIONAL ASSESSMENT

Environmental incidents not showing the potential for a MEI from the first assessment require a second assessment to ensure that all impacts to the environment have been considered. This assessment is completed following the TotalEnergies Group Guide and Manual to determine the level of environmental severity (TEPUK, 2014).

The assessment of the environmental severity (P) is:

$$P = \sqrt[4]{V \times D \times S \times E}$$

Where:

V = Volume that reaches the impacted medium
D = Hazard level of the spilled product for the impacted medium
S = Sensitivity of the impacted medium
E = Extent of the medium (length of shoreline or surface area) that is impacted

The final level of severity is then determined according to Table B-3, where a severity of 5 (catastrophic) or above is deemed to be equivalent to a MEI.

Table B-3 Environmental sensitivity scoring matrix from TEPUK (2014)

Severity	Accidental pollution events	Result of the equation $P = \sqrt[4]{V \times D \times S \times E}$
2 – Moderate	Small pollution with a minimal environmental impact	P < 2.5
3 – Serious	Pollution of limited extent and environmental consequences	2.5 < P < 3.5
4 – Very serious	Pollution having significant environmental consequences	3.5 < P < 4.5
5 – Catastrophic	Large-scale pollution of ecosystems having a recognised ecological value	4.5 < P < 5.5
6 - Disastrous	Pollution having a massive and durable consequences for vast ecosystems having a high ecological value	10.5 < P

B.2.1 Volume (V)

The volume criteria score is determined by the volume of oil that reaches the potentially impacted medium and is classified into the following categories listed in Table B-4.

Table B-4 Volume scoring matrix

	Volume that reaches the medium Expressed in tonnes of product
V = 2	Less than 1 t
V = 3	Between 1 t and 9.9 t
V = 4	Between 10 t and 99 t
V = 5	Between 100 t and 999 t
V = 6	More than 1000 t

The mass balance of oil over the duration of the release is presented in Figure B-1. The deterministic model indicated that evaporation was the major removal mechanism for the release. This accounted for approximately 60% of the released oil by the end of the model (day 210), whilst approximately 18% was biodegraded. At the end of the model run: approximately 14% of the released hydrocarbons remained within the water column; approximately 8% becoming deposited within the seabed sediment; approximately 0.1% present on the sea surface and approximately 0.1% leaving the modelled grid area. Less than 0.1% of the released hydrocarbons was predicted to come ashore (Table B-5).

Figure B-1 Mass balance of oil from Alwyn East blowout deterministic scenario

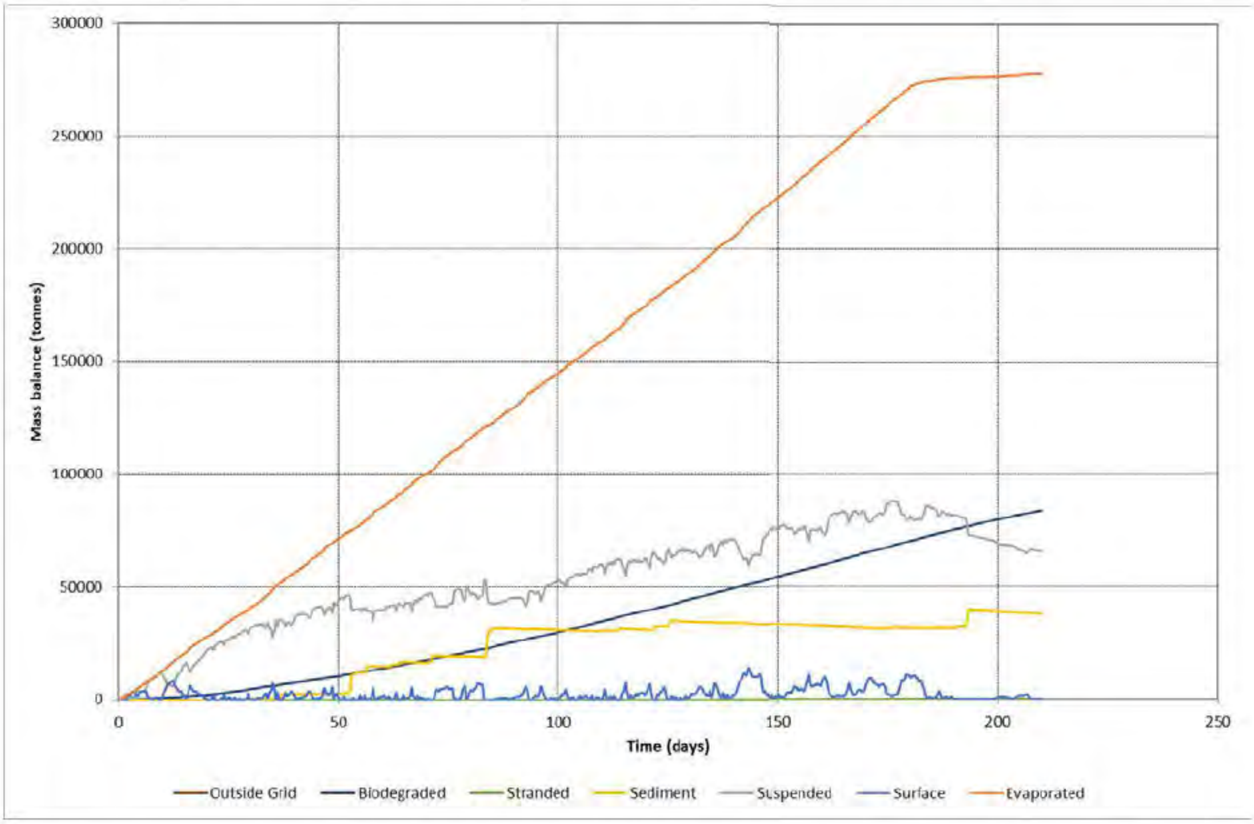


Table B-5 Mass balance of oil from the Alwyn East blowout deterministic model scenario

Fate	Maximum mass (te)	Mass balance after 210 days	
		Mass (te)	Percentage (%)
Surface	14,250	423	0.09
Atmosphere	277,900	277,900	59.63
Water Column	88,130	65,420	14.04
Sediments	39,460	37,900	8.13
Ashore	338	85	0.02
Biodegraded	84,050	84,050	18.04
Outside Gridded Area	247	247	0.05

Using the mass balance, the maximum mass predicted ashore is 338 tonnes, which is predicted to be reached approximately 178 days after the release (Figure B-1). Based on Table 7-4 this would equate to a volume score (V) of 5.

Volume (V_{shore}) = 5

The maximum oil on the surface is 14,250 tonnes approximately 143 days after release (Figure B-2). This volume would equate to the highest volume score, V = 6.

Volume (V_{marine}) = 6

B.2.2 Hazard (D)

The product hazard levels are classified based on their ITOPF Grouping[w] and the impacted medium (Table B-6).

Table B-6 Product hazard level classification

	Impacted medium			
	Off-shore marine	**Surface water**	**Land and standing water**	**Air**
ITOPF Group 1 (°API > 45)	D = 4	D = 5	D = 4	D = 6
ITOPF Group 2 (°API 35 - 45)	D = 4	D = 5	D = 4	D = 4
ITOPF Group 3 (°API 17.5 - 35)	D = 6	D = 6	D = 2.5	D = 2.5
ITOPF Group 4 (°API < 17.5)	D = 5	D = 5	D = 2.5	-

The worst-case blowout deterministic scenario was modelled with a specific density relative to pure water (°API) of 44.9 which is classified within ITOPF Group 2. This would produce the hazard score of **D = 4**, for the impacted medium of land and standing water.

Hazard (D_{shore}) = 4

Based on the assumed oil characterisation, the hazard score (D) for the offshore marine environment would be 4.

Hazard (D_{marine}) = 4

B.2.3 Sensitivity (S)

The sensitivity of impacted environments takes into account the ecological value or importance of the impacted medium (Table B-7).

Table B-7 Sensitivity (S) scoring matrix

Sensitivity	S score
Non-sensitive ecosystems (of no ecological value)	S = 2
Moderately sensitive ecosystems (of minor ecological value)	S = 3
Sensitive ecosystems (of significant ecological value, possible protected by weak regulations or the equivalent thereof)	S = 4
Sensitive and protected ecosystems (of major ecological value, protected by moderate or strict regulations, or the equivalent thereof)	S = 6

As discussed above, there are four VECs within the UKCS predicted to receive oiling greater than 0.8 kg/m2 (ITOPF heavy oiling threshold); two of which are SSSIs (Figure B-2). Under the description of "moderate or strict" defined in TEPUK 2014, SSSIs are considered to be a category IV by the International Union for Conservation of Nature (IUCN) (Crofts & Phillips, 2013) and therefore would produce a shore sensitivity score of S = 6[x].

[w] Oil types are often classified into four main groups, roughly according to their specific density or API, where Group 1 oils are non-persistent and Group 4 oils are very persistent.
[x] However, it should be noted that this accounts for worst-case score based on information from GM-GR-ENV-006. If this assessment was conducted using the L2-SE-04-025 guidance, the resultant score would be 3 as there are no areas registered by UNESCO in the world heritage list (S=6) or internationally recognised sites, e.g. Ramsar sites (S=4), which have the potential to be contaminated by greater than 0.8 kg/m^2 and SSSIs would result in a score of 3.

Sensitivity (S_{shore}) = 6

In terms of surface oiling, there are 22 VECs within the UKCS predicted to receive surface oiling above the 0.1 µm (0.0001 mm) threshold (O'Hara and Morandin, 2010). These VECs include 12 SSSIs and the Ronas Hill – North Roe and Tingon RAMSAR site (Figure B-2 and Figure B-3).

As explained in the shore sensitivity score, SSSIs are classified as a category IV by the IUCN (Crofts & Phillips, 2013). Also, RAMSAR sites are of international designation. Therefore, this would result in a score of **S = 6**.

Sensitivity (S_{marine}) = 6

Figure B-2 Deterministic modelling: Proximity of protected sites and maximum shoreline oiling

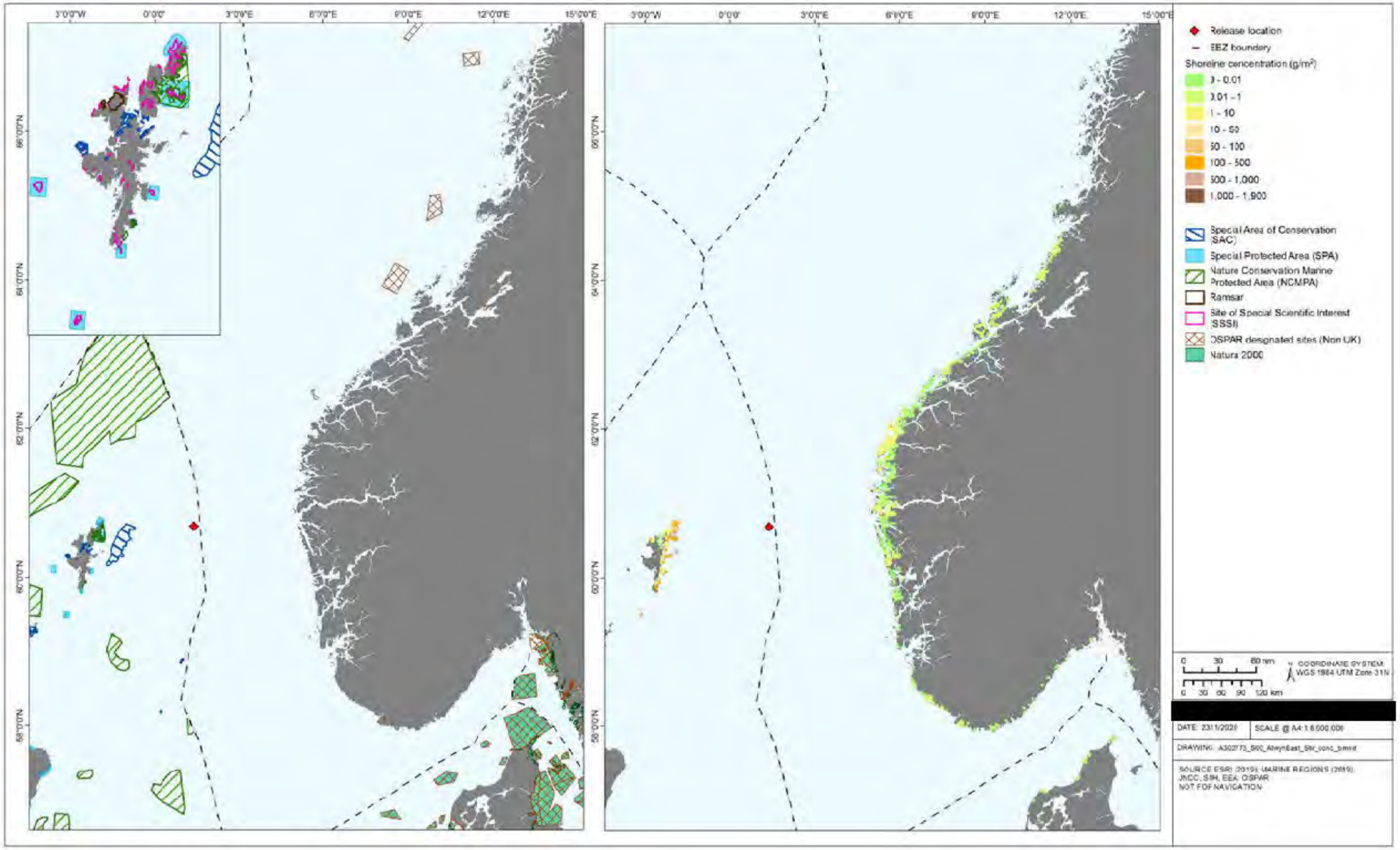
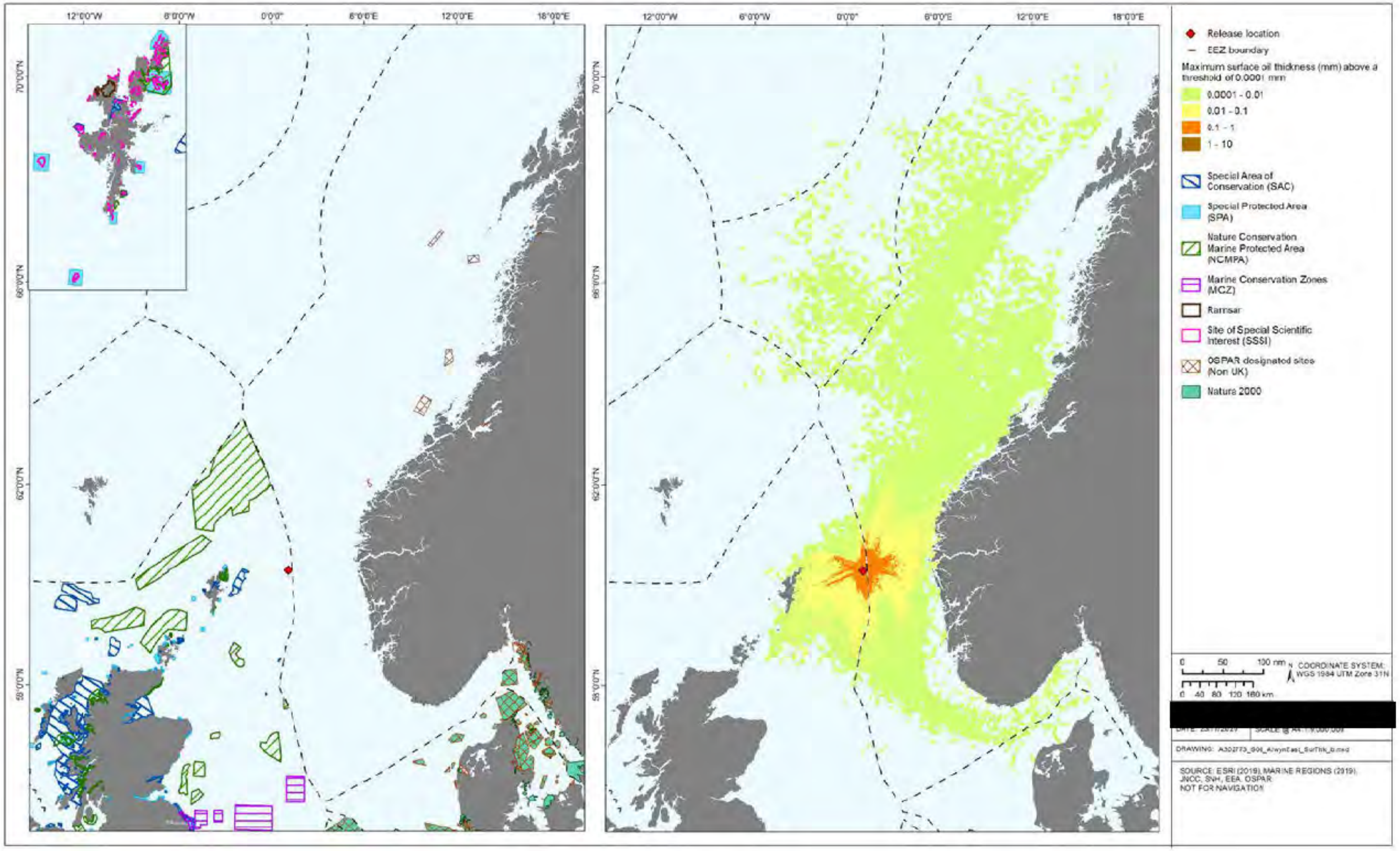


Figure B-3 Deterministic modelling: Proximity of protected sites and maximum surface oiling



B.2.4 Extent (E)

The extent of the impacted environments is in relation to the surface area or length of pollution (Table B-8).

Table B-8 Extent of impacted environment scoring matrix

Extent (E)	Length of shoreline (L) in km	Surface area (S) in hectares
E = 2	L < 0.05	S < 0.2
E = 3	0.05 < L < 0.5	0.2 < S < 2
E = 4	0.5 < L < 5	2 < S < 10
E = 5	5 < L < 50	10 < S < 50
E = 6	L > 50	S > 50

Using the criteria presented by Patin (2004), reproduced in Appendix B.3, the spatial scale for the worst-case blowout scenario was classified as "regional" for both surface and shoreline trajectories. Due to the impacts being predicted to spread over a shelf area greater more than 100 km^2.

Shoreline contamination above the thresholds detailed in Section B1.2 indicates that a considerable length of UK and Norwegian coastline is predicted to experience shoreline oiling (see Figure B-3). Therefore, this would result in a score of **E = 6.**

Extent (S_{shore}) = 6

The GM-GR-ENV-006 methodology states that the Extent criterion is redundant for offshore scenarios without impacts on shorelines. However, from Figure B-3, there is potential for impact. Due to the "regional" classification as described above, a score of E = 6 was determined.

Extent (E_{marine}) = 6

B.2.5 Assessment outcome

An assessment performed using TEPUK (2014) suggests a potential severity of **"Catastrophic"** for shoreline and offshore marine environmental receptors (Table B-3):

$\boldsymbol{Pshore} = \sqrt[4]{(5 * 4 * 6 * 6}$ $\boldsymbol{P = 5.2}$ (Shoreline is the impacted medium)

$\boldsymbol{Pmarine} = \sqrt[4]{(6 * 4 * 6 * 6}$ $\boldsymbol{P = 5.4}$ (Offshore marine environment is the impacted medium)

As a value of 5 or above is considered to indicate a MEI, the Alwyn East blowout is considered to be a MEI.

B.3 PATIN (2004) CONSEQUENCE ASSESSMENT

Impact Scales and Gradation of Oil Spill Ecological Hazards and Consequences in the Marine Environments" classification guide described by Patin (2004)

Table B-7 Consequence Assessment – Spatial Scale (Area)

Spatial scale	Area under impact
Point	Less than 100 m^2
Local	Range from 100 m^2 to 1 km^2
Confined	Range from 1 km^2 to 100 km^2
Sub-regional	More than 100 km^2
Regional	Spread over shelf area

Table B-8 Consequence Assessment – Temporal Scale

Temporal scale	Longevity
Short term	Several minutes to several days
Temporary	Several days to one season
Long-term	One season to one year
Chronic	More than one year

Table B-9 Consequence Assessment – Reversibility of Changes

Reversibility of changes	Longevity of disturbance
Reversible (acute stress)	Acute disturbances in the state of environment and stresses in biota that can be eliminated either naturally or artificially within a short time span (several days to one season)
Slightly reversible	Disturbances in the state of environment and stresses in biota that can be eliminated either naturally or artificially within a relatively short time span (one season to three years)
Irreversible (chronic stress)	Prolonged disturbances in the state of environment and stresses in biota that exist longer than three years

Table B-10 Consequence Assessment – General Assessment

General assessment	Disruption
Insignificant	Minimal changes that are either absent or not discernible.
Slight	Slight disturbances to the environment and short-term stresses in biota are discernible (below minimum reaction threshold 0.1% of natural population reaction).
Moderate	Moderate disturbances to the environment and stresses in biota are observed (changes up to 1% of natural population reaction are feasible).
Severe	Severe disturbances to the environment and stresses in biota are observed (up to 10% of natural population).
Catastrophic	Catastrophic disturbances to the environment and stresses in biota are observed (up to 50% of natural population). Changes are irreversible and stable structural and functional degradation of a system is evident.

APPENDIX C COMMITMENTS TABLE

Item	ES Section Number	Issue	Mitigation and Management Action
1	5.6	Atmospheric emissions	Emissions associated with current and anticipated production are covered by the following permits: • PPC/5 - this covers emissions from the plant qualifying combustion equipment (e.g. the gas turbine generators on the platform); • Flare Consent - flaring activities during well test and start-ups (initial start-up and following additional planned or unplanned well shutdowns) will be applied for under Alwyn Annual Flare Consent (2022 application expected in October 2021) and the duration of flaring will be limited as far as is practicable to reduce the emissions; • Vent Consent – venting activities during drilling or production will be applied for under the Alwyn Annual Vent Consent (2022 application expected in October 2021). Venting levels are typically very low and limited to programmed well maintenance routines, such as those required for leak testing; • Various processes and procedures (i.e. maintenance procedures, ongoing monitoring, competent personnel, internal/third party auditing) will contribute to optimisation of energy efficiency and thereby minimising emissions; • Fuel monitoring on Alwyn North is a platform-wide system rather than turbine specific. It is externally verified as part of ETS and EEMS reporting; • Current platform load and operating philosophy is resulting in the turbines operating at the higher end of their efficiency curves – this typically results in reduced CO and unburnt hydrocarbon emissions. Burner Temperature spreads are routinely measured giving indication of combustion performance; • The platform is currently investigating a number of options to optimise load control and process optimisation on the platform as a result of recent energy efficiency audits; • Monitor Atmospheric emissions with a live dashboard with all greenhouse gas emissions monitored 24/7 against business performance contract with an annual CO_2e target and optimise operations accordingly; • Monitor health of equipment using a live digital tool to ensure its optimum configuration in order to reduce GHG emissions as far as practically poss ble; and • All combustion equipment will be subject to regular monitoring and inspections to ensure an effective maintenance regime is in place, ensuring all combustion equipment runs as efficiently as poss ble. Energy Performance checks are conducted by a third party as part of this maintenance regime.
2			• All supply vessels employed during drilling activities will comply with the Merchant Shipping (Prevention of Air Pollution from Ships) (Amendment) Regulations 2014; • Drilling and vessel operations will be carefully planned to reduce vessel numbers and the duration of operations; and • Use of low sulphur diesel (as per UK regulatory requirements).
3	6.5	Oil discharges	Oil discharges are controlled by the following: • Alwyn North NAB Platform Oil Discharge Permit (Ref. OLP/144) monthly reports highlighting oil-in-water discharge and biannual returns for other constituents of produced water under EEMS; • Discharges of oil during drilling will be assessed and applied for under a drilling Oil Discharge Permit, if needed (to be submitted prior to drilling campaign commences); • Alwyn Produced Water site management procedure, which provides operating guidance to ensure highest

Item	ES Section Number	Issue	Mitigation and Management Action
			possible oil in water quality, and additional steps to be attempted in case of high oil levels; and • The PWRI system at Alwyn normally operates at a worst-case 90% efficiency, thereby significantly reducing the likelihood of discharge of produced water.
4	6.5	Chemical discharges	Chemical discharges are controlled under the following permits and procedures: • Alwyn North NAB Production Chemical Permit SAT (Ref. CP/69); • All chemicals for the drilling campaign will be selected on their technical specifications as well as for their potential environmental impacts. Use and discharge of these chemicals will be assessed in detail using the CHARM system where appropriate, and the results will be submitted in a Chemical Permit SAT at least 28 days before drilling commences; • Annual chemical substitution plan identifies how the use of hazardous chemicals is proposed to be phased out; • Chemical management procedure, which helps to optimise chemical dosing thus minimising chemical discharges and ensures only approved chemical products can be used; and • The discharge point from the Alwyn platform will be assessed under RBA, currently scheduled for 2022. This will allow a thorough review of the produced water discharge and the functioning of the produced water treatment system on the platform.
5	7.7	Accidental hydrocarbon release	The Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 implement the EC Offshore Directive. As part of this, a verification scheme exists for safety and environment critical elements (SECEs)
6			There will be appropriate well control and blowout preventer for the Alwyn East well.
7			TEPUK will conduct drill kick exercises that will be fully documented.
8			The Alwyn East standalone OPEP will be in place for the drilling activities, including modelling and appropriate response planning.
9			Development of, and conformance to, appropriate maintenance procedures.
10			Environmentally critical equipment to the operations will be identified within the maintenance systems of the host development. These will be inspected regularly including audit trails.
11			Simultaneous operations (SIMOPs) will be actively identified and managed.
12	8.3	Environmental monitoring	A commitments register will be established for tracking all the commitments made within this ES for the drilling campaign and the production phase, as laid out in Appendix C. This will also include any further commitments that arise out of the regulatory review of this ES and the stakeholder consultation process.

APPENDIX D TYPICAL CHEMICALS USED DURING DRILLING CAMPAIGNS

Acidity Control Chemical

Products used to control the degree of acidity or alkalinity in drilling fluids. pH has a strong influence on the properties of many drilling fluid systems and additives e.g., affecting the solubility of thinners or the dispersion or flocculation of clays.

Base oil

The continuous phase in oil-based drilling fluids. Oil-based drilling fluids are water-in-oil emulsions in which water is the dispersed phase and oil is the dispersion, or continuous, phase.

Biocide

A chemical or treatment that kills bacteria. Biocides are often used in water muds vulnerable to bacterial attack such as those containing natural starches and gums. Biocides, can be used to control sulphate-reducing bacteria, slime-forming bacteria, iron-oxidizing bacteria and bacteria that attacks polymers in fracture and secondary recovery fluids. In polymers, the degradation of polymers in fluids can be controlled to avoid the formation of a large biomass, which could plug the formation.

Brine

A mixture of water and a soluble inorganic salt, commonly sodium chloride NaCl, Potassium Chloride KCl and Calcium Chloride CaCl2. Brines are commonly used in completion operations and are preferred because they have higher densities than fresh water but lack solid particles that might damage producible formations. The emulsified Calcium Chloride [CaCl2] solution (or any other saline phase) in an oil mud is referred to as "brine" or "brine phase". A brine without or very little suspended solids is a clear brine.

Cement or Cement Additive

Any Chemical or material added to a cement slurry to modify the characteristics of the slurry or set cement. Cement additives include accelerators, retarders, fluid-loss additives, dispersants, extenders, weighting agents, lost circulation additives or ones designed for specific events.

Completion Fluid

A solids-free liquid used to "complete" an oil or gas well. This fluid is placed in the well to facilitate final operations prior to initiation of production, such as setting screens production liners, packers, downhole valves or shooting perforations into the producing zone. Completion fluids are typically brines (chlorides, bromides and formates), but in theory could be any fluid of proper density and flow characteristics. The fluid should be chemically compatible with the reservoir formation and fluids, and is typically filtered to a high degree to avoid introducing solids to the near-wellbore area.

Corrosion Inhibitor

A chemical substance or combination of substances that prevents or reduces corrosion thus protecting iron and steel components in the wellbore and treating equipment from corrosive fluids.

Detergent / Cleaning Fluid

Detergent are surfactant type mud additives used to prevent shales and clays from sticking to the drilling assembly or plugging the annulus and flowlines. Some Detergent are used as mud lubricants that lessen the torque and drag of the drill string as it is rotated and moved up and down in the hole.

Dispersant

A substance that aids in breaking up solids or liquids and thus improve the separation of the particles and to prevent their settling or clumping. Dispersants are used extensively in cement slurries to improve the flow behaviour of the slurry.

Dye

Substances used in production for detecting the presence of surface cracks and surface imperfections in welds or castings. The dye Methylene Blue is used to determine the amount of clay-like materials in a water-base drilling fluid.

Emulsifier

A chemical used to creates or stabilise an emulsion, (a physical mixture of two or more immiscible liquids), by reducing the surface tension between the two liquids to achieve stability.
Two emulsion types used as muds are:

- oil-in-water (or direct) emulsion, classified as a water-base mud
- water-in-oil (or invert) emulsion, classified as an oil-base mud.

Filtrate Reducers

An additive used to reduce fluid loss to the formation from a wellbore fluid, such as Bentonite clays, lignite or carboxymethylcellulose (CMC).

Fluid Loss Control Chemical

Mud additives used to reduce the amount of filtrate that passes through the filter medium. Different materials are available for all types of water- and oil-base mud systems.

Lost Circulation Material

Substances added to drilling fluids when there is an uncontrolled flow of whole mud into a formation downhole. Materials used to control lost circulation include: Fibrous materials like (cedar bark, shredded cane stalks, mineral fibre and hair), flaky materials such as (mica flakes and pieces of plastic or cellophane sheeting) or granular materials such as (ground and sized limestone or marble, wood, walnut shells, Formica, corncobs and cotton hulls).

OPF additive

An additive used in the preparation of an Organic-phase drilling fluid, an emulsion of water and water-immiscible organic fluids of animal, vegetable or mineral origin.

Pipe Dope

A blend of lubricating grease and fine metallic particles used to prevent metal-to-metal damage (galling) and seal pin threads when making a connection in the pipe.

Pipe Release Chemical

Products used to help free a deferentially stuck pipe by attacking and break down the filter cake, thereby reducing the bond between the filter cake and the pipe. Also refer to as a spotting fluid.

Scavenger (Hydrogen Sulphide / Oxygen)

Oxygen and Hydrogen Sulphide scavengers remove these respective components from water by combining them into the scavenger chemicals. An oxygen scavenger reacts with dissolved oxygen (O2) to reduce corrosion. A sulphide scavenger removes all three soluble sulphide types, H2S, S-2 and HS-, and forms a product that is non-hazardous and noncorrosive.

Thinners

An alternate name for a deflocculant, a thinner is used to reduce viscosity or prevent flocculation. Most deflocculants are low-molecular weight anionic polymers that neutralize positive charges on clay edges. Examples include polyphosphates, lignosulfonates, quebracho and various water-soluble synthetic polymers.

Viscosifier

Any material that increases the viscosity of fluids and/or slurries.

Water Based Drilling Fluid Additives

Generic term to describe products used with Water Based Drilling Fluids, e.g. viscosifiers, fluid loss control agents, lost circulation material, lubricants etc.

Weighting chemical

Weighting chemicals / agents or heavyweight additives are high-specific gravity solid materials used to increase slurry density of a drilling fluid for control of highly pressured wells. Barite being the most common.

Well Bore Clean-up Chemical

Chemicals used to remove drilling fluid, debris and other residues that could remain in the wellbore at the end of the drilling process.